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El Houssine Bouiamrine
Laboratory of Soil Microbiology
and Environment, Department
of Biology, Moulay Ismail
University, Faculty of Sciences,
Meknes, Morocco

Lamiae Bachiri
Laboratory of Soil Microbiology
and Environment, Department
of Biology, Moulay Ismail
University, Faculty of Sciences,
Meknes, Morocco

Jamal Ibijbjen
Laboratory of Soil Microbiology
and Environment, Department
of Biology, Moulay Ismail
University, Faculty of Sciences,
Meknes, Morocco

Laila Nassiri
Laboratory of Soil Microbiology
and Environment, Department
of Biology, Moulay Ismail
University, Faculty of Sciences,
Meknes, Morocco

Correspondence

El Houssine Bouiamrine
Laboratory of Soil Microbiology
and Environment, Department
of Biology, Moulay Ismail
University, Faculty of Sciences,
Meknes, Morocco

Fresh medicinal plants in middle atlas of Morocco: Trade and threats to the sustainable harvesting

El Houssine Bouiamrine, Lamiae Bachiri, Jamal Ibijbjen and Laila Nassiri

Abstract

Traditional medicine plays an important role in the primary health care of many people living in rural areas of the developing world. In Morocco traditional medicine is very popular. It is an important form of health care for many rural people especially in Atlas mountainous regions. The present research work was carried out during 2015-2016 in Middle Atlas of Morocco to study the uses and methods of harvesting medicinal plants. The results show that 65 medicinal species were inventoried in the study area. The majority of plants identified in this survey were herbs (63, 07%), although shrubs, trees and various life forms of plant species also play an important role in traditional medicine in the Middle Atlas area. The majority of the medicinal plants traded are harvested from the wild, most of them in an unsustainable manner. Many herbaceous plants traded are uprooted to use only the aerial part. The majority of street vendors are rural women who know well traditional medicine and the identification of medicinal plants. But they know nothing about biodiversity conservation and sustainable harvesting of plants. Today many medicinal plants face extinction but detailed information is lacking. The aim of this study is to examine the practices of harvesting medicinal plants through street vendors in middle Atlas of Morocco in order to propose strategies for preserving biodiversity and for sustainable harvesting of plants.

Keywords: Medicinal plants, Middle Atlas, unsustainable harvesting, threats to plant biodiversity

1. Introduction

Medicinal plants have been widely utilized as effective remedies for curing multiple ailments since the very beginning of human civilization. Ancient humans obtained most of their medicines from green plants, as documented evidence from the major centers of civilization indicates ^[1]. Today, populations in developing countries still depend on medicinal plants for their primary care. However, this past decade has obviously witnessed a tremendous surge in acceptance and public interest in natural therapies both in developing and developed countries, with these herbal remedies being available not only in drug stores, but now also in food stores and supermarkets ^[2].

The Mediterranean Basin is one of the rich regions on medicinal plant biodiversity on Earth and includes greatest areas for endemic plants. The Mediterranean Basin is considered the third richest hotspot in the world in terms of its plant biodiversity ^[3]. Morocco is one of the important biodiversity centers in the Mediterranean basin. The country is characterized by high vascular plant diversity with an estimated 4200 species and subspecies of which 22% are endemic ^[4]. Approximately 800 of listed species are aromatic and medicinal plants ^[5].

The global trade in medicinal plants has become very profitable which is now estimated at US\$ 90 billion with an annual growth rate of 7% ^[6]. Medicinal plants occupy an important place in traditional medicine and play an important role in the Moroccan economy. Indeed, the medicinal and aromatic plant (MAP) sector plays a very important socio-economic role, with annual revenues generated from MAP export of about US\$ 55.9 million ^[7].

In Middle Atlas of Morocco, medicinal plants are sold regularly in the traditional markets and urban centers in different seasons throughout the year. This trade provides an acceptable minimum income in many households. Increased demand, coupled with unsustainable collection from the wild plants has led a number of important plant species to become scarce in areas where they were previously abundant ^[8].

In addition, numerous medicinal species are threatened by issues ranging from human activities to habitat loss. Despite the importance of Moroccan biodiversity hotspots, little is being done in terms of habitat protection, conservation assessment and rising public awareness [9].

