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Original Research Article

Medicinal Plants of Moulay Yaâcoub Province in Morocco: An Ethnobotanical and Biodiversity Survey

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ABSTRACT

Currently, many medicinal plants continue to be utilized for the treatment and prevention of diseases. Numerous studies conducted in Morocco indicate that aromatic and medicinal plants (MAPs) have been used for centuries to cure various ailments. The distribution of therapeutic herbs through herbal markets plays a crucial role in preserving cultural heritage. this study was conducted among residents of the Moulay Yaâcoub province with the aim of documenting ethnobotanical knowledge and identifying different medicinal and aromatic plants used in traditional herbal medicine by this community. To identify a diverse range of medicinal and aromatic plants characteristic of the target area, open-ended interviews were conducted with locals using semi-structured questionnaires in the form of ethnobotanical surveys. Ethnobotanical indices, including relative frequency of citations, use value, relative importance, and informant consensus factor, were employed to quantify the use and cultural significance of medicinal and aromatic plants in the province of Moulay Yaâcoub. The data were analyzed using different statistical parameters. According to the research results; the population of the Moulay Yaakoub province utilizes 93 species of vascular plants from 41 botanical families. The most prevalent families are Lamiaceae (17.20%), Asteraceae (8.60%), Apiaceae (7.53%), Brassicaceae, Euphorbiaceae, and Zingiberaceae, each accounting for 4.30% of the species mentioned. This ethnobotanical study conducted in the Moulay Yaâcoub province allows for the selection of various medicinal and aromatic plants used in traditional phytotherapy by the local population. Consequently, further research is needed, the main focus is on isolating and identifying particular bioactive compounds found in plant extracts.

Keywords: Medicinal plants; Morocco; Moulay Yaâcoub; Plants; Phytotherapy

Introduction

Ecological ethno botany is the study of the relationship between humans and plants. Traditional medicine is a practice based on various cultures' theories, beliefs, and experiences, which relies on natural resources and the knowledge and skills required to utilize them.[1] Plants have played a crucial role in human history as traditional remedies across generations. [2] the use of herbal medicine continues to increase globally, with many people using these products to treat various diseases in different healthcare settings.[3,5] indigenous knowledge of plants as medicines is often passed down orally from one generation to another.[6] Botanical surveys in the form of a well-structured questionnaire are considered an essential tool for recognizing and documenting medicinal plants.[7, 8] Morocco has a high ecological and flora diversity, which constitutes a rich plant reserve, with more than 4500 species of about 940 genera and 135 families. [9] this biodiversity translates into a wealth of medicinal and aromatic plants that are sources of natural products used in various areas, such as food, cosmetics, pharmaceuticals, and perfumery.[10, 11] mountainous regions are known for their high levels of endemism,[36,37] making them biodiversity hotspots.

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Morocco in particular, holds a privileged position among Mediterranean countries due to its rich biodiversity and long-standing medical traditions based on the use of medicinal plants.[38] Phytotherapy has always played a significant role in Morocco's healthcare practices, and the province of Moulay Yaâcoub in the Fes-Meknes region serves as a prime example.

However, an analysis of Moroccan medicinal literature reveals that information on regional medicinal plants is often fragmented and scattered. The recorded number of medicinal plant species does not exceed 600, which accounts for only 14.28% of Morocco's total flora 36. Recognizing the importance of this medicinal plant heritage, we hold the belief that consistent monitoring and evaluation, encompassing quality and quantity aspects, are essential.

The aim of this survey was to assess the knowledge and use of medicinal and aromatic plants in the treatment of various diseases in the province of Moulay Yaâcoub. The goal was to promote the development of this underdeveloped region of the country and to support future scientific validation of the effectiveness of these plants. Unfortunately, there have been few ethnobotanical studies conducted in the province of Moulay Yaâcoub. In this context, we first established an inventory of traditional indigenous medical knowledge as a valuable resource for natural medicine, with the intention of sharing it with the disadvantaged population who cannot afford modern medication.

The data collected will be analyzed using various quantitative indices, including value of use (UV), relative frequency of citation (RFC), level of reliability (LF), and informant consensus factor (ICF).

Material and Methods

Study area

The province of Taounate is located to the north, while the prefecture of Fez is situated to the east and south. To the south, one can find the

provinces of Sefrou and Elhajeb, and to the west, there are the prefectures of Meknes and the province of Sidi Kacem.[25, 26, 27]
The province of Moulay Yaâcoub Figure 1 and 2 boasts thermal springs, which are conveniently located near Fez, just 20 kilometers to the northwest. The sulfurous spring, which emerges from a depth of 1500 meters at a temperature of 52°C, is renowned for its health benefits. The discovery of hyper thermal sulfurous seawater's potential to relieve many illnesses such as skin problems and rheumatic diseases additionally, the province's topography is challenging, featuring plateaus and hills with elevations ranging from 350 to 500 meters, as well as agricultural plains and mountains, including Zalagh and Tghat, with peaks reaching around 910 meters. The province of Zouagha Moulay Yaâcoub has a continental climate, with temperatures ranging from a minimum of 10°C to a maximum of over 30°C. A random survey of villages revealed that 80% of the respondents use and value species of the *Capparis spinosa, Marrubium vulgare*. The individuals interviewed have revealed the frequent use of certain plants for various categories of illnesses. Notably, the *Capparis spinosa* plant stands out as a significant remedy for multiple ailments, including rheumatism, anemia, backache, female infertility, diabetic disorders, and more.
On the other hand, the *Marrubium vulgare* plant is commonly employed for wound healing, acting as a skin anti-scarring agent. It is also utilized as a disinfectant and in the treatment of diabetes, high blood pressure, and respiratory diseases such as coughs, asthma, and bronchitis. Scientific research confirms the effectiveness of these plants. [39, 40, 41]
Thus, the size of the sample can be determined using the following formula [4]:

