Large-scale ethnomedicinal inventory and therapeutic applications of medicinal and aromatic plants used extensively in folk medicine by the local population in the middle atlas and the plain of Saiss, Morocco

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Research

Abstract

Background: In this work, we carried out a thorough ethnomedicinal investigation of the aromatic and therapeutic plants used in several Middle Atlas and the plain of Saiss provinces (central Morocco). Our goal was to gather data on the variety of plants used, their therapeutic applications, and the portions utilized by local inhabitants.

Methods: In eight provinces, including Azrou, Ifrane, Elhajeb, Immouzar, Sefrou, Fez, Meknes, and Mrirt, interviews were done during the 2018-2019 season. Descriptive and multivariate statistics were used to analyze the collected data. To assess the value of medicinal plant resources, we estimated the Family Use Value (FUV), Medicinal Use Value (MUV), and Relative Frequency of Citation (RFC). We next sought consensus among the participants on the reported cures for each category of disorders using the ICF.

Results: A total of 154 different kinds of aromatic and medicinal plants from 56 different families were discovered, and local people used them for therapeutic purposes. The most recorded family was Lamiaceae, with 14 species and FUV=0.47. *Urtica pilulifera* L, was the most frequently utilized species and had the highest RFC equal to 0.425. The most frequently utilized preparation techniques were decoction and brewing, and the most frequently administered portions were the leaves and leafy stems. Additionally, the ICF values per use category ranged from 0.53 to 0.97. Cancer was the category with the highest ICF value (0.97). Conclusions: By advancing knowledge of the medicinal flora and preserving ancestors' wisdom in Morocco's Middle Atlas and the plain of Saiss, the current study could be of tremendous service.

Keywords: Ethnomedicinal, medicinal plants, Middle Atlas, Plain of Saiss, Morocco, traditional medicine.

Background

People have always coexisted with plants and reaped their therapeutic and nutritional benefits (Sharma *et al.* 2021; Singh *et al.* 2022). Aromatic and medicinal plants are prized by a number of industries (cosmetics, pharmaceuticals, agri-food, phytosanitary, culinary, etc.) because of their active components, which serve as the foundation of the economy and societal growth (Osorio *et al.* 2021; Premachandran & Murthy 2022).

Morocco is one of the Mediterranean nations with a long history of employing medicinal plants as natural substitutes for medication, food, and a variety of other uses (Chaachouay *et al.* 2022; Zougagh *et al.* 2019). Its civilizations have preserved this heritage through the ages out of respect for these riches of flora. The scientific pharmacopoeia is starting to apply this knowledge as a result of scientific advancements (Beniaich *et al.* 2022). Because of a variety of geographical and climatic circumstances, Morocco has a vast wealth of aromatic and medicinal plants, which merits additional research and development in light of the more demanding and competitive global market. This is not by accident (Bouyahya *et al.* 2018; Elachouri *et al.* 2021).

Morocco has an extremely diverse ecology because of its biogeographical location and Mediterranean climate, resulting in a significant floristic multiplicity (Ajbilou *et al.* 2006; Msanda *et al.* 2021). Therefore, it is one of the Mediterranean nations whose people have long practiced traditional medicine and have gained knowledge in this area through the usage of medicinal herbs (Scherrer *et al.* 2005). With over 5200 plant species, including 900 indigenous species, the Moroccan pharmacopeia is both rich and diverse (Barkaoui *et al.* 2017). In addition, only 10% of these plants are cultivated, with the majority being found in the wild. Morocco, with all of its scientific, industrial, and social authority, has been able to advance this MAP industry after realizing its wealth in this field.

However, as in the vast majority of terrestrial areas and everywhere else on earth, the biodiversity crisis persists, with the irrational exploitation of natural species from relatively few wild cultures posing a serious threat to them (Kleijn *et al.* 2011). It is getting more and more difficult to preserve and protect this abundance of flora in the face of this dire and dangerous scenario (Pyšek *et al.* 2020). Data on aromatic and therapeutic plants are extremely incomplete and dispersed, according to an analysis of the Moroccan medicinal literature (Benkhnigue *et al.* 2010, 2014). Similarly to this, only a small number of individuals presently possess traditional knowledge, and among them, there is a significant rate of illiteracy (Hseini & Kahouadji 2007). To improve, conserve, and utilize traditional knowledge rationally, it is necessary to preserve ancestral knowledge and convert it into scientific knowledge. An ethnomedicinal study was done in the Middle Atlas and the Plain of Saiss region, which have a sizable amount of floristic and ecological diversity and provide its population with a wealth of traditional phytotherapy expertise.

In order to identify the various plants used in traditional pharmacopeia and gather as much data as possible on how these plants are utilized, a series of ethnomedicinal surveys were conducted in the Middle Atlas and the plain of Saiss region. The principal objectives of this paper were; i) the identification of medicinal plants used among the populations of the Middle Atlas and the plain of Saiss, ii) the characterization of use methods and used parts, and iii) the description of the local population that uses these plants.

Material and Methods

Study area

This study was carried out in two regions: the Middle Atlas and the Plain of Saiss, located in central Morocco (Fig. 1). The Saiss plain covers an area of 40.075 km2, which is equivalent to 5.7% of the country. Additionally, this region administratively unites the seven provinces of El Hajeb, Boulemane, Taounate, Moulay Yaâcoub, Ifrane, Sefrou, and Taza with the two prefectures of Fez and Meknes. Additionally, there are 194 communes in this region, including 33 municipalities and 161 rural communes. Due to its history and its geographical location in the heart of the Kingdom, the Region of Fez-Meknes constitutes a strategic crossroads for the various economic activities and for the internal and external animation of the exchanges. The Middle Atlas, on the other hand, is a mountainous region that extends from Khenifra to the east of Morocco. This chain connects Khenifra-Beni Mellal, Fez-Meknes, Deraa Tafilalt, and Taza-El Hociema.

According to its geographic location, the climate of the Saiss plain (Fez-Meknes region) can be divided into three categories. The continental climate, which predominates in the northern regions, is typified by hot, dry summers and chilly, humid winters. On average, around 500 mm of rainfall occurs annually. In mountainous zones of the Middle Atlas, the winter is chilly, muggy, and snowy, while the summer is mild. The annual average rainfall is over 700 mm, and the downpours are followed by hailstorms and flooding. The climate is semi-arid and there is only an

average annual rainfall of 250 mm in Boulemane's high hills. With virtually daily frosts and a large number of days without a thaw, the winter is bitterly cold and snowy.

