

# Use of Ethnomedicinal Plants by the People Living in the Middle Atlas Mountains in Morocco

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## ABSTRACT

Morocco has a high level of biodiversity and endemism of medicinal plants. However, these plants are threatened by the growing human population and climate change. The loss of medicinal plants will have a potential negative impact on the population who rely heavily on these plants for the treatments of diseases. The objective of the present study was to document ethnomedicinal knowledge use to treat different human ailments from people living in the Middle Atlas Mountains of Morocco. Field work was conducted between March and May of 2017. Data was collected from 320 users through a questionnaire survey. Results of the study indicate that people of the Middle Atlas use 44 plant species mostly herbs (66%) for ethnomedicinal purposes. The highest the Informant Consensus Factor value (0.93) was obtained for gastrointestinal problems followed by respiratory infections (0.92), and neurological problems (0.82), and based on the species Use Value, the five most commonly used ethnomedicinal plants species were *Thymus vulgaris*, *Mentha pulegium*, *Aloysia citriodora*, *Rosmarinus officinalis*, *Lavandula dentata* and *M. rotundifolia*. The present study showed that traditional treatment using medicinal plants in widespread in the study area. Protection measures should be taken to conserve precious multipurpose species that are facing overexploitation. Moreover, medicinal plants treating major ailments in the region may be subjected to phytochemical and pharmacological investigations for the identification of bioactive compounds.

**Keywords:** Medicinal and aromatic plants; Middle atlas mountains; Ethno-medicine

## INTRODUCTION

Traditional medicine, as defined by the World Health Organization (WHO), is the knowledge, skills and practices based on the theories, beliefs and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health, as well as in the prevention, diagnosis, improvement or treatment of physical and mental illnesses [1]. Traditional medical knowledge is seeing increased attention worldwide considering global health care demand and the significant role of traditional medicine in meeting the public health needs of developing countries. Approximately 80% of the population in developing countries depends on traditional medicine for primary health care needs [2-6]. In addition, the pharmaceutical and biotechnological industries are much interested in using this knowledge for the discovery and development and application for new active products on health and new genes with properties for food improvement.

The flora of Morocco is the second most biological diverse country

in the Mediterranean region after Turkey, in terms of species, and the richest in North Africa [7], with about 4200 taxa including 1282 subspecies of which 22% (879 taxa) are endemic [8]. The number of medicinal and aromatic plants (MAP) in Morocco is estimated at about 800 species. The MAP sector plays a very important socio-economic role, with annual revenues generated from MAP export of about 500 million Moroccan Dirhams (about US \$56 million) and provides employment to local and rural communities generating an estimated 500.000 work-day per year. However, this diversity is threatened by numerous factors including destruction of natural habitats, cleaning of vegetation for agricultural expansion, and climate change. These factors lead to a serious decline in the number of medicinal plant species available, which in turn lead to a decline in annual revenues generated from the MAP industry and more importantly a loss of traditional medical knowledge associated with these plants.

Studies on indigenous knowledge about the utilization of medicinal

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plants in different parts of Morocco have been documented previously, including the Rif and the High Atlas Mountains [9-21]. There is only one published report on the use of MAP in the Middle Atlas Mountain areas, and it covered only the city Khenifra [22]. The present study aimed at investigating the traditional utilization of MAP by the people living in different areas in the Middle Atlas Mountains of Morocco. The study area is part of the country's richest biodiversity center, presents a particularly high rate of endemism and is a rich source of ethnobotanical knowledge. Specific objectives of the study were: (i) to identify plant species used in the treatment of various diseases, and (ii) to document traditional recipes from medicinal plants including modes of preparation, dosage, mode of administration and potential side effects associated with medicinal plant uses. This study identified the most widely used plants, which can be used as starting plant materials for the identification and development of new and useful medicinal substances.

## MATERIALS AND METHODS

### Study area

In the heart of northern Morocco, between the Rif and the High Atlas, the Middle Atlas is a major component of the Moroccan terrain. It runs about 450 km from the Southwest to the Northeast and covers a total area of 27,550 km<sup>2</sup>, which is 15% of the country's total mountain area. The Middle Atlas is 100 km wide in the North and only 30 km wide in the South.