$$N = \frac{Z^2}{D^2} \times P(1-P) \text{ (Eqn.1)}$$

N: represents the sample size,
Z: is the confidence level according to the normal distribution (for a 95% confidence level, z = 1.96, for a 99% confidence level, z = 2.575).
P: is the estimated proportion of the population with the characteristic (an unknown proportion of the population: p = 0.5) and d represent the tolerated margin of error.
D: a margin of error of 5%
The result is as follows:

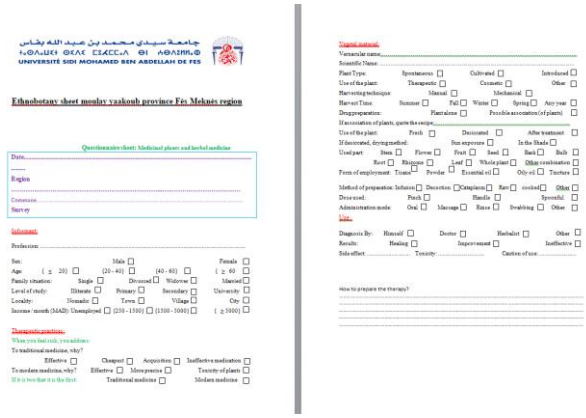
$$N = \frac{1{,}96^2 \times 0{,}5 \times 0{,}5}{0.05^2} = 384,16$$

Ethnobotanical survey and data collection
Between November 2020 and May 2021, a study was conducted in the province of Moulay Yaâcoub to explore medicinal and aromatic plants (MAPs). The research involved conducting open interviews with local residents to identify different MAPs, followed by administering surveys to gather information on the therapeutic uses and preparation methods of these plants. The surveys included questions about the gender, age, education level, and family status of the informants, as well as details regarding the specific plant parts used and the methods of administration. A total of 400 surveys were collected, and the data was processed using Excel and Minitab software to generate tables and graphs.
Plant species identification was conducted at the Laboratory of Engineering, Electrochemistry, Modeling, and Environment (LIEME). This is situated at the Faculty of Science, Sidi Mohamed Ben Abdellah University in Fes, Morocco.

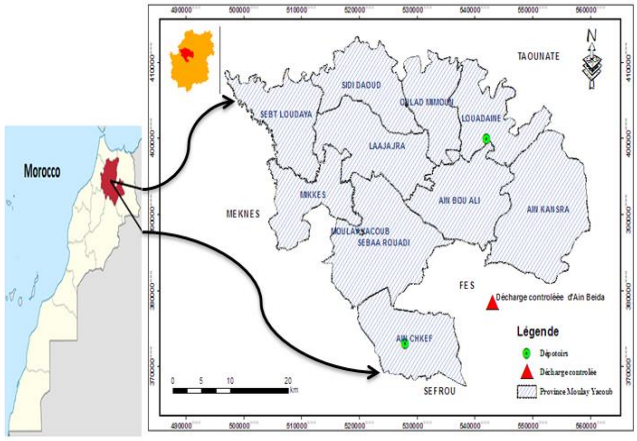
Data analysis
Use Value (UV)
The Use Value (UV) is another index commonly used in Ethnobotanical studies to assess the relative importance of a plant species in a given area. It takes into account both the number of citations and the cultural significance of each use. The formula is $UV = \frac{Ui}{Ni}$ where Ui is the number of uses mentioned for a particular plant species and Ni is the number of informants who mentioned it. A higher UV value indicates a higher cultural importance of the plant species in the study area.[28, 29, 30]

$$UV = \frac{U}{N} \text{ (Eqn. 2)}$$

Where U is the number of uses mentioned by each informant and N stands for the number of informants.



The ethnobotanical questionnaire used in the province of Moulay Yaâcoub, Morocco.



Study area: Province Moulay Yacoub

Figure 1: Geographical location of the survey area, Moulay Yaâcoub, Morocco

Relative Frequency Citation (RFC)
The collected information was analyzed by using a relative frequency citation index (RFC) which reflects the local importance of each species as follows:

$$RFC = \frac{FC}{N} \text{ (Eqn. 3)}$$

$(0 < RFC < 1)$
The term FC, or Frequency of Citation, represents the number of informants who report the use of a specific plant species in Ethnobotanical surveys. It indicates how frequently a particular plant is mentioned by the informants. [12, 13]

Fidelity Level (FL)
FL is applied to identify the most appropriate species to use in treating a specific ailment .[14] the fidelity level was determined as follows:

$$FL = \frac{Np}{N} \text{ (Eqn. 4)}$$

The abbreviation N_P stands for the Number of Informants who reported using a specific species for a particular disease remedy, while N represents the total number of informants for the application of that species.