The collection of data was realised in six sites, including Azrou, Immouzar, Ifrane, in Middle Atlas, as well as Elhajeb, Fez and Meknes in Saiss plain.

Figure 1. Geographical location of the study sites

Interviews with resource people and methodology

The ethnomedicinal ethnopharmacological survey was conducted in the 2018-2019 academic year. In order to achieve the study's goals, a questionnaire form was created and sent throughout the neighborhood. At the study sites, it was expected to gather as much information as possible about medicinal and aromatic plants. The survey was divided into two sections: one for the respondent's biography (surname, first name, age, sex...) and one for the plants (vernacular name, portion used, pathologies treated...). The ethnomedicinal surveys were conducted utilizing the random and stratified sampling strategy (Daget & Godron, 1982), which enabled the use of a representative sample and is a useful method for getting the most comprehensive inventory feasible (Lahsissene *et al.* 2009).

The study region, which spanned from Sefrou to Mrirt via Immouzar, Ifrane, Fes, Meknes, El Hajeb, and Azrou, was divided into eight strata for this study. Each stratum has twenty-five people that were interviewed. In order to determine the groupings of plants utilized and all the traditional local therapeutic uses, the data was gathered, processed, and statistically analyzed using Microsoft Word Excel and SPSS software.

In this study, we included common names because both our informants used the Arabic and Roman alphabets to refer to them. We followed Bellakhdar's instructions for romanizing the vernacular names (Bellakhdar, 1997). The

Plant List website was used to review and update all scientific names (Rivera *et al.* 2014; www.theplantlist.org). The WHO's global illness classifications (Staub *et al.* 2015).

Similarly, the determination of the collected species was done thanks to the botany professor of the laboratory of research and the documents (Fennane, 1999; Fennane *et al.* 2007, 2014), the traditional Moroccan pharmacopoeia, ancient Arabic medicine, popular knowledge (Bellakhdar, 1997), and the medicinal plants of Morocco (Sijelmassi, 1993)

Calculation of indexes

Data from informant interviews were examined using several statistical quantitative tools, such as medicinal Use Value (Phillips & Gentry 1993), Relative Frequency of Citation (RFC) (Tardío & Pardo-de-Santayana 2008), Family Use Value (FUV) (Ghasemi *et al.* 2013) and Informant Consensus Factor (ICF) (Heinrich *et al.* 1998), in order to determine the importance of medicinal plant resources (MUV) (Bouayyadi & Zidane 2020; Orch *et al.* 2020).

Statistics

Before starting the statistical analysis, we checked for the normality of all studied parameters. Further, we calculated the percentages of all variables, including sex ratio (females and males), ages (25-34, 35-44, 45-54, 55-64 and 65-74 years old), levels of education (primary, college, high school, university, and illiterate), professions (Herbalists, traditional practitioners, housewives, Peasants, and without), and therapeutic practices (modern, traditional, and both). Sex ratio was compared with a simple t-test (two variables).

To clarify the variation in educational levels of interviews, studied sites (n=8 sites) were considered as independent variables, while education levels (n=5) were considered as dependent variables and then analyzed with Detrended Correspondence Analysis. A similar method was used to clarify the distribution of age groups (n=5), professions (n=6), and therapeutic practices (n=3) among studies provinces (n=8). As a result, only axes with eight values superior to 1 were considered.

Results and Discussion

Demographic characteristics of participants

The people surveyed differed in terms of age, sex, level of education, profession, and therapeutic practices. The results found are presented in table 1 as follows:

Table 1. Demographic characteristics of the participants (Age, Gender, Education, Profession and Therapeutic practices)

	Categories	Statistics (200)	Percentages (%)
Age	25-34	45	22.5
	35-44	**51**	**25.5**
	45-54	40	20
	55-64	39	19.5
	65-74	25	12.5
Gender	F	73	36.5
	M	**127**	**63.5**
Education	Illiterate	39	19
	Primary	**62**	**31**
	College	49	25
	High school	38	19
	University	12	6
Profession	Without	25	12
	Housewife	56	28
	Herbalist	**71**	**35**
	Tradipratician	10	5
	Peasant	23	12
	Other	15	8
Therapeutic practices	Traditional medecine	60	30
	Modern medecine	17	8
	Both	**123**	**62**

Age groups

A total of two hundred informants were interviewed in the study zone and the results are presented in table 1. The age of the studied people ranged from 25 to 74 years old. However, the 35-44 age group was the most dominant with 25.5%, followed by the 25-34 age group with 22.5%, and the 45-54 age group with 20%. In contrast, the 55-64 and 65-74 age groups were the least recorded with 19.5% and 12.5%, respectively. These findings revealed that young people today are increasingly interested in medicinal plants and are working to preserve their ancestors' knowledge. Our findings are in contradiction with investigations conducted in other Moroccan regions, including Bouhachem Natural Regional Park (Rif of Morocco), Nador (Northeastern Morocco), and High Moulouya (Central Morocco), where adults over the age of 50 dominated the users of the aromatic and medicinal plants (Bachar *et al.* 2020; Benlamdini *et al.* 2014; Hayat *et al.* 2020). For example, age groups of 50-60 and over 60 dominated the interviews conducted by Najem *et al.* (2020) in the Middle Atlas (central Morocco) with 30.37% and 24.36% respectively. In our case, age groups of 65-74 and 55-64 dominated four cities, Meknes, El Hajeb, Azrou, and Ifrane. In Immouzar three age groups, including 25-34, 35-44, and 45-54 were dominant, while in both Fez-Sefrou and Mrirt, the interviewees did not have a specific age (the age groups were indifferent) (Fig. 2). Similar results were recorded in El Hajeb, Ifrane, and M'rirt where the users of medicinal plants were dominated by 50-60 and over 60 age groups (Najem *et al.* 2020).