The objectives of this work are to inventory the medicinal plants sold on the Middle Atlas markets, in order to value them for sustainable exploitation. The study also examines the threats to medicinal plant resources by the harvesters and traders of medicinal plants in the Middle Atlas region.

2. Materials and methods

2.1 Study area

Middle Atlas is a mountain range in central Morocco. It is part of the Atlas mountain range, a vast mountainous region with more than 100,000 km², 15 percent of its landmass, rising above 2,000 meters. The Middle Atlas Mountains are among the areas of plant diversity in Morocco that host high species diversity, high endemism rates and they are IUCN priority sites for conservation in the Mediterranean region [10]. Because of its elevation, snow persists in the Middle Atlas in the winter and can appear starting at 600 m above sea level.

The Study area occupies an important area in Mountain chains of the Middle Atlas (Figure 1) and containing two national parks (Ifrane National Park and Khenifra National Park) considered as Plant Biodiversity Hotspots [8, 11]. It includes villages and rural areas of the cities of Khenifra, Itzer, Timahdit, Ifrane, Azrou, Mriat and Lekbab.

Major activity of the rural people depends on agriculture and pastoralism and they have limited access to medical service. Plant-derived products are used in the production of traditional medicines and cosmetics. They are particularly important for people of the region, as they are sometimes the only source of medicine readily available [8]. The conditions of hospitalization of patients and medical care are difficult.

2.2 Data Collection

The study was conducted during 2015-2016 in villages and rural areas of Middle Atlas. Information on local uses of plants was collected from various localities by arranging interviews and discussions with rural people and plant street vendors.

During the survey, frequent field trips and plant collections from plant vendors were made from various far flung and remote regions of the study area.

The information are collected by using a pre-quiz sheet included research area (district, village), local name of the medicinal plant, the way of harvesting, the part of harvested plant, life forms of plant, parts used, method of preparation and methods of administration. The location of the different sampling sites was determined by the stratified sampling method.

One hundred twenty informants (34 males and 86 females) aged 32 to 86 were interviewed in this research.

2.3 Species identification

The plant species collected during surveys were identified by the botanical team of Environment and Soil Microbiology Unit of Moulay Ismail University's Faculty of Science and using the Flora, the catalogue and various books of botany and medicinal plants. Study data were compiled using Microsoft Office Excel 2010 program.

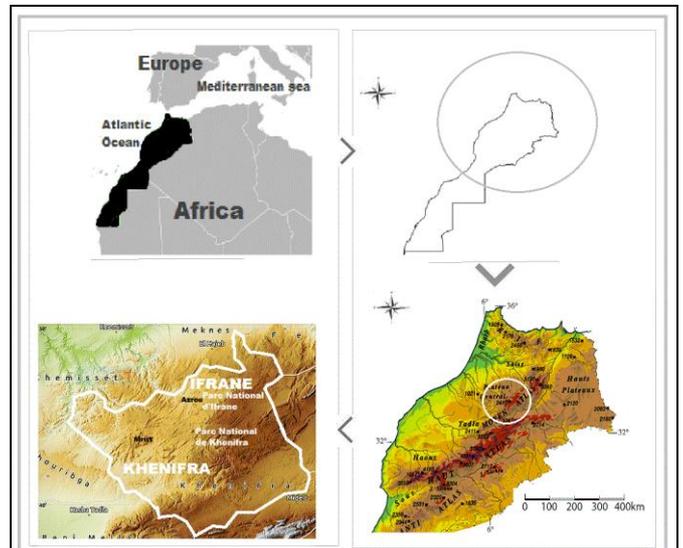


Fig 1: Location map of study area

3. Result and discussion

During the present study, a total 65 plant species belonging to 34 families were reported. In terms of the number of important plant cited, Lamiaceae is the most predominant family of ethnomedicinal importance with 13 medicinal plants. It was followed by Astéraceae with nine species, Apiaceae, and Fabaceae with 3 species each and Apocynaceae, Caryophyllaceae, Euphorbiaceae, Myrtaceae, Rhamnaceae, Rosaceae (2 species each). Other families were represented with one species each (Table 1).