Informant Consensus Factor (ICF)
The ICF (Informant Consensus Factor) is a measure of the agreement among informants on the most important plants used for a particular purpose. [35] It is calculated as the difference between the number of use citations (Nur) and the number of species used (Nt), divided by the number of use citations minus one (Nur-1). The formula is$= \frac{Nur-Nt}{Nur-1}$. A

high ICF value indicates a high level of agreement among informants on the most important plants used for a particular purpose. [15]

$$ICF = \frac{Nur - Nt}{Nur - 1}$$ (Eqn. 5)

Where Nur designates the number of use records for each disease category and N_t refers to the number of taxa used for a particular use category.

Statistical analysis

The knowledge scores were analyzed using statistical software packages including XLSTAT, Minitab (for social sciences), and Excel. These analyses aimed to assess the influence of factors such as gender, education level, and age on ethno medicine knowledge. Various statistical parameters were calculated, and the data were transformed into appropriate graphical representations to facilitate the study and significance of the results.

Results and Discussion

Demographic characteristics of interviewees

In this study, 200 of the 400 participants use solely traditional medicine, 95 only modern medications, and 105 utilize both phytotherapy and contemporary medicine. There are 289 people who use medicinal and aromatic plants, according to the survey (72.25 %).

Use of medicinal plants by age

The data presented in Figure 3 indicates that individuals between the ages of 40 and 50 were ranked highest, with a 43% frequency of medicinal herb usage. Following them, those aged between 30 and 40 years accounted for 18 percent of the respondents.

People under the age of 20 make relatively little use of medicinal plants, ranking last with 4%. This reflects the younger generation's lack of familiarity with traditional herbal medicine.

It can be seen that the 30-50 age group represents a very high percentage of all respondents. Traditional knowledge of medicinal plants is passed down orally from generation to generation and, if not preserved, is increasingly under threat. As a result, the main source of information on traditional herbal therapies is people aged between 30 and 50. [16]

Use of medicinal plants by gender and education level

In the study region, 75% of the women interviewed utilized medicinal plants, while only 25% of men did so. Additionally, women were found to be more knowledgeable about ethno botany than men.[31, 32] Figure 4 illustrated that the majority of respondents were illiterate, with a 36% usage rate of medicinal plants. Information is generally passed down orally from generation to generation, particularly among the uneducated. Respondents with primary education showed a higher usage rate of traditional medicine at 28%, followed by those with secondary or university education that had a usage rate of 4% and 10%, respectively. The use of plants without proper knowledge of their origin, dosage, and impact on the body can be dangerous to human health, as they may have negative health consequences such as digestive issues, cardiovascular, neurological, respiratory problems, and even death. It is important to note that plants are not always safe and may be toxic or fatal to humans, despite being labeled natural or organic does not imply that they are free of toxins.

Source of information

The community of Moulay Yaâcoub has access to. There are multiple sources of information available. Ancestral experience is the most significant source, accounting for 55% of the total, indicating the transmission of traditional knowledge orally from generation to generation. The second most important source is herbalists (21.10%), followed by reading and research (4.41%), doctors and pharmacists (2.94%), and the end-user (0.98%). It is worth noting that the study also focused on aromatic plants, which are widely used by the local population for their fragrance and flavor, as well as for their medicinal properties.

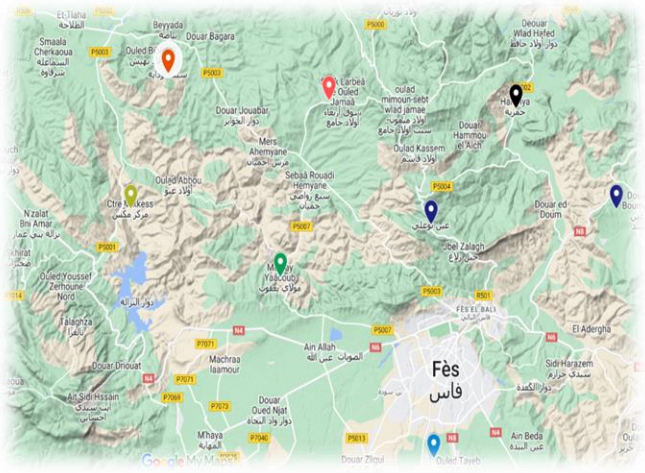


Figure 2: Distribution of survey points in the study area.