This study was carried out between the months of March and May of 2017. Eight towns and villages were investigated (Figure 1), they were: Azrou, Boulmane, El Hajeb, Ifrane, Khenifra, Midelt, Mrirt, and Zaouiat-Cheikh, and 320 people participated in this study.

### Data collection

A questionnaire was used to collect information from individuals about the MAP they use in the treatment of diseases. The questions focused on local names of the medicinal plants, types of diseases

treated, mode and method of remedy preparation, parts of the plants used, use of fresh or dry plants, use of single or a mixture of plants for remedy preparation, mode of administration, dose requirement, and usable duration regarding each medicine, and any side effect of medicinal plant use. Questionnaires also contained information on the sociocultural aspect of the respondents.

### Data organization

Data were organized using Microsoft Excel software. The habits of the plants were categorized into three groups, that is, herbaceous, shrubs, and trees. The status of recorded plants was divided into three groups of wild, cultivated, and both wild and cultivated. The parts used by the healers were categorized into 6 groups, that is, fruits, leaves, leaves and stems, seeds, roots, or the whole plant. Human ailments treated by the traditional healers were divided into 7 categories such as gastrointestinal, respiratory, cardiovascular, dermatology, metabolic, neurology, and osteology. Route of administration of plant remedies was classified into three groups such as oral, dermal, and both oral and dermal. Questionnaire data were analyzed for basic categorization of the respondents' gender, age groups, education level, and occupation.

### Data analysis

**The Informant Consensus Factor (ICF):** The informant consensus factor (ICF) was calculated to estimate the user variability of medicinal plants [23,24]. The ICF ranges from 0.00 to 1.00 and it has been used in prioritizing medicinal plants for further scientific validation of plants and plant products [25,26], as pharmacologically effective remedies are expected from plant with higher ICF values [27]. High ICF values are obtained when only one or a few plant species are reported to be used by a high proportion of informants to treat an ailment, whereas low ICF values indicate that informants disagree over which plant to use [23]. High ICF values can thus be used to identify particularly interesting species for the search of bioactive compounds [24]. ICF is calculated using the following formula:

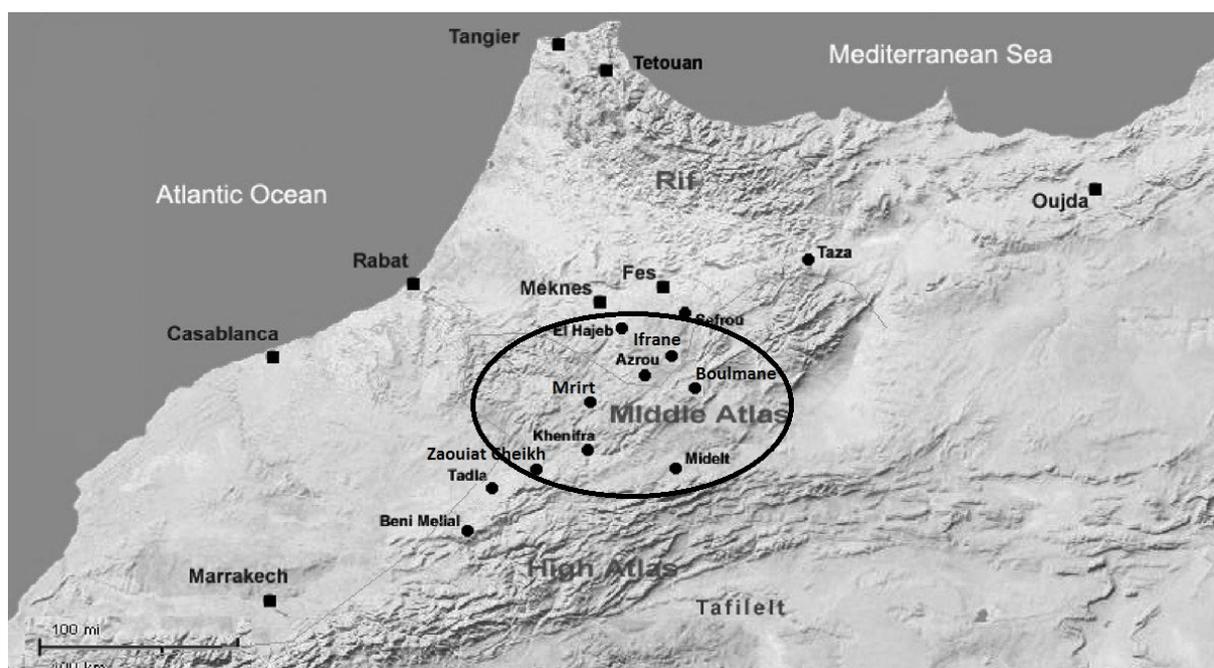


Figure 1: Map of the study area showing towns where the study was conducted (Courtesy of Prof. J. Wyrzten, Yale University).

$$ICF = \text{Nur} - N_t / (\text{Nur} - 1)$$

Where “Nur” refers to the total number of use reports for each disease cluster and “Nt” refers to the total number of species used for that cluster.

**The Use Value (UV):** The Use Value (UV) was calculated according to Phillips et al. [28] using the following formula:

$$UV = \sum / N$$

Where “ $\sum$ ” refers to the number of uses mentioned by the informants for a given species and “N” refers to the total number of informants interviewed. If a plant secures a high UV score, that indicates that there are many use reports for that plant, while a low score indicates fewer use reports cited by the respondents.

## RESULTS AND DISCUSSION

Among the 320 respondents, 184 (57.5%) were male and 136 (42.5%) were female. The largest proportion of the respondents (25%) was quadragenarian (40-49 years old) (Table 1). Most of the respondents were illiterate (34%) followed by those who received primary education (25.6%). Most of the respondents are jobless (46%), followed by students (12.8%) and salesperson (11.8%) (Table 1). There was no correlation between the age of the respondent and the number of medicinal plants known.

The present study provides information on ethnobotanical uses of 44 plants species belonging to 24 families and 14 genera. Out of the dominant family with the highest number of medicinal plants was Lamiaceae (14 species) followed by Apiaceae (5 species), and Asteraceae (4 species). This is consistent with the previous study of

**Table 1:** Gender, age group, literacy level, and occupation of the interviewed people in the region.

Variables	Parameters	Total	Percentage (%)
Gender	Male	184	57.5
	Female	136	42.5
Age groups	< 20	11	3.4
	20 - 29	59	18.4
	30 - 39	56	17.5
	40 - 49	80	25
	50 - 59	56	17.5
	60 - 69	42	13.1
Educational level	> 69	16	5
	Illiterate	109	
	Primary	82	
	Secondary	65	
	University	64	
Occupation	Jobless	148	
	Students	41	
	Salesperson	38	
	Farmers	27	
	Govt. job	20	
	Technicians	15	
	Retired	11	
	Drivers	9	
Teachers	6		
Herbologists	5		

Bouiamrine et al. [29] who reported that Lamiaceae, Apiaceae, and Asteraceae are widely used as MAP in the Middle Atlas Mountains, although their use in treatment of specific major ailments was not indicated. The use of members of the above families in herbal medicine is known the city of Khenifra [22], and in other parts of Morocco [10-15,17-18,20], indicating their importance in medicinal applications. In fact, several plants species belonging to Lamiaceae, Apiaceae, and Asteraceae are known for their antimicrobial, antibacterial, anti-inflammatory, and antioxidant activities [30,31].

Moreover, the residents mostly use herbs (66%) for their remedies (Table 2), which are widely distributed in the Middle Atlas Mountains and can easily be harvested [29]. Of the 44 species, 66% were wild while 27% were cultivated. This study thus highlights the dependence of traditional healers on the Middle Atlas Mountains in obtaining their ethnomedicines from the natural environment.

Different parts of medicinal plants are used by the respondents in the treatment of illnesses. Leaves and stems (43%) or leaves only (27%) are the most frequently used plant parts for the treatment of diseases, due to their richness in bioactive compounds compared to other plant parts. Seven disease categories were identified in this investigation. Most respondents have indicated that they take herbal medicines orally using decoction or infusion.