Lamiaceae and Astéraceae were the most represented families of medicinal plant used by Middle Atlas population. Lamiaceae and Asteraceae families, which are well represented in the Middle Atlas area, are also among the nine main families in the spontaneous flora of Morocco [12-14] and constitute the most used groups in phytotherapy in most of other Mediterranean countries [15-17]. However, among the totality of identified species, the families least represented with a single species are the main source of the medicinal flora.

The medicinal plants traded by street vendors (Figure 2A) in middle Atlas are herbaceous plants (Figure 2B) and woody plants (Figure 2C). The most of plant species identified were herbs (63, 07%), followed by shrubs (12, 3%) and trees (9, 23%). Other plant species are climbing plants, sub-shrubs and bushes (15, 38%) (Figure 3). Herbs are mainly preferred and used for their leaves, bulb and roots. Shrubs are also primarily used for their roots, flowers and Leafy branches. Trees are mostly used for their stem bark, root bark and leafy branches with a few species are used for their fruits. The analyzed results suggest that herbs are the most used plant forms by population of Middle Atlas. This may be due to the wealth of an herbaceous biodiversity in the region. Indeed, the Middle Atlas region is considered a biodiversity hotspot [4]. This biodiversity of herbaceous plants is protected by a very important forest cover. The importance of using herbaceous plants in the middle Atlas in traditional medicine is in agreement with the previous results published concerning Morocco [18, 13, 14] and Other Mediterranean countries [19, 20].



Fig 2: Fresh Medicinal Plants in the traditional markets of the Moroccan Middle Atlas (Photos: Bouiamrine EH, in the locality of Khenifra (Morocco),

- A: Women street vendors of fresh medicinal plants,
 B: Herbaceous medicinal plants,
 C: Medicinal woody plants

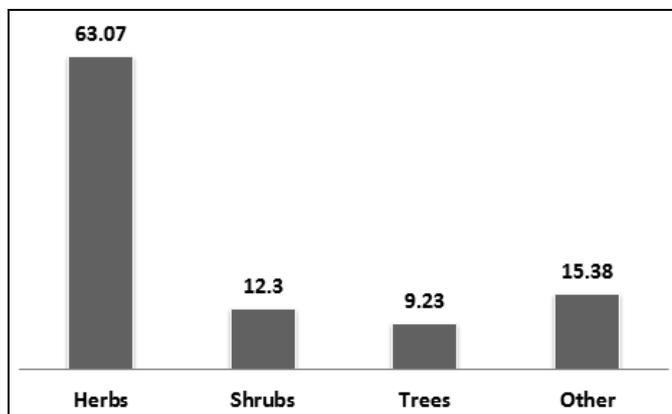


Fig 3: Distribution of medicinal plant species in life forms

According to the results of the survey, the majority of medicinal plants traded in traditional markets are wild plants (83, 07%). Species that are both wild and cultivated are in the order of 12, 3%. Cultivated plants constitute only 4, 62% of total of species (Figure 4). It should be emphasized that the cultivated plants are mainly food plants such as fruit or vegetables (walnut, pomegranate tree, prickly pear.) or condiment plants (absinthe, verbena, sage...). There aren't any plants cultivated mainly for these therapeutic properties.

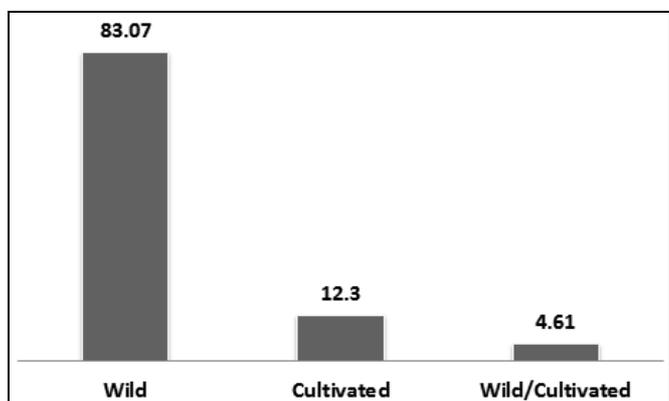


Fig 4: Percentage of wild and cultivated medicinal plant species

This indicates that the population of Middle Atlas mainly depends on the wild source rather than cultured plants. Wild