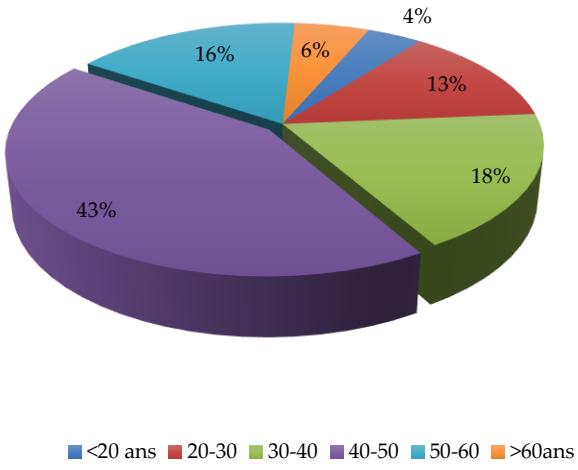


Figure 3: Frequency of plant use by education level

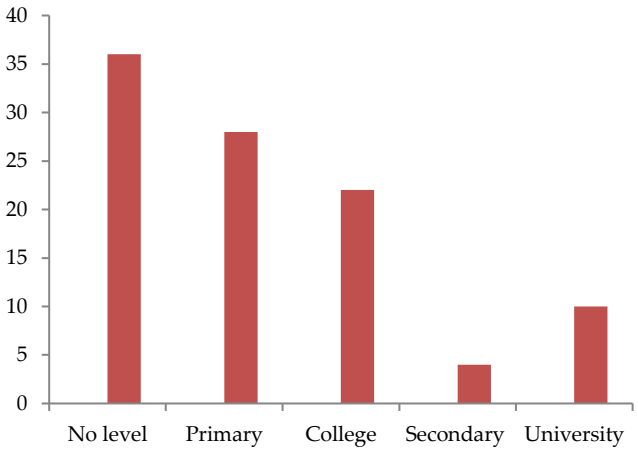


Figure 4: Frequency of plant use by education level.

Distribution of medicinal plants

The investigation of species diversity revealed that the population of Moulay Yaâcoub uses 93 vascular species from 41 botanical families (as shown in Table 1). The most commonly represented families in the region are Lamiaceae (16 species), Asteraceae (8 species), Apiaceae (7 species), and Brassicaceae, Euphorbiaceae, and Zingiberaceae each have 4 species. Together, these families make up 35 species, or approximately 37.11% of the total. The prevalence of Lamiaceae and

Asteraceae aligns with Ethnobotanical research conducted in other North African countries, including Algeria .[17, 18]

Commonly treated diseases and remarkable plants

Table 2 shows a diversification of medicinal and aromatic plants that characterize the targeted region (province of Moulay Yaâcoub) used for the treatment of several diseases. However, it is important to note that the most frequently mentioned diseases include gastrointestinal pain (18.02%), respiratory diseases (9.01%), Osteoarticular disorders. (8.11%), cosmetic uses for skin and hair care (17.12%), oral diseases (7.21%), skin disorders (8.11%), diabetes (11.71%), cardiovascular diseases (5.41%), fever (12.61%), and neurological disorders (2.70%).

Some examples of the medicinal and aromatic plants most cited by the local population in Moulay Yaakoub province during the botanical survey period

Based on the number of citations, *Salvia officinalis* (98 citations) and *Rosmarinus officinalis* (70 citations) are the most commonly used species. *Salvia officinalis* leaves in decoction are used to treat digestive disorders, and it is a digestive plant with multiple medicinal properties. Sage has been used for the regulation of perspiration, menstrual cycles, sore throats, gingivitis, and wound disinfection. Numerous researchers have conducted several studies on the chemical constituents of *Salvia officinalis*, revealing the presence of various compounds such as: α-thujone, β-thujone, and camphor, Cineole, Humulene, α-pinene, Camphene, and Limonene. The leaf extract of Salvia officinalis has been found to have anti-inflammatory, anti-diarrheal, and antipyretic activities.[19]

Parts of used plants

The examination of the data in Figure 5 revealed that leaves are the most commonly used part, accounting for 29.3 percent, followed by aerial parts (26.7%), fruits (16%), seeds (16%), and roots (8%). These findings are in line with other Ethnobotanical research that found leaves and seeds to be the most commonly employed parts in the treatment of various diseases. The increased use of leaves can be attributed to their simplicity and the speed with which they can be harvested. In addition, leaves serve as the primary site of photosynthesis in plants and, in some cases, a storage site for organic compounds responsible for the plant's biological characteristics. These factors contribute to the widespread use of leaves in various applications and remedies. [20, 33, 34]

Various methods of preparing the plants

The analysis of the collected information in Figure 6 showed that the most commonly used method of preparation is infusion, accounting for 45%, followed by decoction (26%), powder form (24%), The remaining methods, namely Compress, Poultice, Raw State, and Maceration, represent a very low percentage, each being less than 5%. Infusion and decoction are the preferred methods, as they extract the most active compounds and cancel out the undesirable effects of certain recipes. [21,22.] Infusion is a method of extracting the active principles or aromas of a plant by dissolving it in initially boiling liquid that is then left to cool. The term also refers to drinks prepared by this method, such as herbal teas or regular tea. Decoction, on the other hand, is a method of extracting the active principles and/or flavours of a preparation, usually a plant, by dissolving it in boiling water. It is typically used for the harder parts of plants such as roots, seeds, bark, and wood. It is used in herbal medicine, dyeing, brewing, and cooking. [23] the term also refers to the preparations obtained by this method. Powders are obtained through drying and grinding. The whole plant retains its quality well after drying, as plant cells are adapted to water scarcity. However, grinding has the potential to affect the stability of active ingredients over time. The quality of grinding is an important factor in achieving a high-quality powder, ideally as fine as possible (using hammer, scissors, or disc grinding).

