Trop J Nat Prod Res, March 2025; 9(3): 1192 - 1203 ISSN 2616-0684 (Print)
ISSN 2616-0692 (Electronic)

Tropical Journal of Natural Product Research

Available online at https://www.tjnpr.org

Original Research Article

Status of the use of naturalized medicinal plants from the Tata region (southeast of Morocco) in traditional medicine

Abdelkrim Agour [1]*, Tarik Chelouati[1], Mostafa Messkini[1], Otmane Zouirech[1], Abdelfattah El Moussaoui[2], Ibrahim Mssillou[1], Amina Bari[3], Elhoussine Derwich [1]

[1]*Laboratory of Biotechnology, Conservation and Valorization of Bioressources, Faculty of Sciences Dhar El Mahraz, University Sidi Mohamed Ben Abdellah, Fez 30050, Morocco*
[2]*Plant Biotechnology Team, Faculty of Sciences, Abdelmalek Essaadi University, Tetouan 93002, Morocco*
[3] *Laboratory of Biotechnology, Environment, Agrifood, and Health, Faculty of Sciences Dhar el Mahraz, University of Sidi Mohamed Ben Abdellah, Fez 30050, Morocco.*

ARTICLE INFO

Article history:
Received 30 December 2024
Revised 09 January 2025
Accepted 06 February 2025
Published online 01 April 2025

ABSTRACT

Traditional uses of medicinal and aromatic plants in Morocco hold a significant place among different populations. However, the practice of this heritage may decline due to various factors. In order to assess the current state of traditional uses of native medicinal and aromatic plants in the Tata region, an ethnobotanical survey was conducted in four municipalities of this region. 221 interviews were carried out using semi-structured questionnaires, and plant samples were collected and georeferenced. The data obtained were analyzed using Microsoft Office Excel, calculating citation frequency (CF) and the Family use-value (FUV). The interviewed inhabitants revealed that 61.09% of native medicinal plants are readily available. 20 families comprising 32 species are utilized by the surveyed population, with Apiaceae (FUV=0.0192) being the most dominant, followed by Asteraceae (FUV=0.0166) and Zygophyllaceae (FUV=0.0127). *Ammodaucus leucotrichus* Coss was the most commonly mentioned plant by the surveyors, with a citation frequency of 47.05%, followed by *Acacia raddiana* (Savi) (CF=33.93%) and *Zygophyllum gaetulum* Emb. (CF=25.33%). 27 of the identified species in the study area were not mentioned by the surveyed individuals, accounting for nearly half of the medicinal plants identified in the region. The current state of medicinal plants in the four municipalities requires prompt intervention to protect this heritage and preserve its biodiversity wealth. This can be achieved by implementing ex-situ cultivation to multiply and conserve vulnerable plant resources, as well as raising awareness among the region's inhabitants about the scarcity of many species and promoting the use of plants in traditional medicine.

Keywords: *Flora, Ethnobotany, native plants, Tata Province, Southeast Morocco*
.

Introduction

Traditionally, plants have played a significant role in providing primary healthcare due to their invaluable sources of pharmaceutical products[1] and their use has been the focus of ethnobotanical studies around the world [2,3,4,5,6,7,8]. Wild or naturalized plants provide healing power to hundreds of millions of people worldwide [9]. The use of plants for medicinal purposes is increasingly accepted globally compared to conventional medicine [10] and are the subject of ongoing scientific research [11,12,13]. Despite the importance of medicinal plants, many plants with therapeutic properties also pose a real danger due to their toxicity, requiring regulation and control of their use [14 15].

In Morocco, a range of bioclimates has facilitated the establishment of a rich flora with a high rate of endemism. Among this flora, 800 species and subspecies are aromatic and/or medicinal plants[16]

*Corresponding author. E mail: abdelkrimagour1@gmail.com
Tel:+212777801988

Citation: Agour A, Chelouati T, Messkini M, Zouirech O, Moussaoui AE, Mssillou I, Bari A, Derwich E. Status of the use of naturalized medicinal plants from the Tata region (southeast of Morocco) in traditional medicine. Trop J Nat Prod Res. 2025; 9(3):1192 - 1203 https://doi.org/10.26538/tjnpr/v9i3.40

Official Journal of Natural Product Research Group, Faculty of Pharmacy, University of Benin, Benin City, Nigeria

.The vascular flora of Morocco is the richest in North Africa, with approximately 5.211 taxa [17], of which about 22% are endemic [18]. Plants in Morocco are used in traditional pharmacopoeia to treat various diseases [19]. Poverty, lack of medical services, geographical isolation, and challenging living conditions contribute to the use of traditional medicine by certain populations [20]. Moroccan traditional medicine draws from Arab-Islamic medicine while also incorporating elements from European, Greek, Sub-Saharan African, Indian, and Chinese medicine [21]. In some regions of Morocco, the choice of traditional medicine is justified by the lower cost, effectiveness, and lower toxicity compared to the side effects of synthetic drugs [22].

Documenting indigenous knowledge through ethnobotanical studies is important for the conservation and utilization of biological resources [23]. Moreover, specific uses are still observed in each locality, reflecting the uniqueness and diversity of therapeutic traditions among populations [24]. Therefore, populations living in oasis regions will have practical knowledge of traditional medicine that may differ slightly or moderately from other regions of Morocco.

The Tata Province is part of the oasis zones, and this region has experienced climate changes, particularly noticeable through phenomena such as increased intensity of sunlight in summer and irregular rainfall patterns in autumn. According to the climatic scenario considered by the National Meteorology Directorate, the average annual number of very hot and hot days in summer would increase by 2 to 10 days (2 to 6 days). Winter precipitation levels decrease (ranging from -10% to -30%) [25]. These climate changes will have negative effects on plant diversity as well as the use of plants in traditional medicine.

In addition to climate change, other factors contribute to the rapid loss of traditional knowledge regarding the use of medicinal plants, such as the loss of expertise due to the passing of elderly individuals, migration, and the alteration of physical and biological environments. Therefore,

documenting traditional knowledge becomes necessary to assess the state of traditional medicine in this region. The objective of this study is to evaluate the status of utilization of naturalized plants in the Tata Province for traditional medicine: a case study of four municipalities (Akka, Kasbat Sidi Abdellah Ben M'barek, Tizounine, and Ait Ouabelli).

Materials and Methods

Study Area Description

The Tata Province (Figure1) is located in the southeast of Morocco within the Anti-Atlas region. The Anti-Atlas is a mountain range south of the High Atlas, stretching approximately 750 km in length and 250 km in width, following a southwest to northeast direction from the Atlantic Ocean in the west to Algeria in the east [26].

Due to its position in a pre-Saharan region, the Tata Province benefits from a hot, semi-arid Mediterranean climate with Atlantic and sub-Saharan influences, characterized by dry summers. The average maximum monthly temperature typically reaches 35 to 36 °C in July-August. It is characterized by extreme aridity, with low precipitation of about 100 mm, primarily in the form of thunderstorms, and significant fluctuations in daily and annual temperatures. The temperature varies between 49 °C and 12 °C. Year-to-year precipitation variations are significant, possibly due to changes in currents [27].

The water resources in the region, apart from occasional winter precipitation, mainly rely on the infiltration of rainwater into the Anti-Atlas mountain, which recharges the groundwater. As for seasonal waters, they consist of floodwaters from the southern slope of the Anti-Atlas, at the river level, which flow into the Draa River [27].

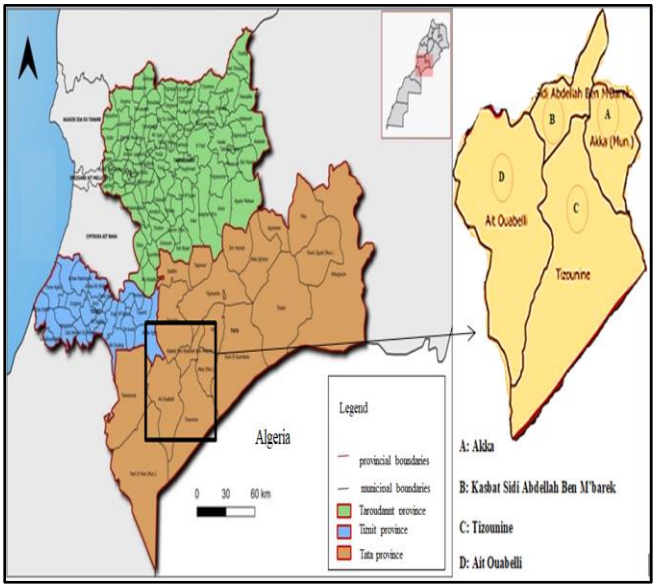

Figure 1. Geographical location of the four communes involved in the ethnobotanical study (A, B, C and D) [49].