The highest ICF values were obtained for gastrointestinal (ICF=0.93) and respiratory diseases (ICF=0.92), followed by cardiovascular (ICF=0.9), neurological (ICF=0.82) and metabolic problems (ICF=0.8) (Table 2). Boiled water is commonly believed to serve as a vehicle to transport the remedies. Boiling both helps extract the active components from plants, but also helps eliminate impurities. In general, decoction and infusion are the most common methods used to prepare the plant material, which is used fresh or dried (Table 3).

### Medicinal plants for gastrointestinal diseases

The most reported plant species uses for gastrointestinal diseases include *Thymus vulgaris* (126 times), *Rosmarinus officinalis* (44 times), *Aloysia citriodora* (40 times), *Mentha rotundifolia* (30 times), *Lavandula dentata* (20 times), *Artemisia absinthium* (18 times), *T. zygis* (18 times) and *Salvia officinalis* (16 times). These results support the previous finding of El Midaoui et al. [22] who reported the use of these plants in the treatment of gastrointestinal diseases in the city of Khenifra, which is situated in the Middle Atlas Mountains. These plant species are also used to treat gastrointestinal diseases in other parts of Morocco including the city of Kenitra [12], Settatt [13], the North East [14], the High Atlas [15], Agadir [17], and the Moroccan central plateau [32].

### Medicinal plants for respiratory diseases

People living in the Middle Atlas use four main plants species to treat respiratory diseases; *M. pulegium* (100 times), *T. vulgaris* (31 times), *R. officinalis* (22 times) and *L. dentata* (16 times). El-Midaoui et al. [22] reported the use of *M. pulegium* and *T. vulgaris* by people living in the city of Khenifra to treat indigestion and respiratory infections, respectively. These plant species are used to treat respiratory diseases by people living in other parts of Morocco [12-15,17,20].

Table 2: Informant Consensus Factor (ICF) for different ailment categories.

Use categories	Plant species (number of use reports)	Number of taxa (N)	Number of use reports (Nur)	ICF
Gastrointestinal	<i>Thymus vulgaris</i> (126), <i>Rosmarinus officinalis</i> (44), <i>Aloysia citriodora</i> (40), <i>Mentha rotundifolia</i> (30), <i>Lavandula dentata</i> (20), <i>Artemisia absinthium</i> (18), <i>Thymus zygis</i> (18), <i>Salvia officinalis</i> (16), <i>Mentha pulegium</i> (14), <i>Tetraclinis articulata</i> (14), <i>Thymus broussonetii</i> (14), <i>Ammodaucus leucotrichus</i> (11), <i>Chenopodium ambrosioides</i> (11), <i>Calamintha officinalis</i> (9), <i>Foeniculum vulgare</i> (9), <i>Trigonella foenum graecum</i> (9), <i>Origanum majorana</i> (6), <i>Cuminum cyminum</i> (4), <i>Artemisia herba-alba</i> (3), <i>Ceratonina siliqua</i> (3), <i>Coriandrum sativum</i> (3), <i>Cynara cardunculus</i> (3), <i>Marrubium vulgare</i> (3), <i>Allium sativum</i> (2), <i>Eugenia caryophyllata</i> (2), <i>Laurus nobilis</i> (2), <i>Lavandula stoechas</i> (2), <i>Peganum harmala</i> (2), <i>Punica granatum</i> (2), <i>Ruta montana</i> (2).	30	442	0.93
Respiratory	<i>Mentha pulegium</i> (100), <i>Thymus vulgaris</i> (31), <i>Rosmarinus officinalis</i> (22), <i>Lavandula dentata</i> (16), <i>Mentha rotundifolia</i> (8), <i>Aloysia citriodora</i> (6), <i>Allium sativum</i> (5), <i>Tetraclinis articulata</i> (5), <i>Artemisia herba-alba</i> (4), <i>Marrubium vulgare</i> (4), <i>Thymus broussonetii</i> (3), <i>Zingiber officinale</i> (3), <i>Alpinia officinarum</i> (2), <i>Artemisia absinthium</i> (2), <i>Calamintha officinalis</i> (2), <i>Myrtus communis</i> (2), <i>Salvia officinalis</i> (2).	17	217	0.92
Cardiovascular	<i>Aloysia citriodora</i> (10), <i>Salvia officinalis</i> (2).	2	12	0.9
Dermatology	<i>Lavandula dentata</i> (6), <i>Allium sativum</i> (5), <i>Olea europea</i> (4), <i>Daphne gnidium</i> (3), <i>Lawsonia inermis</i> (3), <i>Matricaria camomilla</i> (3), <i>Nigella sativa</i> (3), <i>Rosa damascena</i> (3), <i>Argania spinosa</i> (2), <i>Mentha viridis</i> (2), <i>Myrtus communis</i> (2), <i>Tetraclinis articulata</i> (2), <i>Trigonella foenum graecum</i> (2)	13	34	0.63
Metabolic	<i>Trigonella foenum graecum</i> (10), <i>Coriandrum sativum</i> (4), <i>Petroselinum sativum</i> (4), <i>Laurus nobilis</i> (2), <i>Linum usitatissimum</i> (2).	5	22	0.8
Neurology	<i>Aloysia citriodora</i> (21), <i>Chenopodium ambrosioides</i> (4), <i>Origanum majorana</i> (4), <i>Salvia officinalis</i> (3), <i>Lavandula dentata</i> (2), <i>Ocimum basilicum</i> (2), <i>Rosmarinus officinalis</i> (2), <i>Tetraclinis articulata</i> (2).	8	40	0.82
Osteology	<i>Thymus broussonetii</i> (2), <i>Zingiber officinale</i> (2).	2	4	0.66