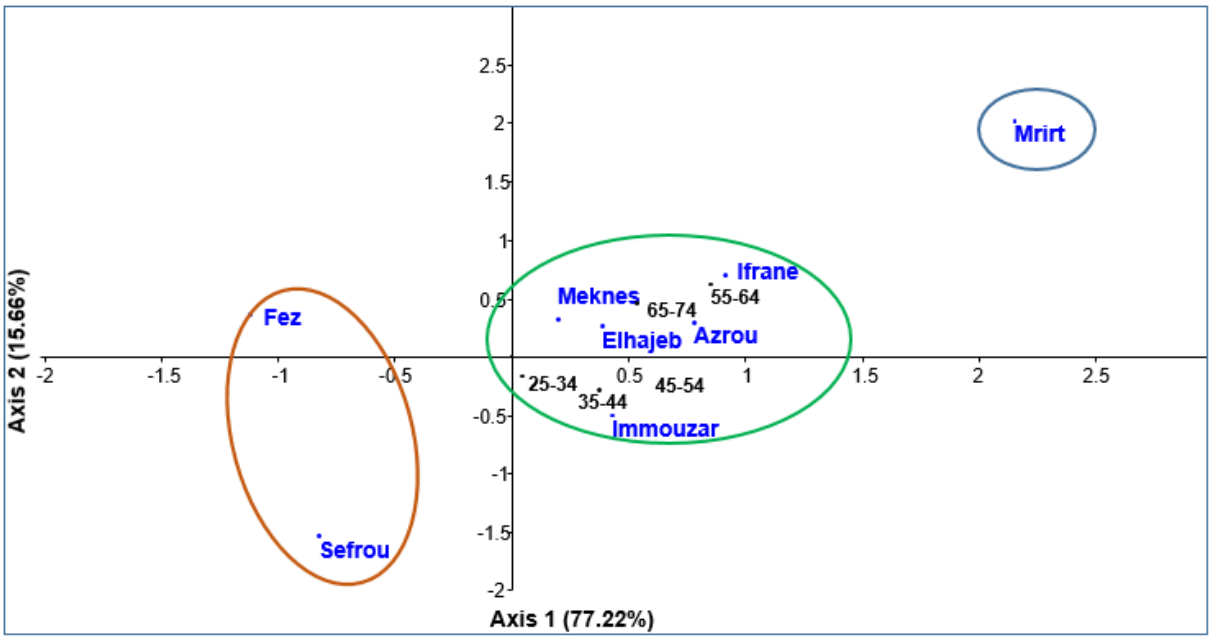

Figure 2. Distribution of informants' age group following studied regions

Gender

The majority of interviewees (64%) were men, indicating that there are still more men than women working in the phytotherapy and sale of aromatic and medicinal plants (n=73) (n=200, t=6.22, p<0.001). The establishment of grouping units in the shape of cooperatives or organizations with a focus on medicinal and aromatic plants has, however, made the presence of women more apparent in recent years. This rate indicates that women are more interested in traditional pharmacopeia, which is in contradiction with the results mentioned in the Middle Atlas, Northwest, and High Atlas of Morocco, where 87.40% were men and only 12.60% were women (Bachar *et al.* 2020; Bouayyadi & Zidane, 2020; Hilah *et al.* 2016, Najem *et al.* 2020).

Education level

The education level of the studied samples was variable (Table 1). Elementary education and college were the most dominant, with 31% and 25%, followed by high school diplomas and illiteracy with 19%. In contrast, only 6% of interviewed people have a university education (Fig. 3). Regarding geographical distribution, university education was dominant only in Fez, while in Sefrou and Meknes, high school was dominant. Illiterate and primary-dominant people dominated the investigated population in five cities, including Immouzar, Azrou, Elhajeb, and Ifrane from the Fez-Meknes region, and Mrirt from Beni-Mellal-Khenifra. These findings showed that the majority of participants have a medium education level, which is similar to the 42% of secondary and 28% of primary education levels recorded in the Middle Atlas by Najem *et al.* (2020).

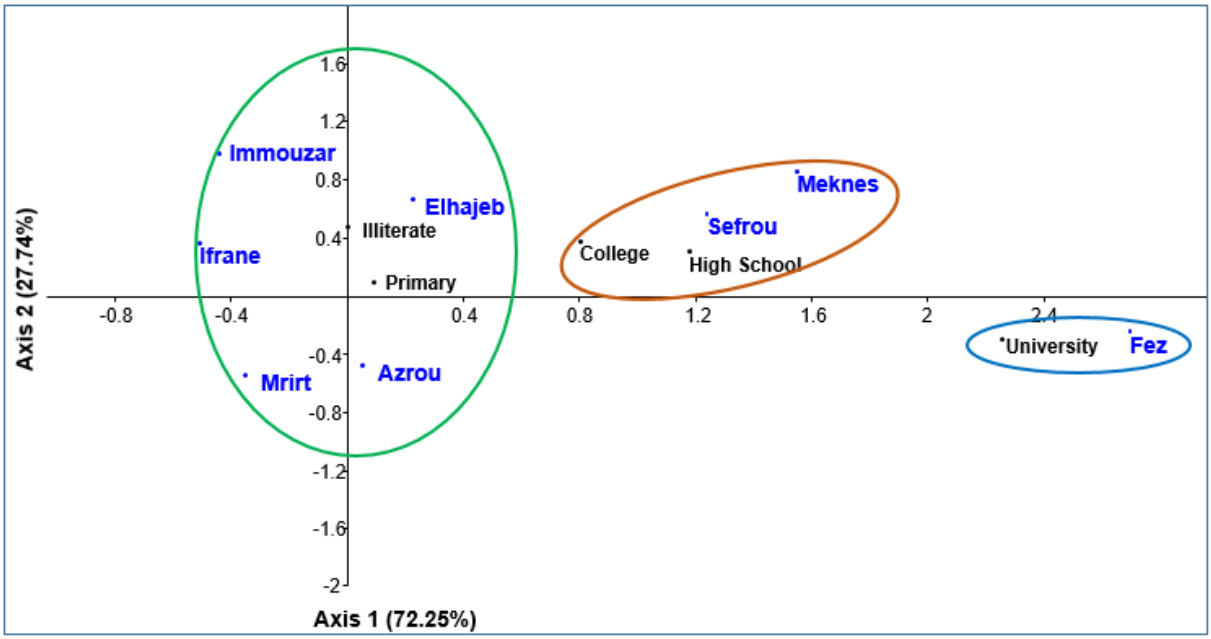

Figure 3. variation of the education level of intervewees among prospected provinces

Profession

According to their profession, respondents were distributed as follows: Herbalists represented 35% of the surveyed population, followed by 28% of housewives and 12% of farmers. Further, 12% of participants were peasants and 5% were tradipratician, while participants without jobs and other non-specified professions presented 12% each. In contrast, the dominant professions in Meknes, El Hajeb, Ifrane, and Immouzar were herbalist, peasant, housewife, and others, whereas the tradipratician was the only one in Fez. In Azrou and Mrirt all interviewed people were without professions, and in Sefrou all recorded professions were equal (Fig. 4). These results are the first in the study area, because the previous studies conducted in the zone didn't investigate the professions of populations (Najem *et al.* 2019, 2020).