Table 1: Medicinal plants employed within the region of Moulay Yaâcoub in Morocco

Family	*Scientific name*	Arabic name	Used part	Preparation mode	Traditional use
Amaranthaceae	*Spinacia oleracea* L. 201Am 01 So 001	Sabanikh	Aerial part	Other	Digestion, immune system
Aizoaceae	*Malephora lutea* (Haw) Schwanthes 202Az 01 Ml 001	Lghassoul	Stem/Leaf	Decoction	Hair care, cosmetics
Amaryllidaceae	*Allium sativum* L. 203Li 01 As 001	Touma	Fruit	Other	Hair care, Appetite stimulant
Apiaceae	*Ammi visnaga* L. 204Ap 01 Av 001	Khila	Aerial part	Infusion	Digestive problems, respiratory system
	Pimpinella anisum L. 205Ap 02 Pa 001	Habbat hlawa	Entire plant	Decoction	sciatica
	Foeniculum vulgare P.Mill 206Ap 03 Fv 001	Nafaa	Entire plant	Powder	Obesity, stomach pain, intestinal diseases
	Petroselinum sativum Hoffm. 207Ap 04 Ps 001	Lmaadnouss	Stem, leaf	Decoction	Kidney stones
	Foeniculum dulce D.C 208Ap 05 Fd 001	Bessbass	Fruit	Powder/decoction	Difficult digestions or stomach aches
	Eryngium tricuspidatum L. 209Ap 06 Et 001	Mghizela	Sheet	Powder	Fever

	Cuminum cyminum L. 210Ap 07 Cc 001	Kamoun	Fruit	Infusion / powder	Tiredness, activation of blood circulation, regulation of hormones
Asteraceae	*Artemisia absinthium* L. 211As 01 Aa 001	Chiba	Aerial part	Infusion	stomach ache, tiredness
	Inula viscosa Ait. *(Dittrichia viscosa* L. Greuter*)* 212As02 Iv 001	Inula (magramane)	Aerial part	Infusion / decoction	anti-inflammatories
	Helichrysum italicum 218As07 Iv 001	Limortel	Aerial part / Entire plant	Decoction /infusion	promotes the disappearance of rosacea and varicose veins, against burning
	Chamaemelum nobile L. 213As 03 Cn 001	Babounj	Sheet	Decoction	Indigestion
	Artemisia herba alba Asso 214As 04 Aha 001	Chih	Sheet	Infusion/ maceration / decoction	digestive problems, joint and muscle pain
	Echinops spinosus L. 215As 05 Es 001	Taskra	Root	Infusion/ decoction	regulate the menstrual period, increase the sperm count
	Stevia rebaudiana Bertoni 216As 06 Sr 001	Stivia	Aerial part/ Sheet	Infusion/ decoction	Antidiabetic
	Anacyclus pyrethrum L. 217As 07 Ap 001	Ginass	Root	Powder	against tiredness, activation of blood circulation, regulation of hormones
Brassicaceae	*Lepiduim sativum* L. 218Br 01 Ls 001	hab rechad	Fruit	Infusion/cataplasm	Reduces the effects of anemia, memory
	lepidium meyenni Walp. 219Br 02 Lm 001	ochbat maka	Sheet / Root	Infusion/ decoction	Tiredness - stress
	Brassica nigra L. 220Br 03 Bn 001	Bouhamou	Aerial part	Powder	Difficulty of digestion
	Nasturtium officinale R. Br. 221Br 04 No 001	Grnounch	Aerial part	Other	strengthen hair, cosmetics
Cactaceae	*Opuntia ficus indica* (L.) Mill. 222Ca 01 Opi 001	Zeaboul	Flower/fruit	Infusion/other	cosmetics
Capparaceae	*Capparis spinosa* L. 223Cp 01 Cs 001	Kbar	Fruit	Powder	antidiabetic
Caryophyllaceae	*Corrigiola telephiifolia* Pour. 224Cr 01 Ct 001	sarghina/fowa	Root	Powder /infusion	strengthen the immune system