Table 3: Ethnomedicines of the study area.

Botanical Name	Local Name	Family	Habit	Status	Part Used	Recipes and dosage
<i>Allium sativum</i>	Touma	Alliaceae	Herb	Cultivated	Bulbs	- Decoction or infusion of dried bulbs to prepare herbal tea/2-3 times per day for one week/no reported side effect. - Cataplasm for skin diseases.
<i>Chenopodium ambrosioides</i>	M'khinza	Amaranthaceae	Herb	Wild	Leaves	Decoction or infusion of dried or fresh leaves to prepare herbal tea/2-3 times per day for one week/no reported side effect.
<i>Coriandrum sativum</i>	Kazbour	Apiaceae	Herb	Cultivated	Leaves and Stem	Infusion of fresh leaves/stem to prepare herbal tea/2-3 times per day for one week/no reported side effect.
<i>Cuminum cyminum</i>	Kamoun	Apiaceae	Herb	Cultivated	Seeds	A spoonful of grounded seeds/3 times per day/no reported side effect.
<i>Foeniculum vulgare</i>	Besbass	Apiaceae	Herb	Wild	Seeds	A spoonful of grounded seeds/3 times per day/no reported side effect.
<i>Petroselinum sativum</i>	Meadnouss	Apiaceae	Herb	Cultivated	Leaves and Stem	Infusion of fresh leaves/stem/2-3 times per day for one week/no reported side effect.
<i>Ammodaucus leucotrichus</i>	Kamoun Soufi	Apiaceae	Herb	Wild	Leaves and Stem	Decoction of dried leaves/stem/3 times per day for one week/no reported side effect.
<i>Artemisia herba-alba</i>	Chih	Asteraceae	Herb	Wild	Leaves and Stem	Infusion or decoction of fresh leaves/stem to prepare herbal tea/2-3 times per day for one week/no reported side effect.
<i>Artemisia absinthium</i>	Chiba	Asteraceae	Shrub	Wild and Cultivated	Leaves and Stem	Infusion or decoction of fresh or dried leaves/stem to prepare herbal tea/1-3 times per day for one week/no reported side effect.
<i>Cynara cardunculus</i>	Kharchouf	Asteraceae	Herb	Cultivated	Leaves and Stem	Infusion of dried leaves/stem to prepare herbal tea/2-3 times per day for one week/no reported side effect.
<i>Matricaria camomilla</i>	Babounj	Asteraceae	Herb	Wild	Flowers	- Infusion or decoction of fresh flowers to prepare herbal tea/2-3 times per day for one week/no reported side effect. - Cataplasm for skin diseases.