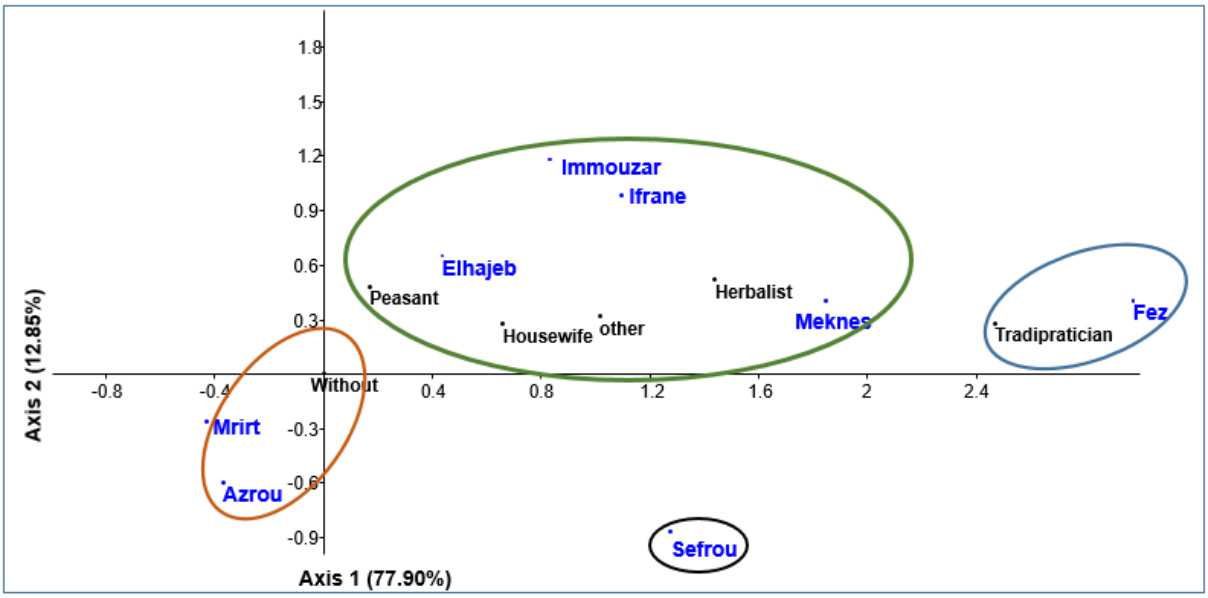

Figure 4. Variation of professions of interviewees among prospected provinces

Therapeutic uses

Concerning the therapeutic uses (Table 1), only 8% of the investigated population is treated with modern medication, while 92% of those questioned utilized traditional medicine or a combination of both traditional and modern uses. The use of both modern and traditional medicines (n=137) was significantly superior to single modern (n=48) and traditional (n=19) uses (n= 200, f= 60.72, p<0.001) (Fig. 5). These demonstrated how the local

populace is compelled to use this traditional medicine due to their ancestors' knowledge and their extremely low economic status. Similar results were mentioned currently in the North of Morocco (Redouan *et al.* 2022), the Middle Atlas (Najem *et al.* 2020), and the Plain of Saiss (Beniaich *et al.* 2022). In our case, the type of medicine was variable among the studied sites. In Elhajeb, Sefrou, Azrou, and Mrirt, modern medicine was the dominant method, while traditional medicine was dominant in Immouzar and Ifrane. In contrast, both modern and traditional medicine were recorded in Fez and Meknes.

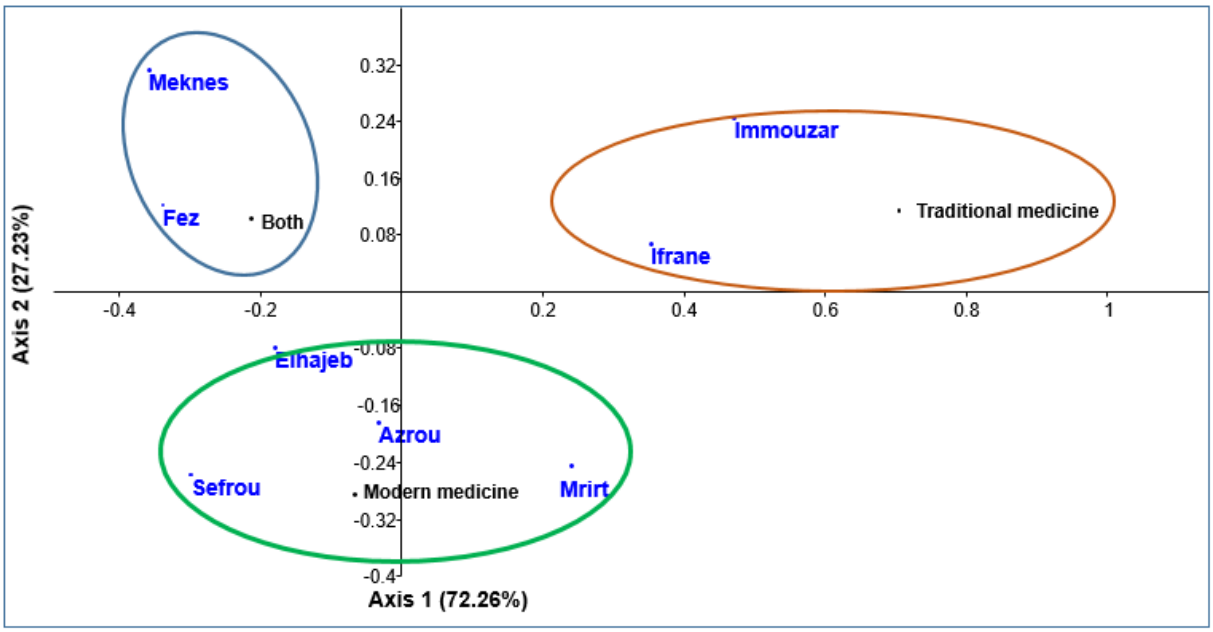

Figure 5. Variation of type of medicine among prospected provinces

Medicinal plants and associated knowledge

Medicinal plants

The plants used for medicinal purposes in the region of the middle Atlas and the Saiss plain are presented in Table 2 and arranged in alphabetical order of their family and botanical names with the relevant information. The results obtained enabled us to identify a total of 154 aromatic and medicinal plants from 56 different families that were recorded in the study zones. Further, the Lamiaceae and Asteraceae were the most used families. An inferior number of medicinal plants were mentioned in other Moroccan areas. In the Central Middle Atlas, 76 medicinal plants, included in 67 genera and 40 families, were recorded as antidiabetic (Hachi *et al.* 2016). In the Ain Leuh, 123 medicinal plants from 53 families have been identified for use in traditional medicine (Akdime *et al.* 2015). In our case, *Urtica pilulifera* L, *Mentha pulegium* L, *Thymus zygis* L, *Herniaria glabra* L, *Rosmarinus officinalis* L, *Salvia officinalis* L, and *Corrigiola telephiifolia* Pourr. were the most frequently mentioned species by the respondents. These plants were frequently used to treat digestive disorders. Additionally, we demonstrated that the aerial portion of the leaf and stem were the most administered. The recipes were mostly made via brewing or decoction.