Four municipalities (A, B, C et D Figure1) were selected to collect ethnobotanical data. These municipalities are characterized by the presence of alluvial deposits from watercourses in the form of badlands, which contain various structures and textures of silty deposits [26]. The climate of the study area is desert to semi-desert. Wind action is particularly noticeable in this region, where soils and rocks are not protected by vegetation cover [26]. The population of the municipalities included in the study area was estimated at 17586 inhabitants in 2014, distributed as follows: 6870 inhabitants in the urban municipality of Akka, 2401 inhabitants in the rural municipality of Ait Ouabelli, 6196 inhabitants in the rural municipality of Kasbat Sidi Abdellah Ben Mbarek, and 2119 inhabitants in the rural municipality of Tizounine [28].

Study Methodology

Data Collection Tools and Procedures

To understand the use of native plants in traditional medicine in the region, an ethnobotanical survey was conducted from February 2019 to August 2021. During this period, a total of 221 interviews were conducted in the four municipalities of the Tata region. Data was collected through semi-structured interviews with individuals of different ages. The interviewers conducted the interviews in the local language (Arabic Darija or Amazigh language). Prior to collecting ethnobotanical data, the interviewers were informed that the research objective was academic and not commercial. Participants provided oral informed consent to participate in this study and were free to withdraw their information at any time.

Identification and Preservation of Plant Species

Plant samples were collected from multiple sites (Figure2), and each collected species was georeferenced using the SWmaps application to determine its presence in a specific physical location. A photographs were taken before samples collection. Subsequently, whole or part of the collected plants were pressed in newspaper and dried appropriately in the laboratory. Finally, the specimens were deposited in the herbarium of the Laboratory of Biotechnology, Environment, Agri-Food, and Health at the Faculty of Sciences Dhar Elmahraz, USMBA, Fes.

Figure 2. Two examples of plant sample collection sites

To determine the scientific names of the medicinal plants identified in this study, reference documents cited by some authors in ethnobotanical studies were consulted [29] [30], as well as online databases, namely (https://atlas-sahara.org/; https://www.teline.fr/). The scientific names were confirmed in the laboratory by a Botanist at the Faculty of Sciences Dhar Elmahraz, Fes.

Data Analysis

After collecting the data using the field survey forms, the manually entered information was transferred to a database and analyzed using Microsoft Office Excel 2010 software.

Use Value (UV) and Family Use Value (FUV)

Use Value (UV): Calculated using equation 1: $UV = \Sigma Ui/N$ (1)

where Ui is the number of use citations for each species mentioned by each informant, and N is the total number of informants [31]. This calculation allowed us to determine the relative importance of locally known species and the most frequently reported species in treating diseases.

Family Use Value (FUV): This value helps identify the importance of plant families in traditional medicine. It was calculated using equation 2 : $FUV = VUs/Hs$ (2)

where UVs is the use value of species within the botanical family, and Ns is the total number of species within that family [32].

Citation Frequency (FC)

The citation frequency (CF) was calculated using equation 3: $CF = \left(\frac{NCS}{NCAS}\right) * 100$ (3)

Where: NCF: Number of citations for that species; NCAS: Total number of citations for all species

Results and Discussion

Profile of interviewees
Age Groups
In this study, except for the age group of individuals under 20 years old, the percentages of the age groups of the interviewed individuals were close (Figure.3). The percentages are as follows: 4.52% (<20 years); 16.28% (20-30 years); 18.55% (31-40 years); 20.36% (41-50 years); 24.88% (51-60 years); and 14.02% (>60 years). Knowledge of using medicinal plants is more prevalent among the age group over 60 years, while it is lower in the younger age groups, especially those under 20 years old.

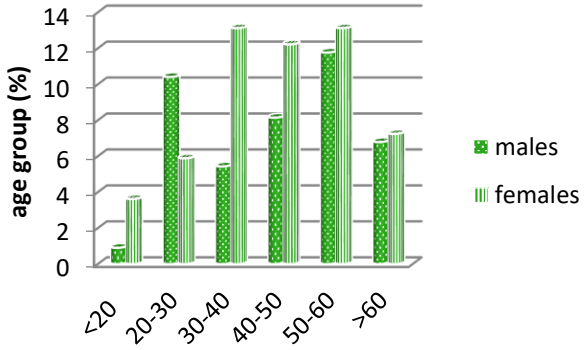

Figure 3: Age groups of the interviewed individuals

Level of Education
In the study area, the majority of medicinal plant users are illiterate, with a percentage of 59.81% (Figure.4). Furthermore, individuals with university and primary education levels show a significant percentage of medicinal plant usage: 18.22% and 14.01% respectively, while those with secondary education levels use medicinal plants to a lesser extent (7.94%).

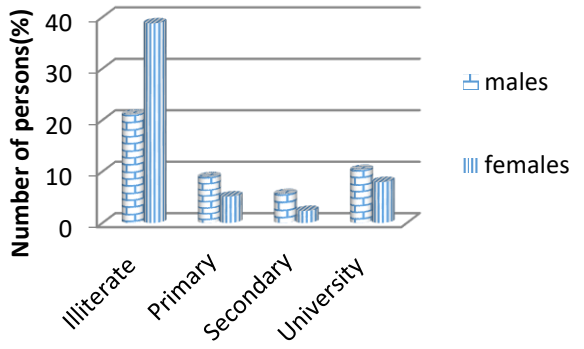

Figure 4: Level of education of interviewees

Collector Type
Half of the plants used by the population in the four municipalities are collected by shepherds (48.01%), and over a quarter (26.23%) of natives plants are collected by sedentary individuals, followed by nomadic people (21.28%). Farmers only account for 7.94% of the collection (Figure.5).

Source of Knowledge on Medicinal Plants
The survey results conducted in the four municipalities of the Tata province showed that 61.75% of users of native plants in the region acquired knowledge about their usage through the experience of others (Figure 6). This reflects the relative transmission of traditional practices from one generation to another. Herbalists (21.05%) and reading (16.14%) were also mentioned as sources of knowledge, while only

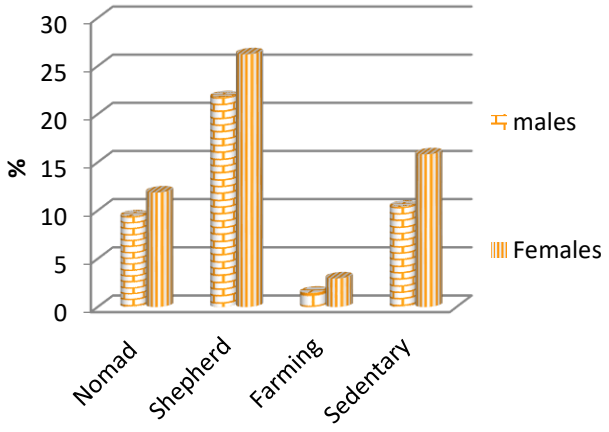

Figure 5: Types of plant collector

1.05% obtained information from pharmacists. Therefore, the experience of others remains the most effective means of transmitting knowledge about the use of plants in traditional medicine.

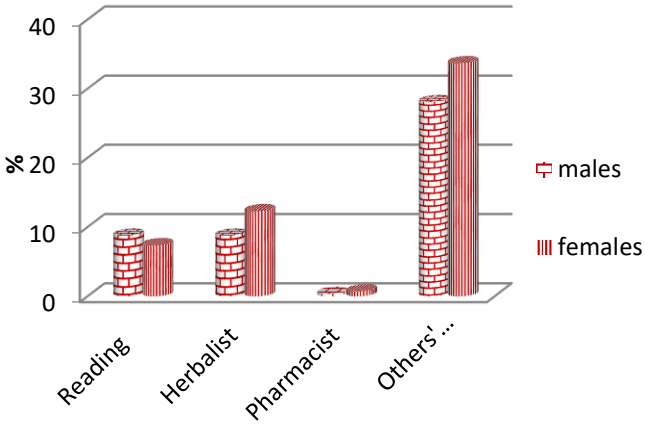

Figure 6: Origin of information for plant users.

Marital Status and Socioeconomic Level
Among all respondents, 65.71% were married, while 30% were single (Figure.7). Based on statistical analysis of the data, the socioeconomic level of the respondents can be divided into two main categories: a group with low socioeconomic status and another with medium socioeconomic status.