Chenopodiaceae	*Chenopodium Ambrosioides* L. 225Ch 01 Ca 001 *Ambrosioides*	Mkhineza	Aerial part / Entire plant	Infusion, Powder	Diarrhea, fever
Euphorbiaceae	*Euphorbia falcate* L. 226Eu 01 Ef 001	hayat noufous	Entire plant	Infusion	Increase sexual desire
	Euphorbia officinarum L. ssp. *Echinus* Vindt. 227Eu 02 Eo 001	Dghmouss	Stem	Raw	strengthen the immune system, cancer
	Ricinus communis L. 228Eu 03 Rc 001	Khrawae	Aerial part	Decoction/infusion	Hair, cosmetics
	Mercurialis annua L. 229Eu 04 Ma 001	Hriga	Aerial part	Infusion/ other	strengthen the immune system, the intestine
Fabaceae	*Trigonella foenum-graecum* L. 230Fa 01 Tfg 001	Halba	Seed	Decoction / Powder	weight increase, immune
	Phaseolus aureus Roxb. 240Fa 02 Pa 001	Soja	Entire plant	Oil	kidney disease
	Glycyrrhiza glabra L. 241Fa 03 Gg 001	Aarq souss	Root	Powder	Cholecystitis, cough, asthma,
Lamiaceae	*Ocimum basilicum 242Lm 01 Ob 001*	Hebak	Aerial part	Infusion	Anti-nausea, antispasmodic of the digestive tract
	Calamintha officinalis Moench. 243Lm 02 Co 001	Maneta	Aerial part	Infusion/ Powder	Digestive disorder, stress, psychological fatigue
	Lavandula officinalis L. 244Lm 03 Lo 001	Khezama	Sheet	Infusion	anti-inflammatory, rheumatism, cramp
	Lavandula stoechas L. 246Lm 04 Ls 001	Helhal	Sheet / stem	Infusion/decoction	antidiabetic
	Origanum majorana L. 247Lm 05 Om 001	mredoudech	Aerial part	Infusion/decoction	headache
	Teucrium polium L. 250Lm 06 Tp 001	Al'khiyyata	Sheet /stem	Infusion/decoction	Anti-inflammatory-antitoxic
	Marrubium vulgare L. 251Lm 07 Mv 001	Mreout	Aerial part	Infusion	antitussive ; anti-infectious, disinfectant
	Mentha x piperita L. 252Lm 08 Mxp 001	naenaae abdi	Aerial part	Infusion	Urinary disorders, Coughs and colds, respiratory problems
	Mentha pelugium L. 253Lm 09 Mp 001	Fliou	Aerial part	Infusion/decoction	Fever/cold

	Mentha rotundifolia Auct. 254Lm 10 Mr 001	Mressita	Aerial part	Infusion/powder	Stomach disease, digestive problems
	Origanum compactum Benth. 255Lm 11 Oc 001	Zaatar	Aerial part	Infusion	Strengthen the immune system
	Rosmarinus officinalis L. 256Lm 12 Ro 001	Azir	Aerial part / Sheet	Infusion	Urinary infections, painful periods, rheumatism, colds
	Salvia officinalis L. 257Lm 13 So 001	Salmia	Aerial part	Infusion	Astringent and antiseptic, anti-inflammatory
	Thymus maroccanus Ball. 258Lm 14 Tm 001	Zeitra	Aerial part	Infusion	stomach problems, digestion problems
	Thymus Zygis L. 259Lm 15 Tz 001	Zeitra	Aerial part	Infusion	Stomach problems, digestion problems
	Vitex agnus-castus L. 260Lm 16 Vac 001	Kharwâe	Sheet/seed	Infusion/ powder	Hair loss, cosmetics
Lauraceae	*Cinnamomun zeylanicum* Nees. 261Lr 01 Cz 001	Karefa	Bark	Powder	Antidiabetic, weight reduction
Linaceae	*Linum usitatissimum* L. 262Ln 01 Lu 001	zeriaat ktan	Fruit/Seed	Infusion	weight reduction, antidiabetic
Myrtaceae	*Myrtus communis* L. 263My 01 Mc 001	Rihan	Entire Plant/Leafs	Infusion	Cancer, anti-stress
	Syzygium aromaticum L. 264My 02 Sa 001	Krenefel	Fruit	Powder /decoction	Nausea, indigestion, headache
Oleaceae	*Olea europaea* L. 265Ol 01 Oe 001	Zitoun	Sheet	Powder /infusion	Diabetes
	Jasminum officinale L. 266Ol 02 Jo 001	Yasamin	Aerial part	Infusion	Trouble falling asleep, soothe tension, calm nerves
Papaveraceae	*Papaver rhoeas* L. 267Pv 01 Pr 001	Belâaman	Fruit	Powder	soothes coughs and throat irritations
	Fumeterre officinale *Fumaria officinalis* L. 268Pv 02 Fo 001	bakalat malik	Aerial part	Infusion/decoction	Skin disease, liver regulator
	Papaver somniferum L. 269Pv 03 Ps 001	Kherchacha	Fruit	Powder	Digestion problems
Pinaceae	*Pinus halepensis* Mill. 270Pin 01 Ph 001	Tayda	Bark	Powder	Respiratory tract diseases, treatment of bronchitis