Distribution of used medicinal plants among studied provinces

The distribution of used medicinal plants in studied sites is presented in Fig. 6. In Mrirt, Elhajeb, Fez, and Ifrane 130 medicinal plant species were dominantly used. In Immouzar, 9 medicinal plants were recorded as dominant medicinal plants, followed by Sefrou with 8 medicinal plants and Azrou with 6 species, while, in Meknes, only two species were documented.

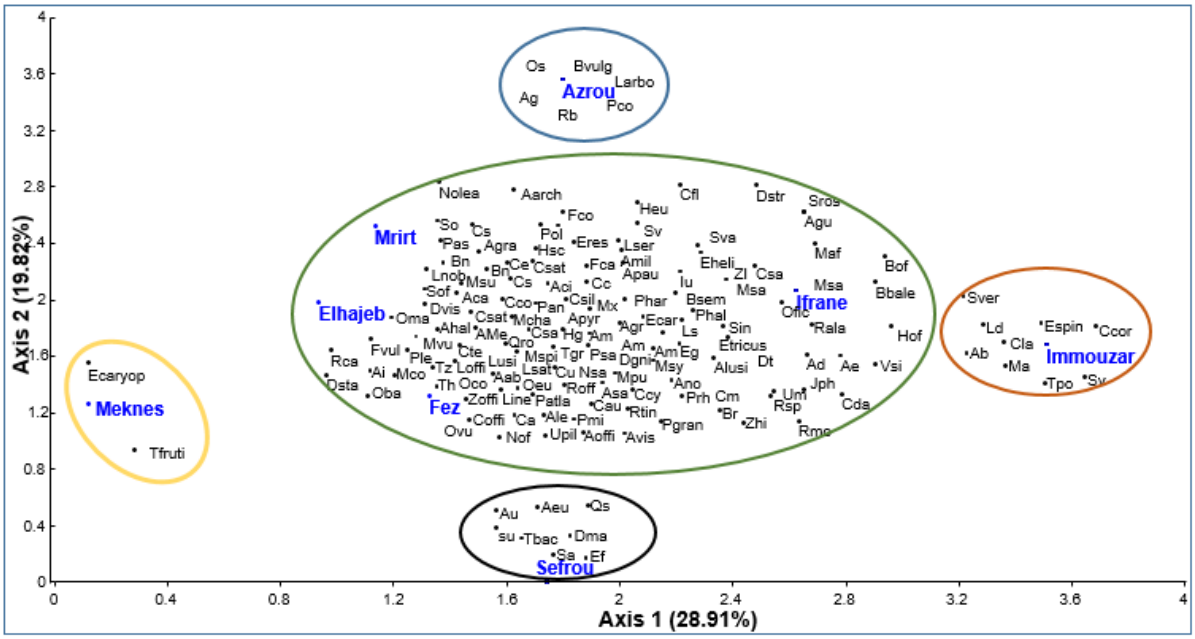

Figure 6. Geographical distribution (axis 1=latitude; and axis 2= altitude) of used medicinal plants among studied provinces analysed with Detrended Correspondence Analysis