Access to Plant Material
The plant material consumed by the population is primarily provided by different collectors. 92.09% of the population has free and unrestricted access to native medicinal plants in the region without having to purchase them from herbalists. PMAs are used to treat a variety of ailments in both sexes. According to several studies, women have a more in-depth knowledge of plant species and their uses, with a 60% predominance. Previous studies in different regions of Morocco have shown that the 30 to 60 age bracket is the one that makes most use of PMAs. In contrast, people under the age of 20 have the lowest rate of use, generally below 9% [33,34,35,36,37]. In the case of rare species, obtaining plant material may require the use of plant propagation methods [38].

Floristic analysis
Collection period

Due to the arid climate prevailing in the four municipalities of the study area, a large portion of the plants used in traditional medicine are collected in winter (32.03%), a period during which the majority of

herbaceous plants reach the flowering stage. Collection decreases in spring (24.09%), then in summer (19.41%), and becomes very low in autumn (0.48%). A significant amount of plants is collected throughout the year (24.02%), most of which are perennial plants (Figure.8)

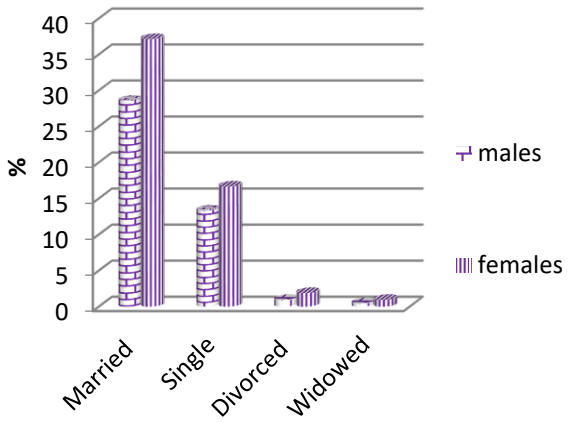

Figure 7. Family situation of people interviewed.

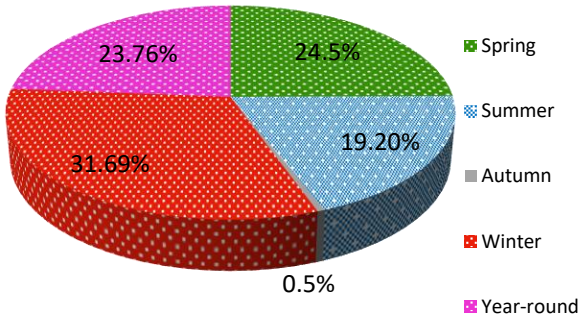

Figure 8. Plant collection period.

Method of preparing remedies

The survey results have shown us that the most common method of preparing remedies using native medicinal plants in the region is decoction (40.86%). This plant material is also heavily used in powdered form (30.77%), followed by infusion (12.71%) and fumigation (7.36%). Other preparation methods are used at values below 4% (Figure.9)

Different types of disease treated by the medicinal plants used

The main diseases treated by medicinal plants collected in the study area show different variations: the highest rate of plants is for the treatment of digestive diseases (39.15%), followed by circulatory and nervous system diseases (32.72%) and skin diseases (13.78%). Respiratory and genital diseases are the least treated by medicinal plants collected in the study area, their percentages being below 9% (Figure.10).

Part used of the plant

The inhabitants of the study area harvest different parts of plants for the preparation of traditional remedies (roots, stems, leaves, flowers, fruits, even whole plants). The leaf has been reported as the dominant part of the plant for the preparation of herbal remedies (34.11%), followed by the fruit (20.55%), the whole plant (16.61%), the stem (10.02%), and the flower (9.14%) (Figure.11). The region is characterized by the richness of these ecosystems in species belonging to the Acacia genus.

The gums from these species are a highly important element used in the treatment of digestive and circulatory system diseases.

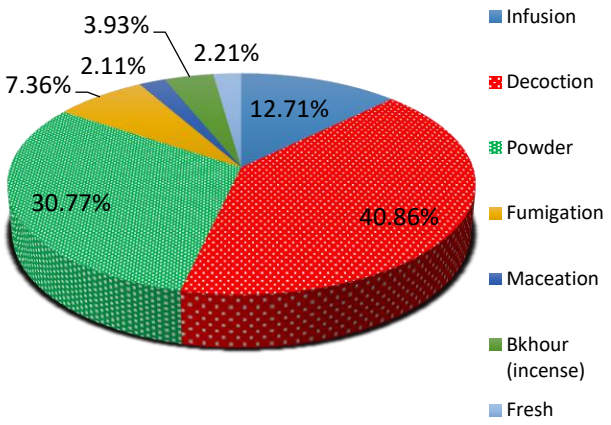

Figure 9. Method of preparing remedies

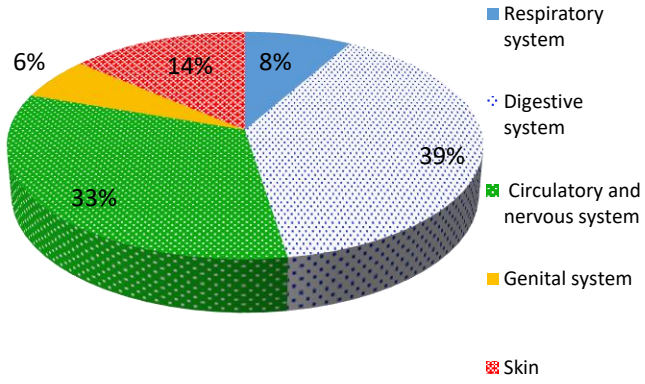

Figure 10. Diseases treated by local plants.

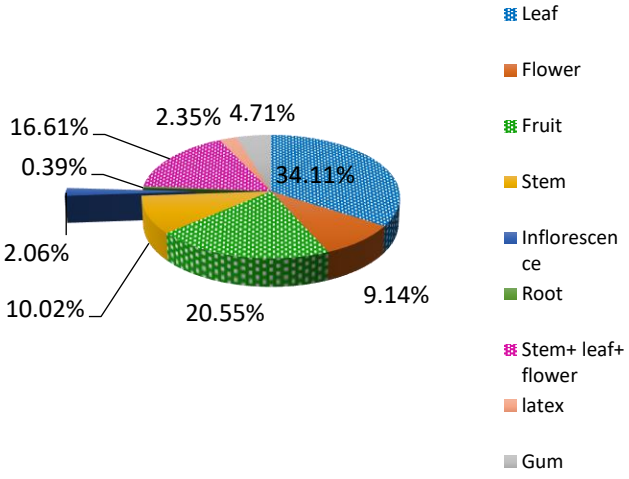

Figure 11. Part used to prepare remedies

Availability of plant material.

The local people interviewed revealed that 61.09% of medicinal plants native to the study area are very available, while 34.19% are rarely available, and 4.70% are very rarely available (Figure.12). This scarcity

is explained by the effect of climate change, which leads to years of drought that have a negative impact on the biomass of many plant species.

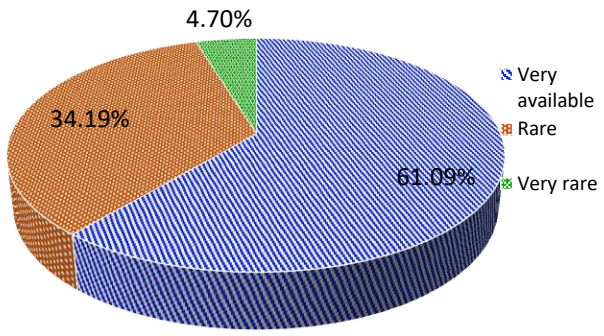

Figure 12. Availability of plant material.

Value of use of botanical families

The survey results show that in the study area, only 20 families, comprising 32 species, are used in traditional medicine. More than half of the families are represented by one or two species, 12 families are represented by one species each, and 6 families are represented by two species each. The calculation of the Family use value (VUF) reveals that there are five botanical families that are most commonly used by the population in the study area **(**Figure 13**)**. The most dominant family is *Apiaceae* with a FUV =0.0192, followed by Asteraceae (FUV=0.0166), *Zygophyllaceae* (FUV=0.0127), *Lamiaceae (FUV=0.0118),* and *Fabaceae (FUV=0.0106).* These families alone represent 37.50% of the species identified in the survey (Table 2). The botanical families with the lowest values of use are *Asclepiadaceae* (FUV=0.0007), *Capparaceae* (FUV=0.0008), *and Malvaceae* (FUV=0.0012).