Piperaceae	*Piper nigrum* L. 271Pip 01 Pn 001	Ibzar	Seed	Powder	Digestive stimulant, anti-inflammatory
Poaceae	*Agropyrum repens* P. Beauv. 272Poa01 Ar 001	Nejam	Root/rhizome	Decoction	Urinary inflammation
	Sorghum vulgare *273Poa 02 Sv 001*	Dora rafiaa	Entire plant/Leafs	Infusion/ powder	Cosmetics for skin and hair
	Panicum miliaceum L. Ou *Penisetum typhoides* Burm. 274Po 03 P 001	Ilane	Fruit	Infusion	Nutritional properties
Ranunculaceae	*Nigella sativa* L. 275Ran01 Ns 001	Sanouj	Seed	Powder	Immune system, skin and hair problems
	Ranunculus bullatus L. 276Ran 02 Rb 001	wdan lhalouf	Root	Powder	Pregnancy
Salicaceae	*Populus alba* L. 277Sal 01 Pa 001	Safsaf	Sheet	Decoction	Fever/weight loss/teeth pain
	Populus nigra L. 278Sal 02 Pn 001	Safsaf	Sheet	Decoction	Fever/weight loss/teeth pain
Solanaceae	*Datura stramonium* L. 279Sol 01 Ds 001	chedak jmal	Seed	Smoking	Muscle relaxation
	Capsicum annuum L. 280Sol 02 Ca 001	felfla hamera	Fruit	Powder	Digestion problem
	Mandragora automnalis Bertol. 281Sol 03 Ma 001	Mandragore	Aerial part	Decoction	Anti-inflammatory
	Capsicum frutescens 282Sol 04 Cf 001	Flifla	Fruit	Powder	Digestive problems, flu, colds
Thymelaeaceae	*Thymelaea hirsute* 283Thy 01 Th 001	Mtnane	Entire plant/leaf	Infusion	Reduction in the rate of hyperglycemia
Verbenaceae	*Aloysia triphylla* Britt. 284Veb 01 At 001	Louiza	Sheet	Infusion	Anti-Stress, easy sleep
Xanthorrhoeaceae	*Asphodelus fistulosus* L. 285Xan 01 Af 001	Brewag	Root	Infusion/maceration	Care for wounds
Zingiberaceae	*Alpinia officinarum* Hance 286Zin 01 Ao 001	Khedanjel	Rhizome	Infusion	reduce rheumatic pain or arthritis

	Elettaria cardamomum White & Maton 287Zin 02 Ec 001	habat hil	Seed	Infusion/ decoction	Perfume for tea or coffee, against grapes
	Zingiber officinale Rosc. 288Zin 03 Zo 001	Skin jbir	Rhizome	Powder / decoction	Rheumatism, colds, fever, diabetes
	Zingiber officinale	Zanjabil	Rhizome	Powder	Digestive problems
Malvaceae	*Malva sylvestris* L. 289Mal 01 Ms 001	Lkhobbiza	Sheet	Decoction	Urinary infections, diarrhea
Musaceae	*Musa acuminata* Colla 290Mus 01 Ma 001	Banan	Barking	Cataplasm	Dental hygiene
Rosaceae	*Rosa centifolia* Mill. 291Ros 01 Rc 001	Lward	Flowers	Cataplasm	hair loss
	Crataegus monogyna Jacq. 292Ros 02 Cm 001	ochbat zoror	Sheet	Infusion	Heart disease
Rubiaceae	*Rubia tinctorum* L. 293Rub 01 Rt 001	Lfowwa	Root	Powder	anemia
Rutaceae	*Citrus limon (*L.) Risso 294Rut 01 Cl 001	Alhamad	Fruit	Juice	kidney disease
	Ruta chalepensis L. 295Rut 02 Rc 001	Fijal	Sheet/ Aerial part	Infusion/decoction	Anti-inflammatory, coffee flavoring
Amaranthaceae	*Atriplex halimus* L. 296Ama 01 Ah 001	Katf	Sheet / Entire plant	Powder /infusion	Cancer
Punicaceae	*Punica granatum* L. 297Pun 01 PG 001	qchor arraman	Exterior shell	Infusion/decoction	anti-inflammatory, cancer, digestive problems
Geraniaceae	*Pelargonium sp* 298Ger 01 Psp 001	Gharnok	Aerial part	Infusion/decoction	skin problems, cosmetic, anti-scar
Scrophulariaceae	*Verbascum thapsus* L. 299Scr 01 Vt 001	maslah ndar	Aerial part	Infusion/decoction	Dry cough, sore throat
Goldcrest	*Cupressus macrocarpa* 300Cup 01 Cm 001	sipri citron	Aerial part	Infusion/decoction	Calm persistent coughs
Meliaceae	*Azadirachta indica* A. Juss. 301Mel 01 Ai 001	ochbat nim	Sheet	Infusion/decoction	Strengthen the immune system
Ginkgoaceae	*Ginkgo biloba* L. 302Gin X Gb 001	ochbat jinko	Ginkgoaceae	*Ginkgo biloba* L. 302Gin X Gb 001	ochbat jinko
Anacardiaceae	*Pistacia lentiscus* L. 303Ana 01 Pl 001	Drow	Sheet	Infusion/decoction	colds, for the stomach

Use value (UV) and relative frequency of citation (RFC)
According to the survey, *Salvia officinalis* emerged as the most extensively utilized plant species, exhibiting the highest UV index (0, 35) and RFC coefficient (0,245). *Rosmarinus officinalis* stood out as another noteworthy medicinal species, ranking second in terms of UV index (0.28) and RFC coefficient (0.26). *Capparis spinosa* secured the third position among medicinal species, displaying a UV index of (0.085) and an RFC coefficient of (0, 0375). Other medicinal species frequently reported, albeit with lesser usage, include *Ruta* (UV = 0.055; RFC = 0.045), *Verbascum Thapsus* (UV = 0.0475; RFC = 0.0375). The frequent mentions of these species by numerous informants contribute to their high UV index. The UV index is directly influenced by the number of informants who report using a particular plant for medicinal purposes. Medicinal plant species with a high UV index require more in-depth phytochemical analysis in order to search for and extract the bioactive molecules that characterize the species for the manufacture of drugs, as described in reference. [45] additionally, these species should be prioritized for conservation since their preferred uses may pose a threat to their populations due to overexploitation.