plants are also the main source of medicinal plants in other regions in Morocco [13, 21, 22] and in other countries of the world [23-25]. Furthermore over 25% of produced medicines in developed countries are derived from wild plant species [26]. Conforming to IUCN, there are between 50,000 and 80,000 angiosperm species used for medicinal purposes around the world. Among these, about 15,000 species are threatened with extinction due to over-harvesting and habitat [27]. According to our observations, harvesting of wild medicinal plants is generally not sustainable. This flora is not only used by local populations for therapeutic purposes but mostly exploited for commercial purposes by vendors coming from other regions. It seems that there aren't any actions talked to preserve the biodiversity of Atlas Mountains ecosystems.

Our results are consistent with data published by the report of the US Agency for International Development about Medicinal and Aromatic Plants (MAPs) sector in Morocco. According to this report, spontaneous plants account for about 90% of production, while only 10% of production is derived from cultivated plants [28]. The unplanned exploitation of wilderness plants for commercial purposes also reported by several authors including in developing countries [25].

The wild medicinal plants are facing tremendous pressure because of over exploitation due to its high market demand. Unsustainable exploitation of wilderness plants owing to its high commercial demand and the poverty of the population will lead to the decline of the majority of vulnerable species. Sometimes lack of awareness lack of the indigenous people about the type, use and management strategies of medicinal plant are the main threaten factor for the loss of medicinal plants [29].

A medicinal plant can usually treat one or more ailments depending on the plant part used. In the majority of cases one plant part may be used to treat more than one ailment. Also, numerous plant parts can be used to treat the same ailment, while one species can be used for treat different ailments depending on its mode of application and administration route. Table 1 presents medicinal species, parts of plants used in traditional medicine and parts of plants traded by street vendors. According to our observations many herbaceous plants are uprooted to use only the aerial part (Figure 5A). The most observed case is that of the following plants: *Ajuga iva*, *Teucrium polium* and *Origanum compactum*. To these plants are added those used for their roots which are automatically uprooted (Figure 5B) as *Aristolochia baetica*, *Anacyclus pyrethrum*, *Herniaria glabra* and *Rubia tinctorum*. In this case it is the aerial part of the plants that is thrown away. Among these plants are the presence of vulnerable species and species listed in the IUCN Red List as *Anacyclus pyrethrum* (Rankou *et al.*, 2015b) [30]. The perennial woody plants are also uprooted like shrubs (*Chamaerops humilis*) (Figure 5C) or partially uprooted like trees. As the example is *Juglans regia* (Figure 5D) partially uprooted to obtain the bark of roots. A large number of street vendors interviewed indicated that they harvest their own medicinal plants. The majority of these street vendors are rural women. They know well the practices of traditional medicine and the identification of medicinal plant species but nothing about sustainable harvesting of plants.

Plant uprooting is more damaging than taking seeds or flowers. For instance, persistent harvesting of the root of plant may threaten the survival of the species. Also, uprooting of deep-rooted species in a fragile ecosystem would result in soil impoverishment by erosion and deprive the plants from their required nutrients [31]. Indeed, according to WHO [32], a great

number of wild-harvested plant species are currently facing extinction or genetic loss through fragmentation of ecosystems by human activities, such as commercial harvesting. In addition to these threats of over-exploitation of plants other threats to plant biodiversity have been reported as climate change and drought, agriculture intensification,

tourism and recreational activities, unsuitable plant exploitation, urbanization and deforestation [9, 33]. Overexploitation of wild medicinal plants, indiscriminate harvesting, and habitat destruction all affect species rarity and sometimes even with extinction.



Fig 5: Whole plant, roots and root bark in the traditional markets of the Moroccan Middle (Photos: Bouiamrine EH, in the different localities of the Middle Atlas (Morocco)).