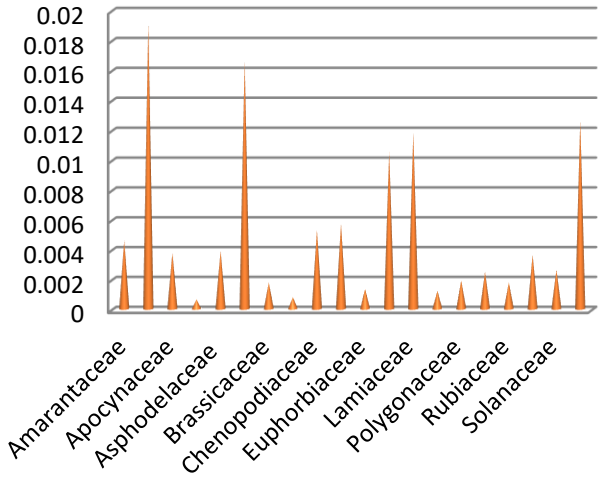

Figure 13. Family Use-Value of different botanical families

Frequency of use of medicinal plants

The citation frequency was used to evaluate the most commonly used plant species by the respondents. The analysis of collected data shows That several medicinal plants are frequently used in the four selected municipalities for the study (Table 1), with examples represented in Figure 14 A. The plant species *Ammodaucus leucotrichus Coss (Apiaceae family)* was the most reported plant by the investigators, with a citation frequency of 47.05%, followed by *Acacia raddiana* (Savi) Brenan (CF=33.93%), *Zygophyllum gaetulum* Emb. & Maire (CF=25.33%), *Mentha suaveolens* Ehrh. (CF=20.81%), *Citrullus colocynthis* (L.) Schrad (CF=18.55%), *Chenopodium ambrosioides* L. (CF=17.19%), *Peganum harmala* L. (CF=15.38%), *Brocchia cinerea* (Dell.) Vis. (CF=14.02%), *Asphodelus tenuifolius* Cav. (CF=12.66%), and *Haplophyllum tuberculatum* (Forssk.) Hand.-Maz (CF=11.76%). Among the least cited species, there are plants well-known for a certain level of toxicity (Echinops spinosus L. (0.90%), *Solanum nigrum* L. (1.35%), *Pergularia tomentosa* L. (2.26%), Chenopodium murale L. (3.16%), *Ricinus communis* L. (4.52%), Calotropis procera Will. (4.97%)), or plants that are rare in the natural environment of the study area (*Maerua crassifolia* Forssk. (2.71%), *Cladanthus eriolepis* (Maire) (4.52%)).

The most cited species (*Ammodaucus leucotrichus* Coss) has a wide range of traditional medicinal uses, including for diarrhea, pulmonary diseases, cough, allergies, anorexia, tachycardia, helminthiasis, gastralgia, stomach pain, otitis, cold, indigestion, fever, anorexia, and heart diseases. Phytochemical analyses have revealed that this species possesses numerous bioactive chemical constituents, providing them with significant pharmacological potential [39]. The most reported medicinal plants by the respondents should be considered in future studies to verify their pharmacological effectiveness through in vivo tests, so they can serve as raw materials for phytochemical compounds used in pharmaceutical products.

27 species belonging to 14 botanical families have been identified in the study area, but they were not mentioned by the interviewed individuals in the context of this study. Examples are represented in Figure.14 B. These species have been reported in the literature as being used in traditional medicine. The dominant families are Asteraceae (5 species), Fabaceae (4 species), and Brassicaceae (3 species) (Table3). Examples of plants, dominant in the study area, but less used as medicinal plants, include *Asteriscus graveolens* (Forssk.) (Asteraceae family), which is traditionally used to treat rheumatic pains and as a spasmolytic. Similarly, *Convolvulus trabutianus* (Convolvulaceae family) has medicinal uses in wound healing, hemostasis, and as an antimicrobial agent [29]. Crotalaria saharae Coss. et Dur. (Fabaceae family) is traditionally used against snake and scorpion bites [40].

A slight difference in the percentage of medicinal plant use between women and men in the study area has been observed, with an advantage for women. Young people, compared to the elderly, generally do not know the names and uses of most plant species. Unfortunately, knowledge related to the use of native medicinal plants in the region is threatened with extinction. The decline in these phytotherapeutic practices and the degradation of plant genetic resources are due to several factors, including climate variability. The low rainfall in the study sites, receiving less than 100 mm of precipitation per year, as well as maximum temperatures exceeding 50°C.

Some biological activities of less pharmacologically studied species

Atractylis aristata Batt. (Asteraceae; Vaucher number: (AA0019220212)): Extracts of *Atractylis aristata* (dichloromethane, ethyl acetate, and n-butanol extracts) possess antioxidant activity, with ethyl acetate extract showing the highest antioxidant capacity (IC_{50} value: 0.097±0.003 mg/ml in the DPPH test and IC_{50} value: 0.077±0.003 mg/ml in the ABTS test). The main compounds detected in the extracts by HPLC-UV are acetylsalicylic acid, ascorbic acid, gallic acid, quercetin, and vanillin [41].

Launaea fragilis (Asso) Pau: (Asteraceae; Vaucher number: (LF0019220212)) The ethanol extract of *Launaea fragilis* has in vitro anticancer activity, as assessed by sulforhodamine B assay. The extract of Launaea fragilis significantly inhibits the proliferation of non-small cell lung carcinoma (H1299) (IC_{50} = 26.5 µg/ml) and also inhibits prostate carcinoma (PC-3) with IC_{50} = 40 µg/ml [42]activity against breast tumor cells MCF-7 (IC_{50} = 64.6 ± 13.7 µg/mL) [43]. Extracts of *Pulicaria undulata* L. could be a potential agent for the treatment of human hepatocellular carcinoma [44].*Echium horridum* Batt.: (Boraginaceae; Vaucher number: (EH0019220211)) Alkaloids extracted from *Echium horridum* have antibacterial effects against *E. coli* with a minimum inhibitory concentration (MIC) of 1.7 mg/ml [45]. *Diplotaxis pitardiana* Maire (Brassicaceae; Vaucher number: (DP0019220211)): The powdered capitula are orally administered by taking a teaspoon of powder in a glass of unsweetened warm milk for the treatment of diabetes [46].*Morettia canescens* Boiss.: (Brassicaceae; Vaucher number: (MC0019220212)) It exhibits antifungal potential against *Aspergillus flavus*. The methanolic extract of this species significantly inhibits spore. germination (97.73%) and effectively controls the production of

aflatoxin B1 [47].*Moricandia suffruticosa* (Desf.) Coss. et Dur. (Brassicaceae; Vaucher number: (MS0019220212)): The aqueous extract of *Moricandia suffruticosa* shows antihyperglycemic activity in diabetic rats. This extract has an antidyslipidemic effect on triglyceride levels, total cholesterol, and lipoproteins. The extract of *Moricandia suffruticosa* has shown significant in vitro antioxidant activity [48]. In addition, 7 species are less studied for their pharmacological activities:*Gymnocarpos sclerocephalus* (Decne.) Ahlgren & *Thulin (Caryophyllaceae* Vaucher number: (GS0019220211)*), Cyper Scirpoides holoschoenus (L.)* (Cyperaceae; Vaucher number: (CS0019220211)), *Lotus glinoides Delile (Vaucher number :* (LG0019220211) *and Lotus* jolyi Batt Vaucher number: (LJ0019220211). (Fabaceae), *Antirrhinum ramosissimum* Coss. et Dur. (Scrophulariaceae; Vaucher number: (AR0019220212)), *Fagonia glutinosa* Delile (Vaucher number: (FG0019220211), and *Fagonia zilloides* Humbert (Zygophyllaceae; Vaucher number: (FZ0019220211)).

Calotropis procera Will.

Warionia saharae Benth

Maerua crassifolia Forssk.

A: Examples of plants cited by informants and identified in the natural environment

Cleome arabica L.

Convolvulus trabutianus Sc. et Mus

Euphorbia calyptrata Coss.

B: Examples of plants not mentioned by informants, but identified in the natural environment.

Gymnocarpos sclerocephalus (Decne.)