-Meknes: Ecaryop: *Eugenia caryophyllata Thunb ;* **Tfruti:** *Teucrium fruticans L.*
-Sefrou : Sa: *Salix alba L. ;* **Aeu:** *Agrimonia eupatoria L. ;* **Au:** *Arbutus unedo L. ;* **Tbac:** *Taxus baccata L. ;* **Su:** *Sambucus nigra L. ;* **Dma:** *Digitalis purpurea L. ;* **Ef:** *Euphorbia falcata ;* **Qs:** *Quercus suber L.*
-Immouzar : Ccor: *Chrysanthemum coronarium L. ;* **Espin:** *Echhinops spinosus L. ;* **Sv:** *Senecio vulgaris L. ;* **Cla:** *Cistus ladanifer L. ;* **Ab:** *Adenocarpus bacquei Batt, Pit. ;* **Ma:** *Mercurialis annua L. ;* **Ld:** *Lavendula dentata L. ;* **Tpo:** *Teucrium polium L. ;* **Sver:** *Salvia verbenaca L.*
- Fez-Ifrane-Elhajeb-Mrirt : Am: *Acanthus mollis L. ;* **Ca:** *Chenopodium ambrosio Andrz. ;* **Hsc:** *Haloxylon scoparium Pomel ;* **So:** *Spinacia oleracea L.;* **Alc:** *Allium cepa L. ;* **Asa:** *Allium sativum L. ;* **Patla:** *Pistacia atlantica Desf. ;* **Plent:** *Pistacia lentiscus L. ;* **Ama:** *Ammi majus L. ;* **Avisna:** *Ammi visnaga (L.) Lam. ;* **Ale:** *Ammodaucus leucotrichus Cos. ;* **Agrave:** *Anethum graveolens L. ;* **Aarch:** *Angelica archangelica L. ;* **Agraveeo:** *Apium graveeolens L. ;* **Cc:** *Carum carvi L. ;* **Csat:** *Coriandrum sativum L. ;* **Ccym:** *Cuminum cyminum L. ;* **Etricus:** *Eryngium tricuspidatum L. ;* **Fcomm:** *Ferula communis L. ;* **Fvul:** *Foeniculum vulgare Mill. ;* **Psa:** *Petroselinum sativum Hoffm. ;* **Pan:** *Pimpinella anisum L. ;* **Ce:** *Caralluma europaea (Guss.) N.E.Br. ;* **Nolea:** *Nerium oleander L. ;* **Apaucin:** *Aristolochia acontophylla Pfeifer. ;* **Amillef:** *Achillea millefolium L. ;* **Apyret:** *Anacyclus pyrethrum L. ;* **Anob:** *anthemis nobilis L. ;* **Aabsint:** *Artemisia absinthium L. ;* **Aherba-al:** *Artemisia herba-alba Asso ;* **AMesatlantic:** *Artemisia Mesatlantica Maire ;* **Acanel:** *Atractylis canellata L. ;* **Agummi:** *Atractylis gummifera L. ;* **Dvis:** *Dittrichia viscosa L. ;* **Lserr:** *Lactuca serriola L. ;* **Larbo:** *Launaea arborescens (Batt.) Murb. ;* **Msal:** *Mantisalca salmantica (L.) Briq. &Cavill. ;* **Mchamom:** *Matricaria chamomilla L. ;* **Os** *Ormenis scariosa (Ball) ;* **Srosmarinif** *Santolina rosmarinifolia L. ;* **Sv** *Senecio vulgaris L.;* **Bvulg:** *Berberis vulgaris L. ;* **Bofficin:** *Borago officinalis L. ;* **Heurop:** *Heliotropium europaeum L. ;* **Br:** *Brassica rapa L. ;* **Bn:** *Brassica napus L. ;* **Bni:** *Brassica nigra L. ;* **Dt:** *Diplotaxis sp. ;* **Lsat:** *Lepidium sativum L. ;* **Noff:** *Nasturtium officinale R.Br.;* **Bbale:** *Buxus balearica L. ;* **Bsemperv:** *Buxus sempervirens L. ;* **Oficus:** *Opuntia ficus indica (L.) Mill. ;* **Cs:** *Capparis spinosa L. ;* **Csa:** *Cannabis sativa L. ;* **Cteleph:** *Corrigiola telephiifolia pourr. ;* **Hg:** *Herniaria glabra L. ;* **SVacc:** *Saponnaria Vaccaria L. ;* **Csalvi:** *Cistus salviifolius L. ;* **Ccolocyn:** *Citrullus colocynthis L. ;* **Jphoen** *Juniperus phoenicea L. ;* **Eheli** *Euphorbia helioscopia L. ;* **Eres** *Euphorbia resinifera L.;* **Ag:** *Astragalus gummifer L. ;* **Alusi:** *Astragalus lusitanicus L. ;* **Cse:** *Cassia senna L. ;* **Csil** *Ceratonia siliqua L. ;* **Msa** *Medicago sativa L. ;* **Rsphae** *Retama sphaerocarpa L. ;* **Tgra:** *Trigonellafoenum graecum L. ;* **Qrotun:** *Quercus rotundifolia ;* **Qs:** *Quercus suber L. ;* **Csat:** *Crocus sativus L ;* **Pas:** *Pelagronium asperum L. ;* **Ai:** *Ajuga iva L. ;* **Coffi:** *Calamintha officinalis L. ;* **Hofficin:** *Hyssopus officinalis L. ;* **Loffi:** *Lavendula officinalis L. ;* **Ls:** *Lavendula stoechas L. ;* **Mvul:** *Marrubium vulgare L. ;* **Mpule:** *Mentha pulegium L. ;* **Msua:** *Mentha suaveolens L. ;* **Mspi:** *Mentha spicata L. ;* **Mx pipe:** *Mentha x piperita L. ;* **Obasil:** *Ocimum basilicum L. ;* **Oco:** *Origanum compactum L. ;* **Ovul:** *Origanum vulgare L. ;* **Omajo:** *Origanum majorana L. ;* **Rofficin:** *Rosmarinus officinalis L. ;* **Sofficin:** *Salvia officinalis L. ;* **Sin:** *Sideritis incana L. ;* **Tz:** *Thymus zygis L. ;* **Zhispa:** *Ziziphora hispanica L. ;* **Cu:** *Cinnamomum verum ;* **Lnob:** *Laurus nobilis L. ;* **Ae:** *Asphodelus sp. ;* **Um:** *Urginea maritima ;* **Lusitatiss:** *Linum usitatissimum L. ;* **Line:** *Lawsonia inermis L. ;* **Pgran:** *Punica granatum L. ;* **Msylves:** *Malva sylvestris L. ;* **Fca:** *Ficus carica L. ;* **Maf:** *Myristic afragrans L. ;* **Eg:** *Eucalyptus globulus L. ;* **Mcomm:** *Myrtus communis L. ;* **Phar:** *Peganum harmala L. ;* **Oeuro:** *Olea europeae L. ;* **Prh:** *Papaver rhoeas L. ;* **Phal:** *Pinus halepensis L. ;* **Ad:** *Arundo donax L ;* **Cdact:** *Cynodon dactylon L. ;* **Pmi:** *Panicum miliaceum L. ;* **Poler:** *Portulaca oleracea L.* **Cflam:** *Clematis flammula L.* **Dstaphisa:** *Delphinium staphisagria L. ;* **Nsa:** *Nigella sativa L. ;* **Pco:** *Paeonia corallina L. ;* **Rb:** *Ranunculus bullatus L. ;* **Ralate:** *Rhamnus alaternus L. ;* **Zl:** *Ziziphus lotus L. ;* **Cm:** *Crataegus monogyna L. ;* **Rca:** *Rosa canina L. ;* **Rtinct:** *Rubia tinctorum L. ;* **Cauran:** *Citrus aurantium L. ;* **Rmon:** *Ruta montana L. ;* **Iu:** *Illicium verum L. ;* **Vsinu:** *Verbascum sinuatum L.* **Dstr:** *Datura stramonium L.;* **Dgni:** *Daphne gnidium L. ;* **Th:** *Thymelaea hirsuta L.;* **Upiluli:** *Urtica pilulifera L. ;* **Aci:** *Aloysia citrodora L. ;* **Aoffi:** *Alpinia officinarum L. ;* **Ecar:** *Elettaria cardamomum L. ;* **Zoffi:** *Zingiber officinale Roscoe*

Table 2. Medicinal plants of the study area, mode of preparation and medicinal use collected by the informant