- A: *Ajuba iva* (Whole plant),
 B: *Rubia tinctorum* (Roots),
 C: *Chamaerops humilis* (Whole plant),
 D: *Juglans regia* (Root and root bark)

4. Conclusion

The rural sector of Middle Atlas of Morocco population is particularly dependent on indigenous plant resources for food and healing. These rural areas are characterized by poverty, illiteracy and high unemployment.

The medicinal plant provides an important source of income for rural population of Middle Atlas, especially through the sale of fresh wild-harvested plant.

Some plants are still abandoned in the region, but they have

overexploited mainly by traders and street vendors.

The natural resources are without protection and these may, in the near future, become endangered or extinct. It is therefore urgent to establish programs of conservation and sensitization of rural populations on the protection of biodiversity. And make a strategy to improve the living standards of the populations in order to reduce the pressure on the natural resources.

Table 1: Recorded detail of plant fresh used and plant fresh solded

Family	Plant name (Scientific name / vernacular name)	Plant part used	Plant part solded
Anacardiaceae	<i>Pistacia lentiscus</i> / Drou, Tikcht	Leafy branches, fruit	Leafy branches
Apiaceae	<i>Ferula communis</i> / Boubal	Flower, bulb	Flower, bulb
	<i>Magydaris panacifolia</i> / Frifra	Inflorescences, fruits	Aerial part, inflorescences, fruits
	<i>Foeniculum vulgare</i> / Amssa	Bulb, seeds	Aerial part, bulb, whole plant
Apocynaceae	<i>Caralluma europaea</i> / Daghmouss	Aerial part	Aerial part
	<i>Nerium oleander</i> / Defla, Allili	Leaves, flower	Leafy branches.
Arecaceae	<i>Chamaerops humilis</i> / D'doum, Jmakh	Whitish apical bud of young plants, flower	whole plant, flower
Aristolochiaceae	<i>Aristolochia baetica</i> / Bereztem, Ajrarhi	Roots	Roots
Asteraceae	<i>Anacyclus pyrethrum</i> / Tiguentest	Roots	Whole plant, roots.
	<i>Artemisia herba-alba</i> / Chih, Izri	Aerial part	Aerial part, whole plant
	<i>Artemisia absinthium</i> / Chiba	Leaves	Leafy branches.
	<i>Atractylis gummifera</i> / Addad	Roots	Roots
	<i>Cladanthus arabicus</i> / Ettafs	Aerial part (Leaves and flowers)	Aerial part