Morettia canescens Boiss

Fagonia zilloides Humbert

C: Examples of plants not mentioned by informants and less studied pharmacologically, but identified in the natural environment

Figure 14: Examples of plant species found in the study area

Table 1: The main botanical families used in traditional medicine in different regions of Morocco

Ethnobotanical Study and Study Area	Most Utilized Botanical Families	Parts Most Used	Preparation Methods	reference
Traditionally Recommended Medicinal Plants by Traditional Practitioners in Eastern Morocco	Lamiaceae (12 species), Fabaceae (11 species), Asteraceae (10 species)	Leaf (34.49%), seed (30.39%), flower (14.78%)	Powder (42.18%), decoction (26.17%)	[21]
Food Preservation	Lamiaceae, Apiaceae and Rosaceae	Leaf (26.37 %)		[50]
les plantes médicinales à Taounate, Pré-Rif du Maroc	Lamiaceae, Asteraceae, Apiaceae, Fabaceae et Rosaceae	Leal and Aerial parts	Decoction (25.18%)	[36]
Taounate: Case of Mernissa - Northern Morocco	Lamiaceae, Apiaceae, Asteraceae, Rosaceae, Fabaceae et Liliaceae	Leaf (59%)	Decoction (40%)	[51]
Toxic Species Used as Medicines, Northeast Morocco	Apiaceae, Astéraceae, Solanaceae et Fabaceae	Seed, Leaf and root		[15]
Treating Diabetes in the Agadir Ida Outanane Region, Southwest Morocco	Lamiaceae, Asteraceae.	Leaf (61%)	Decoction (41.67%)	[52]
Treating Metabolic Diseases, Rif (Northern Morocco)	Lamiaceae, Cupressaceae, Rosaceae, Linaceae	Leaf	Infusion (53.9%)	[6]
Treating Musculoskeletal Diseases, Moroccan Rif	Poaceae	Leaf	Decoction	[53]
Diabetes Treatment in Rabat (Morocco))	Lamiaceae (8 species), Fabaceae (3 species)	Leaf (47.5%), Seed (20.2%)	Infusion (50.9%)	[54]
Medicinal Plants Collected in Sidi Kacem Province (Morocco)	Lamiaceae, Apiaceae and Astéraceae	Leaf	Decoction	[55]
Treating Diabetes in the Tizi n'Test Region (Taroudant, Morocco)	Astéraceae and Lamiaceae	Leaf (37.5%)	Decoction (68.29%), infusion (12.19%)	[56]

Table 2: Plant species mentioned by the respondents and their traditional uses

Families and Scientific Names of Species	Local name	Vaucher number	Citation factor	Therapeutic indication	Part used	Preparation method
Chenopodium murale L. *Amarantaceae*	Tamggout	(CM0019220211)	3.16	Sk.	Leaf	Pdr.
hammada scoparia (Pomel) Iljin *Amarantaceae*	Assay	(HS0019220211)	11.76	D.S., Sk.	Leaf, Stem	Dec., Inf. Pdr
Ammi visnaga L. *Apiaceae*	Lkrwit, lkrwia	(AV0019220211)	14.74	D.S., C.S., N.S.	Fruit	Dec., Pdr. Inf.
Ammodaucus leucotrichus Coss. *Apiaceae*	Talkmount, Lkmoun ssoufi	(AL0019220211)	47.05	D.S.	Fruit	Dec, Inf, Pdr.
Calotropis procera Will. *Apocynaceae*	Tawrzat, Tawrja	(CP0019220211)	2.26	SK.	Aerial parts Latex	Pdr.
Nerium oleander L. *Apocynaceae*	Alili, Defla	(NO0019220211)	7.23	Sk.	Leaf,stem, latex	Pdr.
Pergularia tomentosa L. *Asclepiadaceae*	Tazert, Lghelga	(PT0019220211)	2.26	Sk.	Aerial parts Latex	Pdr.
Asphodelus tenuifolius Cav. *Asphodelaceae*	Tiziyit, Tazayt	(AT0019220211)	12.66	D.S., C.S.	Aerial parts	Dec., Frs.
Anvillea radiata Coss et Dr. *Asteraceae*	Wajjarg, Ajarg	(AR0019220211)	5.88	D.S.	Flower	Pdr.
Brocchia cinerea (Dell.) Vis. *Asteraceae*	Lbrouba, Lgrtoufa	(BC0019220211)	14.02	D.S., C.S.	Aerial parts	Dec., Inf.

Cladanthus eriolepis (Maire) *Asteraceae*	Wijjan	(CE0019220211)	4.52	C.S., Sk.	Aerial parts	Fum., Frs.
Echinops spinosus L. *Asteraceae*	Tabouffit, Bonggar	(ET0019220211)	0.90	C.S.	Aerial parts	Pdr.
Launaea arborescens (Batt.) Murb. *Asteraceae*	Iferskl, Omm lbina	(LA0019220211)	11.31	C.S., N.S Sk.	Leaf Latex	Pdr., Frs
Pulicaria mauritanica Coss. *Asteraceae*	Tawchkint, Ifenzi oudaden	(PM0019220211)	6.33	C.S., D.S. Sk.	Leaf	Pdr., Inf. Frs.
Warionia saharae Benth et Coss *Asteraceae*	Wafssas, Afssas	(WB0019220211)	10.40	C.S., N.S.	Leaf Latex	Pdr. Fum.
Anastatica hierochuntica L. *Brassicaceae*	Lkemcha, Lkchtamt	(AH0019220211)	5.88	D.S., G.S. C.S.	flower, Whole plant	Inf., Dec. Bkh
Maerua crassifolia Forssk *Capparaceae*	Atil, Tatilt	(MC0019220211)	2.71	D.S., C.S.	Leaf, Stem	Dec., Pdr
Chenopodium ambrosioides L. *Chenopodiaceae*	Lmkhinza – Tawijant	(CA0019220211)	17.19	C.S., N.S. R.S.	Aerial parts	Dec., Inf., Pdr.
Citrullus colocynthis (L.) Schrad *Cucurbitaceae*	Afrziz, Hedja, Handal,	(CC0019220211)	18.55	C.S., Sk.	Leaf Fruit	Dec, Pdr. Frc.
Ricinus communis L. *Euphorbiaceae*	Lkherwaa, Wawririt	(RC0019220211)	4.52	C.S. Sk.	Fruit Leaf, Stem	Bkh. Dec.
Acacia raddiana (Savi) Brenan *Fabaceae*	Amrad, Talh	(AR0019220211)	33.93	D.S., C.S. Sk.	Leaf, Fruit, Gum Flower	Dec., Inf Pdr.
Mentha suaveolens Ehrh *Lamiaceae*	Timija	(MS0019220211)	20.81	C.S., D.S. N.S.	Leaf, Flower, Stem	Dec., Inf., Fum., Mac., Pdr.
vitex agnus-castus L. *Lamiaceae*	Angarf, Lkherwaa, wangarf	(VA0019220211)	17.91	D.S., G.S. Sk.	Leaf Flower Fruit	Dec, Pdr Pdr. Pdr.
Malva parviflora L. *Malvaceae*	Lbqoula – Lkhobbiza	(MP0019220211)	4.07	D.S.	Leaf, Stem	Dec., Inf
Rumex vesicarius L. *Polygonaceae*	Lhemmida, Tasmomt, basmom	(RV0019220211)	6.33	C.S., N.S.	Aerial parts	Dec.
Ziziphus lotus (L.) Lam. *Rhamnaceae*	Azggar, Nbeg	(ZL0019220211)	8.14	C.S., D.S. Sk.	Fruit Leaf	Pdr.
Gaillonia reboudiana Coss. et Dur. *Rubiaceae*	Tibskit ntmghart	(GR0019220211)	5.88	G.S. C.S.	Leaf, Stem Flower	Dec, Bkh
Haplophyllum tuberculatum (Forssk.)Hand.-Maz *Rutaceae*	Awermi, Tiwraghin	(HA0019220211)	11.76	C.S., D.S.	Leaf Flower	Dec., Inf Dec
Solanum nigrum L. *Solanaceae*	Aaneb eddib, Tidila	(SA0019220211)	1.35	D.S.	Aerial part	Dec.
Withania adpressa Coss. *Solanaceae*	Aglim, Hbobo, Hjojo	(WA0019220211)	7.23	D.S., C.S.	Leaf, Stem, Fruit	Dec., Pdr.

Peganum harmala L. *Zygophyllaceae*	Lherml	(PH0019220211)	15.38	D.S., C.S. N.S., R.S.	Fruit	Dec., Bkh
Zygophyllum gaetulum Emb. & Maire *Zygophyllaceae*	Laagaya, Tazlozt iyraaman	(ZG0019220211)	25.33	D.S., C.S. Sk.	Aerial parts	Dec., Pdr. Mac.