<i>Cerantonia siliqua</i>	Kharoub	Cesalpiniaceae	Tree	Wild and Cultivated	Fruits	Fruits/3 times per day/no reported side effect.
<i>Tetraclinis articulata</i>	Aerar	Cupressaceae	Tree	Wild	Leaves	- Infusion of dried leaves to prepare herbal tea/2-3 times per day for one week/no reported side effect. - Cataplasm for skin diseases.
<i>Trigonella foenum graecum</i>	Halba	Fabaceae	Herb	Wild	Seeds	- Infusion of a spoonful of grounded seeds/2-3 times per day/no reported side effect – can be taken raw. - Cataplasm for skin diseases.
<i>Calamintha officinalis</i>	Manta	Lamiaceae	Herb	Wild	Leaves	Infusion of fresh or dried leaves to prepare herbal tea/2-3 times per day for one week/no reported side effect.
<i>Lavandula dentata</i>	Khzama	Lamiaceae	Herb	Wild	Leaves and Stem	- Infusion or decoction of fresh or dried leaves/stem to prepare herbal tea/2-3 times per day for one week/no reported side effect. - Cataplasm for skin diseases.
<i>Lavandula stoechas</i>	Halhal	Lamiaceae	Herb	Wild	Leaves and Stem	Infusion or decoction of fresh or dried leaves/stem to prepare herbal tea/2-3 times per day for one week/no reported side effect.
<i>Marrubium vulgare</i>	Mriouta	Lamiaceae	Herb	Wild	Leaves and Stem	Infusion of fresh leaves/stem to prepare herbal tea/2-3 times per day for one week/no reported side effect.
<i>Mentha pulegium</i>	Fliou	Lamiaceae	Herb	Wild	Leaves and Stem	Infusion or decoction of fresh or dried leaves/stem to prepare herbal tea/2-3 times per day for one week/no reported side effect.
<i>Mentha rotundifolia</i>	Marssita	Lamiaceae	Herb	Wild	Leaves and Stem	Infusion or decoction of fresh or dried leaves/stem to prepare herbal tea/2-3 times per day for one week/no reported side effect.
<i>Mentha viridis</i>	Naenane	Lamiaceae	Herb	Cultivated	Leaves and Stem	- Decoction of fresh leaves/stem to prepare herbal tea/2-3 times per day for one week/no reported side effect. - Cataplasm for skin problems.
<i>Ocimum basilicum</i>	Lahbaq	Lamiaceae	Herb	Cultivated	Leaves and Stem	Decoction of fresh leaves/stem to prepare herbal tea/1-2 times per day for one week/no reported side effect.
<i>Origanum majorana</i>	Merdedouch	Lamiaceae	Herb	Wild	Leaves	Decoction of fresh or dried leaves herbal tea/2-3 times per day for one week/no reported side effect.
<i>Rosmarinus officinalis</i>	Azir	Lamiaceae	Herb	Wild	Leaves and Stem	Infusion or decoction of fresh or dried leaves/stem to prepare herbal tea/2-3 times per day for one week/no reported side effect.
<i>Salvia officinalis</i>	Salmiya	Lamiaceae	Herb	Wild	Leaves	Infusion or decoction of fresh or dried leaves to prepare herbal tea/1-3 times per day for one week/no reported side effect.
<i>Thymus broussonetii</i>	Azoukeni	Lamiaceae	Herb	Wild	Leaves and Stem	Infusion or decoction of fresh or dried leaves/stem to prepare herbal tea/1-3 times per day for one week/no reported side effect.
<i>Thymus vulgaris</i>	Zaeter	Lamiaceae	Shrub	Wild	Leaves and Stem	Infusion or decoction of dried leaves/stem to prepare herbal tea/2-3 times per day for one week/no reported side effect.
<i>Thymus zygis</i>	Zeitra	Lamiaceae	Shrub	Wild	Leaves	Infusion or decoction of dried leaves to prepare herbal tea/3 times per day for one week/no reported side effect.
<i>Laurus nobilis</i>	Warqat Mousa	Lauraceae	Tree	Wild	Leaves	Infusion of fresh or dried leaves to prepare herbal tea/2-3 times per day for one week/no reported side effect.
<i>Linum usitatissimum</i>	Zariet El Kattan	Linaceae	Herb	Wild	Seeds	Infusing of a spoonful of grounded seeds/1 time per day/no reported side effect – can be taken raw.
<i>Punica granatum</i>	Romman	Lythraceae	Tree	Cultivated	Peel	Infusing of dried peel/1-2 times per day/no reported side effect.
<i>Lawsonia inermis</i>	Hanna	Lythraceae	Shrub	Cultivated	Leaves	Cataplasm of grounded dried leaves/once a day/no reported side effect.
<i>Eugenia caryophyllata</i>	Qranfel	Myrtaceae	Tree	Wild	Flower buds	Infusion dried flower buds to prepare herbal tea/2-3 times per day for one week/no reported side effect.
<i>Myrtus communis</i>	Rihan	Myrtaceae	Shrub	Wild	Leaves	Cataplasm of dried leaves/2 times per day for one week/no reported side effect.