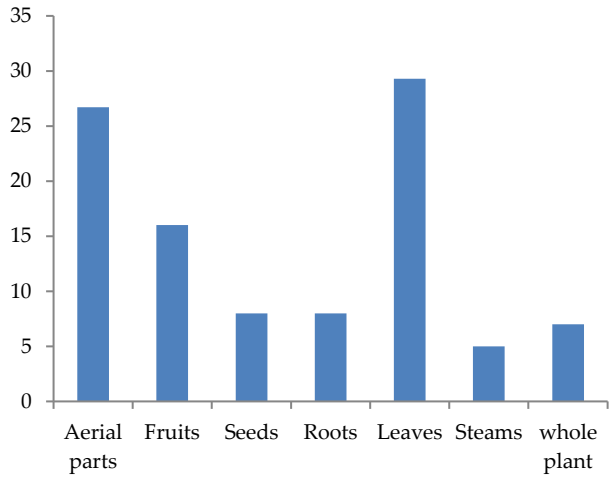


Figure 5: Frequency of used plant parts

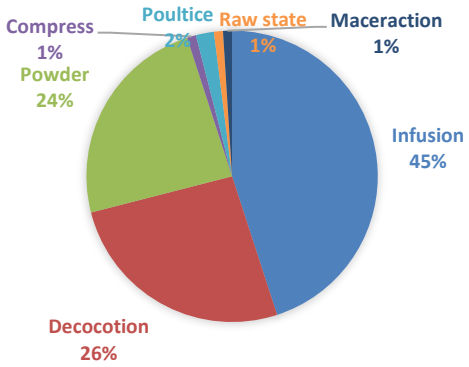


Figure 6: Plant preparation methods

Fidelity level (FL)
The outcomes are presented in the supplementary file, where the fidelity level is indicated. In this file, the particular disease treated by a species is highlighted in bold. The degree of fidelity signifies the preferred species reported by informants in the study area for treating specific diseases. The following plants had the highest LF values (100%) : *Salvia officinals, Rosmarinus officinalis, Malva sylvestris, Rosa canina, Rubia tinctorum, Citrus limon, Elettaria cardamomum, Zingiber officinale Roscoe, Aloysia triphylla/veirvine, Capsicum annuum, Jasminum, Linum usitatissimum, Myrtus communis, Syzygium aromaticum, Vitex agnus-castus, Thymus maroccanus, and Thymus Zygis.*
In general, when the FL (Fidelity Level) of a specific plant is 100%, it indicates that all reports of its use mentioned the same method of plant use for treatment.[44]

Informant Consensus Factors (ICF)
For each condition category, the ICF was determined, and the range was (0.989 -0.950) (Table 2). The ICF values discovered were close to 1, indicating a high level of know homogeneity among the informants. GI difficulties (0.989), skin and hair problems (0.989), diabetes problems (0.987), and respiratory problems all had the highest informant consensus factor values (0.983). Other studies found the same result as Morocco in terms of the greatest ICF of gastrointestinal issues. [24]
The results of the ICF analysis demonstrated that common diseases in the Moulay Yaakoub province had the highest level of consensus among the informants. These high ICF values indicate a reasonable reliability of the informants regarding the use of plant species for treating specific ailments. [42]
The consensus values of the informants also indicated that they shared knowledge about the most important medicinal plant species for treating the most frequently encountered diseases in the study region. Therefore, plant species with high ICF values should be prioritized for further pharmacological and phytochemical studies. [43]

Conclusion

An Ethnobotanical study carried out in the province of Moulay Yaâcoub has highlighted the significance of traditional phytotherapy. The study identified 93 medicinal plant species belonging to 41 botanical groups, which are used to treat a variety of ailments. The study revealed that people aged between 30 and 50 have the most knowledge of traditional herbal medicine, and that the majority of herbal medicine users are uneducated. The study also indicates that leaves processed into decoction and infusions are the most commonly used, and are taken orally. Digestive and respiratory diseases are the most frequently mentioned ailments in these traditional remedies. These findings provide a valuable database for future scientific research aimed at in-depth evaluation and scientific validation, while preserving this important cultural heritage. In addition, Biodiversity in the province of Moulay Yaâcoub has an environmental value of considerable Socio-economic significance, which needs to be preserved from haphazard exploitation.

Conflict of Interest

The authors declare no conflict of interest.

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.

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Table 2: Factor of consensus of informant

Category	Number of used reports	Percentage of used reports	Number of taxa	ICF
Gastro intestinal	2000	33.4	23	0.989
Respiratory problems	300	5.0	6	0.983
Osteoarticular diseases	180	3.0	7	0.966
Skin and hair	1600	26.7	19	0.989
Dental and oral diseases	130	2.2	4	0.977
Skin disorders	182	3.0	9	0.956
Diabetes	400	6.7	6	0.987
Cardiovascular diseases	110	1.8	6	0.954
Fever	986	16.5	20	0.981
Neurological disorders	101	1.7	6	0.950

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