Therapeutic indication : **D.S.**: Digestive system; **C.S.**: Circulatory system; **G.S.**: Genital system; **N.S.**: Nervous system; **RS.**: Respiratory system; **Sk.**: Skin. Me**thod of preparation**: **Bkh.** : Brhour (essens) ; **Dec.** : Decoction ; **Inf.** : Infusion ; **Frs.** Fresh; **Mac.** Maceration; **Fum.** Fumigation; **Pdr.** Powder

Table 3. Plant species encountered in the study area, but not reported by interviewees. ([29] ; [30] ; http://atlas-sahara.org ; https://www.floramaroccana.fr et https://www.teline.fr/fr)

Species name and family	Vaucher number	Local name	Traditional uses	Ref.
Urginea noctiflora Batt. &Trab *Asparagaceae*	(UN0019220211)	Azalim Ouchen, Bsel dib	Wounds and earaches	[57]
Asteriscus graveolens (Forssk.) Less. *Asteraceae*	(AG0019220211)	Tojergt	Rheumatic and spasmodic pain	[29]
Centaurea pungens Pomel *Asteraceae*	(CP0019220212)	Neggayer, Krziz	Cardiovascular diseases	[58]
Ifloga spicata (Forssk.) Sch. Bip *Asteraceae*	(IS0019220211)	Tamrt	Skin lesions	[57]
Matricaria pubescens (Desf.) Sch.Bip. *Asteraceae*	(MP0019220212)	Gertoufa, Tarragt	Flu, hemorrhoids, Rheumatism	[59]
Heliotropium bacciferum Forsk *Asteraceae*	(HB0019220211)	Taynost	Abscesses, boils	[60]
Brassica nigra (L.) W.D.J. Koch *Brassicaceae*	(BN0019220211)	Lkhrdel	Bronchitis, constipation digestive, émétique, rhum stimulant	[29]
Farsetia aegyptia Turra *Brassicaceae*	(FA0019220211)	Laaoud labyed,	Dental and gum pain	[60]
Zilla spinosa Coss. *Brassicaceae*	(ZS0019220211)	Assafou, Ouchfoud	Asthma, kidney stones, helminthiasis	[29]
Cleome arabica L. *Capparaceae*	(CA0019220212)	Lkhanza	Diuretic , Rheumatism	[61]
Convolvulus trabutianus Schw. et Musch *Convolvulaceae*	(CT0019220211)	Asghrghjd	Wound healing, stop bleeding,	[29]
Cuscuta planiflora Ten. *Convolvulaceae*	(CP0019220213)	Lehrir ouchen	antimicrobial Antidepressant	[62]
Euphorbia calyptrata Coss. & Kralik *Euphorbiaceae*	(EC0019220211)	Moulbina, Tinora	Skin diseases, scorpion stings	[29]
Acacia ehrenbergiana Hayne *Fabaceae*	(AE0019220211)	Tamat, Talh	Antibacterial and wound healing	[63]
Astragalus sp *Fabaceae*	(AF0019220211)	Foul libel, Ibawn iraaman	Tonic	[64]
Crotalaria saharae Coss. et Dur. *Fabaceae*	(CS0019220211)	Taqayt iyznkad	Snake and scorpion bites	[40]
Retama raetam (Forssk) *Fabaceae*	(RR0019220211)	Rtem, Talgout	Skin diseases, Abortifacient, toxic Rheumatism, Scorpion bite, Wound healing	[29]
Lavandula coronopifolia Poir. *Lamiaceae*	(LC0019220211)	Amgrzwa	Skin diseases, hair loss	[65]
Marrubium deserti (DeNoe) Coss. *Lamiaceae*	(MD0019220211)	Mriwa, Ifzi, Jaâyda	pain, inflammatory, diabetes	[66]
Plantago amplexicaulis Cav. *Plantaginaceae*	(PA0019220211)	Tiroufin iymxawn	Wound healing, Allergy, Respiratory ailments, Stomachache	[67]
Rumex simpliciflorus Murb. *Polygonaceae*	(RS0019220211)	Tasmoumt	purgative, anti-tumor and anti-inflammatory	[68]
Samolus valerandi L.	(SV0019220211)	Saboun	Kidney stones	[69]

Primulaceae *Caylusea hexagyna Forssk.* *Resedaceae*	(CH0019220211)	Azeldar, timimt		
Reseda Arabica Boiss. *Resedaceae*	(RA0019220211)	Igerjdi,	Strengthen hair	[60]
Reseda villosa Coss. *Resedaceae*	(RV0019220212)	Igerjdi		
Tamarix gallica L. *Tamaricaceae*	(TG0019220211)	Tamayt	Antidiarrheal, Antioxidant, Antimicrobial Anticancer	[70]
Forsskaolea tenacissima lssik *Urticaceae*	(FT0019220211)	Lssig, Taklma	Anti-inflammatory, Antispasmodic, Antidiabetic and Antipyretic	[71]

Conclusion

According to the results of the ethnobotanical survey conducted in the four municipalities of the Tata region (Akka, Kasbat Sidi Abdellah Ben M'barek, Tizounine, and Ait Ouabelli), it is observed that the population uses medicinal plants regardless of age, education level, and socioeconomic status. However, it is worth noting that women are much more active than men, and with age, patients rely more on phytotherapy. The traditional use of naturalized plants in the study area has declined in recent years. Nearly half of the identified medicinal plants in this region were not reported by the interviewed individuals, primarily due to the unavailability of many plant species that have become rare due to climate change (rising temperatures and decreasing precipitation). Several taxa are threatened with extinction in this region, exemplified by three Asteraceae species (*Cladanthus eriolepis* (Maire), *Pulicaria mauritanica* Coss., and *Warionia saharae* Benth and Coss.). However, other factors influence the traditional knowledge in this region, which is now at risk of extinction, such as the lack of interest among younger generations and the use of synthetic drugs. The current status of medicinal plants in the study area requires the protection of this heritage and the preservation of its biodiversity by implementing ex-situ cultivation to multiply and conserve vulnerable plant resources. Additionally, raising awareness among the region's residents about the scarcity of many species is essential. Lastly, further research on pharmacological and biological activities should be considered to discover new plant-based medicines from naturalized plants in this Saharan region

Conflict of interest

The author reports no conflicts of interest in this work.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

References

1. Jordan SA, Cunningham DG, Marles RJ. Assessment of herbal medicinal products: challenges, and opportunities to increase the knowledge base for safety assessment. Toxicol Appl Pharmacol. 2010;243(2):198-216.
2. Jugreet BS, Mahomoodally MF. Essential oils from 9 exotic and endemic medicinal plants from Mauritius shows in vitro antibacterial and antibiotic potentiating activities. South African J Bot. 2020;132:355-362. doi:10.1016/j.sajb.2020.05.001
3. Ullah R, Alqahtani AS, Noman OMA, Alqahtani AM, Ibenmoussa S, Bourhia M. A review on ethno-medicinal plants used in traditional medicine in the Kingdom of Saudi Arabia. Saudi J Biol Sci. 2020;27(10):2706-2718. doi:10.1016/j.sjbs.2020.06.020
4. Zouaoui N, Chenchouni H, Bouguerra A, Massouras T, Barkat M. Characterization of volatile organic compounds from six aromatic and medicinal plant species growing wild in North African drylands. NFS J. 2020;18(September 2019):19-28. doi:10.1016/j.nfs.2019.12.001
5. Hulley IM, Sadgrove NJ, Tilney PM, Van Wyk BE. The ethnobotany, leaf anatomy and major essential oil compounds of *Leysera gnaphalodes* (Asteraceae), a poorly known aromatic herbal tea endemic to southern Africa. South African J Bot. 2019;127:12-18. doi:10.1016/j.sajb.2019.08.022
6. Chaachouay N, Benkhnigue O, Fadli M, El Ibaoui H, Zidane L. Ethnobotanical and ethnopharmacological studies of medicinal and aromatic plants used in the treatment of metabolic diseases in the Moroccan Rif. Heliyon. 2019;5(10):e02191. doi:10.1016/j.h eliyon.2019.e02191
7. Said-Al Ahl H, Naguib NY, Hussein MS. Evaluation growth and essential oil content of catmint and lemon catnip plants as new cultivated medicinal plants in Egypt. Ann Agric Sci. 2018;63(2):201-205. doi:10.1016/j.aoas.2018.11.005
8. Aidi Wannes W, Marzouk B. Research progress of Tunisian medicinal plants used for acute diabetes. J Acute Dis. 2016;5(5):357-363. doi:10.1016/j.joad.2016.08.001
9. Silveira D, Prieto JM, Freitas MM, Mazzari ALDA. Herbal medicine and public healthcare: Current and future challenges. Nat Prod as Source Mol with Ther Potential Res Dev Challenges Perspect. 2018:495-515.
10. Phondani PC, Bhatt A, Elsarrag E, Horr YA. Ethnobotanical magnitude towards sustainable utilization of wild foliage in Arabian Desert. J Tradit Complement Med. 2016;6(3):209-218. doi:10.1016/j.jtcme.2015.03.003
11. Agour A, Mssillou I, El Abdali Y, Bari A, Lyoussi B, Derwich E. Phytochemical characterization, acute toxicity and hemolytic activity of *Cotula cinerea* (Del.) aqueous and ethanolic extracts. J Biol Biomed Res. 2024;1(1):70-78.
12. Mssillou I, Agour A, Lefrioui Y, Chebaibi M. LC-TOFMS analysis, in vitro and in silico antioxidant activity on NADPH oxidase, and toxicity assessment of an extract mixture based on *Marrubium vulgare* L. and Dittrichia viscosa L. J Biol Biomed Res. 2024;1(1):31-45. doi: https://doi.org/10.69998/j2br2 Edited
13. Chebaibi M, Mssillou I, Allali A, Bourhia M, Bousta D, Boschi Gonçalves R F, Hoummani H, Aboul-Soud M, Augustyniak M, Giesy JP,Achour S. Antiviral Activities of Compounds Derived from Medicinal Plants against SARS-CoV-2 Based on Molecular Docking of Proteases. J Biol Biomed Res. 2024;1(1):10-30. doi:https://doi.org/10.69998/j2br1
14. Najem M, Harouak H, Ibijbijen J, Nassiri L. Oral disorders and ethnobotanical treatments: A field study in the central