Family	Cannabaeceae	FUV	Frq	MUV	RFC	Vernacular name	Part used	Mode of preparation	Medicinal use
Acanthaceae	Cannabaeceae	**0.03**							
	Cannabaeceae		**10**	0.03	0.05	Sebana	Leaves	EO/ decoction / cataplasm	The leaves and roots are astringent, detergent, emollient and vulnerary, used as a treatment for dislocated joints and burns
Amaranthaceae	Cannabaeceae	**0.04**							
	Cannabaeceae		**42**	0.01	0.21	Mkhinza	Leaves	Decoction/brewing /cataplasm	For fever, stomachic
	Cannabaeceae		**20**	0.02	0.1	Reemt	Leaves	EO	Treating scorpions and snakebite, diabetes, and stomachache
	Cannabaeceae		**24**	0.01	0.12	Sabanikh	Leafy stem	Cooked	For digestive problems and anemia
Amaryllidaceae	Cannabaeceae	**0.06**							
	Cannabaeceae		**26**	0.025	0.13	Lbesla/Azalim	Bulb	Cooked/raw	Gastritis, against dermatological affections, cold, against eye and ear pain
	Cannabaeceae		**32**	0.035	0.16	Touma/ Tiskert	Bulb	Cooked/raw	Cold, enteritis, anti-rheumatism, antimicrobial, blood pressure reregulation, respiratory disorders, hair care
Anacardiaceae	Cannabaeceae	**0.03**							
	Cannabaeceae		**15**	0.01	0.075	Elbetoum	Leaves / fruit/ stem/flower / resin	Decoction/brewing /cataplasm/EO/ raw/ powder	Digestive infection; Anti-diarrhea
	Cannabaeceae		**29**	0.02	0.145	Drouw	Leaves /fruit/resin	Decoction/ EO	Ear pain, against anorexia, against fractures, headaches
Apiaceae	Cannabaeceae	0.15							
	Cannabaeceae		**30**	0.025	0.15	Atrillal	Fruits	Brewing	To regulate menstruation and diuretic Not only that the plant is used to treat a wide range of human diseases such as leprosy, kidney stones, and infections

	Cannabaeceae		**34**	0,03	0,17	Khella/ Bechnikha	Fruits/ flowers	Decoction/ brewing/ autres	Against diarrhea, gastritis, eczema, wounds, mouthwash, and toothache
	Cannabaeceae		**55**	0.005	0.275	Kamounsouffi	Fruits	Decoction/ brewing	Stomachic
	Cannabaeceae		**32**	0.005	0.16	Chebt	Fruits/ grains	Decoction/ brewing	Stomachic
	Cannabaeceae		**2**	0.005	0.01	Hchicht Lmalayka	Fruits/ root	Decoction/ brewing/ EO	For digestive diseases
	Cannabaeceae		**46**	0.015	0.23	Krafess	Leafy stem	Brewing/decoction /cooked	Counter cooling of the body. calming of the nervous system. eliminating gases
	Cannabaeceae		**50**	0.015	0.25	Kerouia	Leaves/fruit	Decoction/ brewing/ EO	For abdominal pain. bowel pain. and gas
	Cannabaeceae		**54**	0.015	0.27	Kassbour	Leafy stem	Decoction/ brewing/ EO	Against kidney stones and protects the bladder. against hardening of arteries
	Cannabaeceae		**65**	0.005	0.325	Kammoun	Seeds	Brewing/decoction /cooked	Against diseases of the digestive system. against stomach pains
	Cannabaeceae		**3**	0.005	0.015	Merizla	Leaves	Powder	Stomachic
	Cannabaeceae		**10**	0.005	0.05	Lboubal	Flowers/ resin	Decoction/ cataplasm	Stomachic
	Cannabaeceae		**4**	0.005	0,02	Elbessbass	Leaves / fruit	Decoction/ cataplasm	Stomachic
	Cannabaeceae		**38**	0.01	0.19	Maadouness	Leafy stem	Decoction/ brewing/ EO	Calming and against insect bites
	Cannabaeceae		**33**	0.005	0.165	Hebethlawa	Fruits	Decoction/brewing /cataplasm	For abdominal pain
Apocynaceae	Cannabaeceae	0.055							
	Cannabaeceae		**13**	0.02	0.065	Darmouss	Fruits/ graines	Brewing/ powder	For the treatment of diabetes, cancer, cyst, and goiter

	Nerium oleander L.		5	0.035	0.025	Defla	Leaves / flowers/root	Decoction/ brewing	For headaches, wounds, and pain in the teeth and throat, angina infection, colds, anti-diabetic
Aristolochiaceae		0.01							
	Aristolochia acontophylla Pfeir		**40**	0.01	0.2	Barazttem	Leaves / fruit /root	Decoction/brewing /cataplasm	Against cancer and ulcer
Asteraceae		0.305							
	Achillea millefolium L.		**12**	0.01	0.06	Khala	Flowers	EO/ decoction / cataplasm	Wound-healing
	Anacyclus pyrethrum (L.) Lag.		**77**	0.01	0.385	Ark Chlouh/ Tiguendest/ Akirkarha	Leaves / flowers/root	Decoction/brewing /cataplasm/EO/ raw/ powder	Against cysts of the genital tract.
	Anthemis nobilis L.		**21**	0.01	0.105	Babounj Roummi	Fruits/ flowers	Decoction/ brewing/ EO	For insomnia and digestive problems
	Artemisia absinthium L.		**14**	0.035	0.07	Chiba	Leafy stem	Decoction	Against otitis, vertigo, intoxication, Cold and Flu; cholagogue, diuretic, and digestive disorders
	Artemisia herba-alba Asso		**56**	0.06	0.28	Iziiri /Chih	Leafy stem	Decoction	Against rheumatism, cold, stomach, ulcer, tooth pain, hemorrhoids, gastrointestinal, constipation, menstrual pain, antidiabetics, and digestive problems
	Artemisia Mesatlantica Maire		**65**	0.015	0.325	Ifessi/ Chih	Leafy stem	Decoction	Antitussive, antidiabetic, against cooling.
	Atractylis arabica Rech.f.		**20**	0.01	0.1	Nejma	Leaves/ leafy stem	Decoction/brewing /cataplasm	Appetizer. Diaphoretic
	Atractylis gummifera var*. gummifera*		**4**	0.005	0.02	Dlegh	Root	Powder	Facilitate childbirth
	Chrysanthemum coronarium L.		**1**	0.005	0.005	Okhuwan	Leaves/ flowers	Decoction/brewing /cataplasm	For insomnia
	Dittrichia viscosa (L.) Greuter		**59**	0.015	0.295	Magraman/ Terhhal/ Terkal	Leaves/ flowers	Decoction	Against allergy, stomach, and carminative pains