<i>Olea europea</i>	Zitoun	Oleaceae	Tree	Wild and Cultivated	Leaves and Fruits	- Fruits or Infusion of fresh leaves to prepare herbal tea/3 times per day for one week/no reported side effect. - Cataplasm for skin diseases.
<i>Nigella sativa</i>	Habba Souda/	Ranunculaceae	Herb	Wild	Seeds	- Infusing of a spoonful of grounded seeds/1-2 times per day/no reported side effect. - Cataplasm for skin diseases.
<i>Rosa damascena.</i>	Ward	Rosaceae	Shrub	Wild	Flowers	Cataplasm of fresh flowers/2 times per day for one week/no reported side effect.
<i>Ruta montana</i>	L'fijel	Rutaceae	Shrub	Cultivated	Leaves and Stem	Infusion of fresh or dried leaves/stem to prepare herbal tea/2-3 times per day for one week /no side effect.
<i>Argania spinosa</i>	Argan	Sapotaceae	Tree	Wild	Leaves and seeds	- Leaves/seeds/once a day for one week /no side effect. - Cataplasm for skin diseases.
<i>Daphne gnidium</i>	Alzaz	Thymelaeaceae	Shrub	Wild	Leaves	- Infusion of dried leaves/2 times per day for one week/no reported side effect. - Cataplasm for skin diseases.
<i>Aloysia citriodora</i>	Louiza	Verbenaceae	Herb	Wild	Leaves	Infusion of fresh or dried leaves herbal tea/3 times per day for one week/no reported side effect.
<i>Alpinia officinarum</i>	Khoudenjal	Zingiberaceae	Herb	Cultivated	Rhizomes	Decoction of fresh or dried rhizomes/2 times per day for one week/no reported side effect.
<i>Zingiber officinale</i>	Skinjbir	Zingiberaceae	Herb	Cultivated	Rhizomes	Decoction of fresh or dried rhizomes/1-3 times per day for one week/no reported side effect – can be taken raw.
<i>Peganum harmala</i>	Harmel	Zygophyllaceae	Herb	Wild	Leaves	Infusion of dried leaves/3 times per day for one week/no reported side effect.

Table 4: Species use values.

Plant species	Use values
<i>Thymus vulgaris</i>	0.49
<i>Mentha pulegium</i>	0.35
<i>Aloysia citriodora</i>	0.24
<i>Rosmarinus officinalis</i>	0.21
<i>Lavandula dentata</i>	0.13
<i>Mentha rotundifolia</i>	0.11
<i>Tetraclinis articulata, Salvia officinalis</i>	0.07
<i>Trigonella foenum graecum, Artemisia absinthium</i>	0.06
<i>Thymus broussonetii, Thymus zygis</i>	0.05
<i>Chenopodium ambrosioides</i>	0.046
<i>Allium sativum</i>	0.037
<i>Ammodaucus leucotrichus, Calamintha officinalis</i>	0.034
<i>Origanum majorana</i>	0.031
<i>Foeniculum vulgare</i>	0.028
<i>Coriandrum sativum, Artemisia herba-alba, Marrubium vulgare</i>	0.021
<i>Zingiber officinale</i>	0.015
<i>Cuminum cyminum, Petroselinum sativum, Laurus nobilis, Olea europea</i>	0.012
<i>Cynara cardunculus, Matricaria camomilla, Ceratonia siliqua, Lawsonia inermis, Nigella sativa, Rosa damascena, Daphne gnidium</i>	0.009
<i>Lavandula stoechas, Mentha viridis, Ocimum basilicum, Linum usitatissimum, Punica granatum, Eugenia caryophyllata Myrtus communis, Ruta montana, Argania spinosa, Alpinia officinarum, Peganum harmala</i>	0.006