Middle Atlas (Morocco). Heliyon. 2020;6(8):e04707. doi:10.1016/j.heliyon .2020.e0 4707
15. Kharchoufa L, Bouhrim M, Bencheikh N, Addi M, Hano C, Mechchate H, Elachouri M. Potential toxicity of medicinal plants inventoried in northeastern morocco: An ethnobotanical approach. Plants. 2021;10(6):1-21. doi:10.3390/plants10061108
16. Benabid A. Flora and ecosystems of Morocco: Biodiversity assessment and preservation. 2000.
17. Fennane M, Tattou MI. Statistics and comments on the current inventory of the vascular flora of Morocco. Bull l'Institut Sci Sect Sci la Vie. 2012;34(1):1-9.
18. Rankou H, Culham A, Jury SL, Christenhusz MJM. The endemic flora of Morocco. Phytotaxa. 2013;78(1):1-69.
19. Benkhnigue O, Khamar H, Bussmann RW, Chaachouay N, Zidane L. Ethnobotanical and ethnopharmacological study of medicinal plants used in treating some liver diseases in the Al-Haouz Rehamna region. Ethnobot Res Appl. 2023;(17).
20. Sbai-Jouilil H, Fadli A, El Hafian M, El Ayad R, Benharbit O, Zidane L. Floristic and ethnobotanical study of medicinal plants used in the treatment of respiratory diseases in Seksaoua region (Western high Moroccan Atlas). Annu Res Rev Biol. 2017;17(6):1-10. doi:10.9734/ARRB/2017/36526
21. Fakchich J, Kharchoufa L, Bencheikh N, Zerkani H, Ouassou H, Bouhrim M, Cordero M.A.W, Alotaibi, A, Elachouri M. Assessment of Indigenous Plants Knowledge among Traditional Healers in Eastern Morocco: Quali-Quantitative Approach (Part I). Appl Sci. 2022;12(24). doi:10.3390/app122412773
22. Hachi M, Hachi T, Essabiri H, El Yaakoubi A, Zidane L, Abba EH. Ethnobotanical study of medicinal plants in the Central Middle Atlas region (Morocco). IOP Conf Ser Earth Environ Sci. 2022;1090(1):0-22. doi:10.1088/1755-1315/1090/1/012027
23. Cakilcioglu U, Khatun S, Turkoglu I, Hayta S. Ethnopharmacological survey of medicinal plants in Maden (Elazig-Turkey). J Ethnopharmacol. 2011;137(1):469-486.
24. Radi FZ, Khamar H, Remok F, Amine S, Drioiche A, Aoudry S, Zekri N, Bouzoubaa A, Zair T. Aromatic and medicinal plants in the Ifrane region (Morocco): Floristic diversity, with special emphasis on ethnobotanical and socioeconomic studies of six spontaneous plants. J Pharm Pharmacogn Res. 2022;10(3):517-550. doi:10.56499/jppres 21.1331_10.3.517
25. Houzir M. Oasis women and climate change in Morocco. 2017.
26. Berred S, Fadli D, El Wartiti M, Zahraoui M, Berred K, Sadki R. Geomorphosites of the Semi-arid Tata Region: Valorization of an Unknown Geoheritage for Geotourism Sustainable Development (Anti-Atlas, South Morocco). Geoheritage. 2019;11(4):1989-2004. doi:10.1007/s12371-019-00414-w
27. Berred S, Berred K, Fadli D. Geodiversity of Kingdom of Morocco: Tata Province geomorphosites inventory for creating a geopark project (Anti-Atlas). Int J Geoheritage Park. 2022;10(3):367-382. doi:10.1016/j.ijgeop.2022.07.001
28. Belghazi S. Economic and social environment and labour market in five excentral provinces of southern morocco: midelt , tinghir , ouarzazate , zagora and tata economic promotion and local development in the regions of Midelt , Tinghir , Ouarzazate , Zagora and Tata. 2014.
29. Abouri M, El Mousadik A, Msanda F, Boubaker H, Saadi B, Cherifi K. An ethnobotanical survey of medicinal plants used in the Tata Province, Morocco. Int J Med Plants Res. 2012;1(7):99-123.
30. Mouhiddine M, Belkamel A, Bammi J. Local know-how and knowledge of spontaneous medicinal plants in the Tata region: Eco-patrimonial study. Digit Digit Arqueol Arquit e Artes. 2019;(5):113-131.
31. Vitalini S, Iriti M, Puricelli C, Ciuchi D, Segale A, Fico G. Traditional knowledge on medicinal and food plants used in Val San Giacomo (Sondrio, Italy)—An alpine ethnobotanical study. J Ethnopharmacol. 2013;145(2):517-529.
32. Cadena-González AL, Sørensen M, Theilade I. Use and valuation of native and introduced medicinal plant species in Campo Hermoso and Zetaquira, Boyacá, Colombia. J Ethnobiol Ethnomed. 2013;9:1-14.
33. Anyinam C. Ecology and ethnomedicine: exploring links between current environmental crisis and indigenous medical practices. Soc Sci Med. 1995;40(3):321-329.
34. Mohamed B, Khalid S, Fatima J, Lhoussaine ER. Ethnopharmacological Study and Antifungal Activity of Three Plants (Asteraceae Family). 2015;4(September):13-24.
35. Eddouks M, Maghrani M, Lemhadri A, Ouahidi M-L, Jouad H. Ethnopharmacological survey of medicinal plants used for the treatment of diabetes mellitus, hypertension and cardiac diseases in the south-east region of Morocco (Tafilalet). J Ethnopharmacol. 2002;82(2-3):97-103.
36. El-Assri EM, Barnossi A El, Chebaibi M, Hmamou A, Asmi H. Bouia A, Eloutassi N. Ethnobotanical survey of medicinal plants in Taounate, Pre-rif of Morocco. Ethnobot Res Appl. 2021;22:1-23. doi:10.32859/ERA.22.36.1-23
37. Ghanimi R, Ouhammou A, Ahouach A, Cherkaoui M. Ethnobotanical study on wild edible plants traditionally used by Messiwa people, Morocco. J Ethnobiol Ethnomed. 2022;18(1):1-12. doi:10.1186/s13002-022-00500-4
38. El Moussaoui A, Zouirech O,Jawhari FZ, Bari A. Propagation method and germination condition of an arid and semi-arid species: *Withania frutescens* (L.). J Biol Biomed Res . 2024;1(1):62-69. https://fmjpublishing.com/index.php/J2BR/article/view/6.
39. Idm'hand E, Msanda F, Cherifi K. Medicinal uses, phytochemistry and pharmacology of *Ammodaucus leucotrichus*. Clin Phytoscience. 2020;6(1). doi:10.1186/s40816-020-0154-7
40. El Rhaffari L, Zaid A. Phytotherapy practice in southeastern Morocco (Tafilalet). Empirical knowledge for a renewed pharmacopoeia. From the sources of knowledge to the medicines of the future. 2016:293-318. doi:10.4000/books.irdeditions.7244
41. Abid A, Dekmouche, Messaouda Bechki L, Bireche K, Belkhalfa H, Messaoudi A, LakhderBelfar M. Bioactive Composition Analysis using HPLC-UV Profile and Evaluation of Antioxidant activities of different extracts from Aerial parts of *Atractylis*. Res J Pharm Tech. 2022;15(August):3370-3376. doi:10.52711/0974-360X.2022.00564
42. Darier SM El, Kamal SA, Marzouk RI, Nour IH. Anti-Proliferative Activity of Launaea fragilis (Asso) Pau and *Launaea nudicaulis* (L .) Hook . F . Extracts. 2021:27492-27496. doi:10.26717/BJSTR.20 21.35.005674
43. Awadh Ali NA, Sharopovb FS, Alhajc M, Hillb G.M, Porzeld A, Arnoldd N, Setzerb W.N, Schmidtd J, Wessjohannd L. Chemical Composition and Biological Activity of Essential Oil from *Pulicaria undulata* from Yemen. Nat Prod Commun. 2012;7:257-260. doi:10.1177/1934578X1200700238
44. Emam MA, Khattab HI, Hegazy MGA. Assessment of anticancer activity of *Pulicaria undulata* on hepatocellular carcinoma HepG2 cell line. tumor Biol. 2019;(October):1-10. doi:10.1177/1010428319880080
45. El-Shazly A, Abdel-All M, Tei A, Wink M. Pyrrolizidine Alkaloids from *Echium rauwolfii* and *Echium horridum* (Boraginaceae). 1999:295-300.
46. Benkhnigue O, Ben Akka F, Salhi S, Fadli M, Douira A, Zidane L. Catalog of medicinal plants used to treat diabetes in the Al Haouz-Rhamna region (Morocco). J Anim &Plant Sci. 2014;23(1):3539-3568.
47. Mohammedi Z, Atik F. Fungitoxic effect of natural extracts on mycelial growth , spore germination and aflatoxin B1