	<i>Dittrichia viscosa</i> / Terrahla, Magraman	Leaves	Aerial part
	<i>Lactuca serriola</i> / Rabiât Semm, Ahchlaf n'ssem.	Leaves	Aerial part
	<i>Matricaria chamomilla</i> / Babounje	Aerial part (Leaves and flowers)	Aerial part
	<i>Anthemis nobilis</i> / Babounj roumi	Aerial part (Leaves and flowers)	Aerial part
Berberidaceae	<i>Berberis hispanica</i> / Irghis	Roots, leaves and flowers	Stem branches
Brassicaceae	<i>Anastacia hierochuntico</i> / Chjrat Mriam	whole plant	Whole plant
Cactaceae	<i>Opuntia ficus-indica</i> / Hendiya	Flowers and stems	Flowers and stems
Caryophyllaceae	<i>Herniaria glabra</i> / Herras Lehjar	Aerial part	Whole plant
	<i>Corrigiola telephiifolia</i> / Tawsrghint	Roots	Whole plant, roots
Chenopodiaceae	<i>Chenopodium ambrosioides</i> // Mkhinza	Leaves	Aerial part
Cistaceae	<i>Cistus ladaniferus</i> / Touzalt, Toujalt	Leafy branches, leaves	Leafy branches
Cucurbitaceae	<i>Citrullus colocynthis</i> / Taferzizte	Fruitt, seeds	Fruit
Cupressaceae	<i>Tetraclinis articulata</i> / Araâr	Leaves	Leafy branches
Ericaceae	<i>Arbutus unedo</i> / Assasnou, sasnou, Bakhmou	Leaves, stem bark	Leafy branches, stem bark
Euphorbiaceae	<i>Mercurialis annua</i> / Hurriga Melssa	Aerial part	Whole plant
	<i>Ricinus communis</i> / Kharwiâ	Leaves, seeds	Leafy branches, seeds
Fabaceae	<i>Ceratonia siliqua</i> / Tikidit	Fruit	Fruit
	<i>Cassia senna</i> / Sana	Leaves	Leafy branches
	<i>Retama sphaerocarpa</i> / Rrtem	Stem branches	Stem branches
Fagaceae	<i>Quercus ilex</i> / <i>Q. rotundifolia</i> / Thassaft, Akrouch	Stem bark	Stem bark
Juglandaceae	<i>Juglans regia</i> / Msswak, Gargaa	Root bark	Root bark
Gentianaceae	<i>Centaurium pulchellum</i> / Ksset Lhaya	Aerial part (Leaves and flowers)	Aerial part, whole plant
Lamiaceae	<i>Ajuga iva</i> / Chendgoura, Touf Telba	Aerial part	Whole plant
	<i>Lavandula stoechas</i> / Halhal	Aerial part (Leaves and flowers)	Aerial part
	<i>Marrubium vulgare</i> // Merrîwut, Ifzi	Aerial part, leaves	Aerial part, whole plant
	<i>Melissa officinalis</i> / officinale / Hbika	Aerial part, leaves	Aerial part, whole plant
	<i>Mentha pulegium</i> L/ Fliyyo, Tazoukenn	Aerial part, leaves	Aerial part
	<i>Mentha suaveolens</i> / Timijja, Timersad	Aerial part, leaves	Aerial part, whole plant
	<i>Origanum compactum</i> / Zaatâr	Aerial part, leaves	Aerial part, whole plant
	<i>Origanum majorana</i> / Mardadouch	Aerial part, leaves	Leafy branches
	<i>Rosmarinus officinalis</i> / Azir	Leafy branches, leaves	Leafy branches
	<i>Salvia officinalis</i> / Salmiya	Leafy Branches, leaves	Leafy branches
	<i>Salvia verbenaca</i> / khiyyata	Aerial part, leaves	Aerial part
	<i>Teucrium polium</i> / Jaada, Tayrart	Aerial part	Aerial part, whole plant
	<i>Thymus zygis</i> / zaitra Azoukenni, Adouchen	Aerial part	Aerial part, whole plant
Lauraceae	<i>Laurus nobilis</i> / warkat sidna moussa	Leaves	Leaves, Leafy branches
Lythraceae	<i>Punica granatum</i> / Errummane	Rind of fruit, flower	Rind of fruit, flower
Myrtaceae	<i>Eucalyptus globulus</i> / kalitus	leaves	Leafy branches
	<i>Myrtus communis</i> / Rihân	Leafy Branches, leaves	Leafy branches
Poaceae	<i>Zea mays</i> / D'dra, Akhlad	Flower stigma	Flower stigma
Portulacaceae	<i>Portulaca oleracea</i> / Rejla, Tasmamine.	Aerial part	Aerial part
Rhamnaceae	<i>Rhamnus alaternus</i> / Amrirs	Leafy branches, leaves	Leafy branches
	<i>Zizyphus lotus</i> / N'beg, Azar	Fruit, leaves	Fruit, leaves
Rosaceae	<i>Crataegus monogyna</i> / Za'arour / Admâm	Fruit, leaves	Stem branches
	<i>Rosa damascen</i> / Lward	Flower	Flower
Rubiaceae	<i>Rubia tinctorum</i> / Fuwa, Tarûbya	Roots	Roots
Rutaceae	<i>Ruta montana</i> / Fijel, Awermi	Aerial part, roots	Aerial part, roots
Thymelaeaceae	<i>Daphne gnidium</i> / Lezzâz	Leaves	Aerial part
Urticaceae	<i>Urtica membranacea</i> / hariga	Aerial part, leaves, roots	Aerial part, whole plant
Verbenaceae	<i>Aloysia citrodora</i> / Lwwiza	Leaves	Leafy branches.
Xanthorrhoeaceae	<i>Aloe succotrina</i> / Sebar, Sabra	Leaves	Young whole plant, leaves

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