### Medicinal plants for cardiovascular diseases

*Aloysia citriodora* (10 times) and *S. officinalis* (2 times) are the only plant species used by the people of the Middle Atlas to treat

cardiovascular diseases. It has been reported that *S. officinalis* is used by the people of the High Atlas and Izarene region to treat hypertension [12,20,33], and by the people of the Rif Mountains to treat anemia [34].

### Medicinal plants for dermatological diseases

The most reported plants for dermatology use include *L. dentata* (6 times), *Allium sativum* (5 times), and *Olea europea* (4 times). Previous ethnobotanical studies conducted in other parts of Morocco have reported the use of these plants for dermatological uses [9,15,20]. *Allium sativum* and *O. europea* are used by the people living in the Tafilalt region to treat cutaneous leishmaniasis [35] and in the province of Tan-Tan to treat renal lithiasis [36].

### Medicinal plants for metabolic diseases

The most reported plants for metabolic are *Trigonella foenum graecum* (21 times), followed by *Chenopodium ambrosioides* (4 times) and *Petroselinum sativum* (4 times). Previous studies have reported the use of *T. foenum graecum* and *C. ambrosioides* to cure metabolic diseases in the city of Khenifra [22] and in other areas of Morocco [12,18,20,32]. Specifically, *P. sativum* is used by the people of Tan-Tan province in Morocco to treat kidney stones [36].

### Medicinal plants for neurological and osteological diseases

People living in the Middle Atlas Mountains use *A. citriodora* (21 times), *C. ambrosioides* (4 times), *Origanum majorana* (4 times), *S. officinalis* (3 times) to treat neurological illnesses. It has been reported that *A. citriodora* and *O. majorana*, have been used to treat neurological problems in other areas of Morocco [12,17-18,20]. Only two plants species have been reported by the respondents to treat osteological ailments; *T. broussonetii* (2 times) and *Zingiber officinale* (2 times). The later is used by the people living in the High Atlas Mountains to treat osteological problems [15].

## Species Use Value (UV)

Based on the Use Value which ranged between 0.49 to 0.006 (Table 4), the five most commonly used ethnomedicinal plants species were *T. vulgaris* (0.49), *M. pulegium* (0.35), *A. citriodora* (0.24), *R. officinalis* (0.21), *L. dentata* (0.13) and *M. rotundifolia* (0.11).

Many medicinal activities of these plants can be attributed to their essential oils. Previous studies on the chemical composition of essential oils from these medicinal plants in Morocco have indicated that Thymol is the major constituent of essential oil from *T. vulgaris* [37]. Menthol and Piperitone are the major constituents of *M. rotundifolia*, and *M. pulegium* essential oils, respectively [38]. *Rosmarinus officinalis* essential oil is rich in 1,8-Cineole, alpha-Pinene and Camphor [39]. 1,8-Cineol is also the major constituent of *L. dentata* essential oil [40].

## CONCLUSION

The present study showed that the use of MAP for treatment purposes is prevalent in the study areas, which underlines the importance in the documentation of traditional ethnomedicinal knowledge. Based on the species Use Value, the most commonly used ethnomedicinal plants species were *T. vulgaris*, *M. pulegium*, *A. citriodora*, *R. officinalis*, *L. dentata* and *M. rotundifolia*. These plants are used by the people living in the Middle Atlas Mountains to treat various gastrointestinal, respiratory and cardiovascular diseases. Phytochemical and pharmacological studies on highly used ethnomedicinal species can potentially lead to the identification of active substances and potentially lead to the development of new drugs.

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