production of Aspergillus flavus. Aust J Crop Sci. 2013;7(3):293-298.
48. Azzane A, Amssayef A, Eddouks M. Antihyperglycemic and Antidyslipidemic Effect of *Moricandia Suffruticosa* in Normal and Streptozotocin-induced Diabetic Rats. Cardiovasc Haematol Disord Targets (Formerly Curr Drug Targets-Cardiovascular Hematol Disord. 2022;22(1):58-66.
49. AUTAR. Découpage administratif du Ressort Territorial de l ' Agence Urbaine de Taroudant-Tiznit- Tata. https://www.autar.m a/fr/Territoire/D%C3%A9coupage%20administratif.
50. Ez zoubi Y, Lairini S, El Amrani S, El-Akhal F, Farah A, Bouslamti R, El Ouali Lalami A. Ethnobotanical survey of herbs used in the preservation of food products in Fez, Morocco. J Ethn Foods. 2022;9(1). doi:10.1186/s42779-022-00144-5
51. Jeddi M, Ouaritini ZB, Fikri-Benbrahim K. Ethnobotanical study of medicinal plants in northern Morocco (Taounate): Case of Mernissa [Étude ethnobotanique des plantes médicinales au nord du Maroc (Taounate): Cas de Mernissa]. Ethnobot Res Appl. 2021;21:1-23.
52. Ouhaddou H, Alaoui A, Laaribya S, Ayan S. An ethnobotanical study on medicinal plants used for curing diabetes in Agadir Ida Outanane Region, Southwest Morocco. Biol Divers Conserv. 2020;13(1):80-87. doi:10.46309/biodicon.2020.731317
53. Chaachouay N, Benkhnigue O, Fadli M, El Ayadi R, Zidane L. Ethnobotanical study of medicinal plants used to treat osteoarticular diseases in the Moroccan Rif, Morocco. J Pharm Pharmacogn Res. 2019;7(6):454-470.
54. Skalli S, Hassikou R, Arahou M. An ethnobotanical survey of medicinal plants used for diabetes treatment in Rabat, Morocco. Heliyon. 2019;5(3):e01421. doi:10.1016/j.heliyon.2019.e01421
55. Fatima-Zahra E, Fouzia RF, Abdelilah R. Ethnobotanical study of medicinal plants used in traditional medicine in the province of Sidi Kacem, Morocco. Asian J Pharm Clin Res. 2017;10(1):121-130. doi:10.22159/ajpcr.2017.v10i1.14326
56. Katiri A, Barkaoui M, Msanda F, Boubaker H. Ethnobotanical Survey of Medicinal Plants Used for the Treatment of Diabetes in the Tizi n' Test Region (Taroudant Province, Morocco). J Pharmacogn Nat Prod. 2017;03(01):1-10. doi:10.4172/2472-0992.1000130
57. Chehma A, Djebar MR. Les espèces médicinales spontanées du Sahara septentrional algérien: distribution spatio-temporelle et étude ethnobotanique Abdelmadjid Chehma 1 et Mohammed Réda Djebar 2 1). Synthèse Rev des Sci la Technol. 2008;17:36-45.
58. Kadri Y, Moussaoui A, Benmebarek A. Ethnobotanical study of some medicinal plants in a hyper arid region of South-West Algeria " Case of Touat in the wilaya of Adrar ". J Anim Plant Sci. 2018;36(2):5844-5857.
59. Ghourri M, Zidane L, Houda Y, Rochdi A, Fadli M, Douira A. Etude floristique et ethnobotanique des plantes médicinales de la ville d'El Ouatia (Maroc Saharien) Floristic and ethnobotanical study of medical plants of El Ouatia (Morocco). J For Fac. 2012;12(2):218-235.
60. Mouhiddine M, Belkamel A, Bammi J. local know-how and knowledge of medicinal plants in the tata region. etuDe eco-PatRimoniale. 2019:113-131.
61. Ladhari A, Omezzine F, DellaGreca M, Zarrelli A, Zuppolini S, Haouala R. Phytotoxic activity of Cleome arabica L. and its principal discovered active compounds. South African J Bot. 2013;88:341-351.
62. Firoozabadi A, Zarshenas MM, Salehi A, Jahanbin S, Mohagheghzadeh A. Effectiveness of Cuscuta planiflora Ten. and Nepeta menthoides Boiss. & Buhse in major depression: a triple-blind randomized controlled trial study. J Evid Based Complementary Altern Med. 2015;20(2):94-97.
63. Thotathil V, Rizk HH, Fakrooh A, Lakshmaiah S. Phytochemical Analysis of Acacia ehrenbergiana (Hayne) Grown in Qatar: Identification of Active Ingredients and Their Biological Activities. Molecules. 2022;27. doi:10.3390/molecules27196400
64. Shahrajabian MH, Sun W, Cheng Q. A review of astragalus species as foodstuffs, dietary supplements, a traditional Chinese medicine and a part of modern pharmaceutical science. Appl Ecol Environ Res. 2019;17(6):13371-13382.
65. Achour S, Chebaibi M, Essabouni H, Bourhia M, Ouahmane L, Mohammad Salamatullah A, Aboul-Soud M, Giesy J.P. Ethnobotanical Study of Medicinal Plants Used as Therapeutic Agents to Manage Diseases of Humans. Evidence-based Complement Altern Med. 2022. doi:10.1155/2022/4104772
66. Boufous H, Marhoume F, Chait A, Bagri A. Ethnopharmacological survey of medicinal plants with hallucinogenic effect and used against pain, inflammatory diseases, diabetes and urinary lithiasis in Zagora "Morocco." J Intercult Ethnopharmacol. 2017;6(4):342-350. doi:10.5455/jice.20170721062527
67. Hosseini SH, Bibak H, Ghara AR, Sahebkar A, Shakeri A. Ethnobotany of the medicinal plants used by the ethnic communities of Kerman province, Southeast Iran. J Ethnobiol Ethnomed. 2021;17(1). doi:10.1186/s13002-021-00438-z
68. Vasas A, Orbán-Gyapai O, Hohmann J. The Genus Rumex: Review of traditional uses, phytochemistry and pharmacology. J Ethnopharmacol. 2015;175:198-228. doi:10.1016/j.jep.2015.09.001
69. Wagner C, De Gezelle J, Komarnytsky S. Celtic Provenance in Traditional Herbal Medicine of Medieval Wales and Classical Antiquity. Front Pharmacol. 2020;11(February):1-19. doi:10.3389/fphar.2020.00105
70. KalamUrfi M, Mujahid M, Khalid M, Irfan Khan M. Tamarix gallica: For traditional uses, phytochemical and pharmacological potentials. J Chem Pharm Res. 2016;8(1):809-814. www.jocpr.com.
71. Shah SWA, Kamil S, Ahmad W, Ali N. Spasmogenic, spasmolytic and antihypertensive activity of Forsskalea tenacissima L. African J Pharm Pharmacol. 2010;4(6):381-385.