	Echinops spinosissimus Turra	**1**	0.05	0.005	Chouklhmar/Taskra	Root	Decoction	It is used as an abortifacient, diuretic, and for blood circulation, diabetes, dysmenorrhea, gastric pain, hemorrhoids, indigestion, and spasmolytic and varicose problems
	Lactuca serriola L.	**5**	0.01	0.025	Lhedba Lbeldya/ Stemnssem	Leaves	Cataplasm	Anti-poison of snake bites and scorpion stings
	Launaea arborescens Batt.	**1**	0.02	0.005	Interim	Root/ leaves/resin	Brewing/ cataplasm	Used to heal liver, lungs, and stomach, as well as to heal infected wounds
	Mantisalca salmantica (L.) Briq, Cavill.	**10**	0.005	0.05	Thazamourth	Leafy stem	Decoction/brewing/cataplasm	Used to heal diabetic diseases
	Matricaria chamomilla L.	**77**	0.02	0.385	Babounej	Leafy stem	Decoction/ brewing	Against toothache, for hair care and the nervous system
	Ormenis scariosa (Ball) Litard, Maire	**1**	0.005	0.005	Ghartoufa/ Irezgui	Leafy stem	Decoction	Stomachic
	Santolina rosmarinifolia L.	**2**	0.005	0.01	Wezwaza	Leaves/ root/ stem/ flowers	Decoction/ brewing/ EO	Carminative
	Senecio vulgaris L.	**1**	0.015	0.005	Achbet Selma	Leaves/ fruits/ root/ stem/ flowers	Decoction	worms and colic and for menstrual irregularity
Berberidaceae	0.025							
	Berberis vulgaris L.	**1**	0.025	0.005	Adoudrih/ Argiss	Leaves/ fruit /root	Brewing	Used to treat fever, cough, liver disease, depression, and diabetic problems
Boraginaceae	0.02							
	Borago officinalis L.	**3**	0.01	0.015	Bouchnaff	Leaves/ root/ stem/ flowers	Decoction/ brewing	For inflammation, respiratory problems
	Heliotropium europaeum L.	**5**	0.01	0.025	Khenizaretba	Leaves/ root/ stem/ flowers	Decoction/brewing /cataplasm	To induce menstruation and as a febrifuge
Brassicaceae	0.11							
	Brassica rapa L.	**4**	0.015	0.02	Left	Fruits	Cooked/raw	Against weight loss, sore throat, and diabetes

	Brassica napus L.		**10**	0.045	0.05	Left Lfejli	Leaves/ flowers/root	Decoction	Diuretic, anti-scurvy, anti-inflammatory
	Brassica nigra L.		**24**	0.005	0.12	Khardal	Leaves/ seeds	Brewing/ powder	Diuretic, emetic, rubefacient, and stimulant, it is also used as a treatment offended the liver and spleen. It is also used to treat carcinoma, throat tumors, and imposthumes
	Diplotaxis acris (Forssk.) Boiss.		**6**	0.005	0.03	Cheryatt	Leaves/ seeds	Decoction/brewing /cataplasm	Stomachic
	Lepidium sativum L.		**58**	0.015	0.29	Habrechad	Seeds	Macéraation	Stomachic
	Nasturtium officinale R.Br.		**32**	0.025	0.16	Grnounech	Leaves/ root/ stem/ flowers	Powder	Asthma, bronchitis, and cough
Buxaceae		0.03							
	Buxus balearica L.		**13**	0.01	0.065	Azzazer	Leaves	Decoction	For urinary tract infections, swollen airways, cough, and bronchitis. And for muscular pain
	Buxus sempervirens L.		**10**	0.02	0.05	Bakkess	Leaves	Decoction	Against cold and flu
Cactaceae		0.01							
	Opuntia aciculata Griffiths		**13**	0.01	0.065	Handia	Leaves/ fruit/ stem/flower / resin	Decoction/brewing /cataplasm/EO/ raw/ powder	Cold, rheumatism and prostate and dandruff
Capparaceae		0.015							
	Capparis spinosa L.		**19**	0.015	0.095	Lkebbar	Leaves/ fruit	Brewing/ powder	Hypoglycemic; Anti rheumatism
Caprifoliaceae		0.005							
	Sambucus nigra L.		**3**	0.005	0.015	Sembouka	Leaves/ flowers	Decoction/brewing /cataplasm	Diaphoretic, antipyretic, and diuretic

Cannabaeceae		**0.055**						
	Cannabis sativa L.		54	0.055	0.27	If	Seeds / stem	Decoction/brewing /cataplasm/EO/ raw/ powder	Calming of the nervous system and softening
Caryophyllaceae		0.045						
	Corrigiola telephiifolia (L.) Pourr.		**79**	0.02	0.395	Serghina	Root	Decoction/brewing /cataplasm/EO/ raw/ powder	Aperitive, aphrodisiac, anti-diabetic treat flu, dermatological diseases, inflammation, ulcer, cough, and jaundice; it is also used as an anesthetic and a diuretic
	Herniaria glabra L.		**80**	0.01	0.4	Herrast Lhjer	Leaves/ leafy stem	Decoction	Against pain in the urinary tract and the cold against renal lithiasis
	Saponnaria vaccaria L.		**21**	0.015	0.105	Hmaretrass/ Tirirecht	Leaves/ root	Decoction/ brewing	Against scabies and contagious diseases of the skin.
Cistaceae		0.04						
	Cistus ladanifer L.		**2**	0.02	0.01	Touzalt/ Ftah/ Laidane	Leaves/ flowers	Decoction/ brewing	Antiseptic, antibacterial and antiviral
	Cistus salviifolius L.		**5**	0.02	0.025	Boutor	Leaves/ flowers/root	Decoction/ brewing	For dermal diseases and hemorrhoids
Cucurbitaceae		0.025						
	Citrullus colocynthis L.		**45**	0.025	0.225	Lhdele / Tafarzizet	Fruits	Raw/ fumigation	Eczema, antidiabetic, purgative, diuretic
Cupressaceae		0.01						
	Juniperus phoenicea L.		**16**	0.01	0.08	Laaraar/ Takka / Tahlawt	Leafy stem	Decoction/brewing /cataplasm/EO/ fumigation/ powder	Treat hair problems and facial skin, vomiting, digestive disorders
Ericaceae		0.005						
	Arbutus unedo L.		**2**	0.005	0.01	Bakhennou	Leaves/ fruit /root	Decoction	Asthma and stomach problems
Euphorbiaceae		0.035						
	Euphorbia falcata L.		**1**	0.005	0.005	Hayetnoufoss	Leaves/ fruit /root	Brewing	Stomachic
	Euphorbia helioscopia L.		**24**	0.005	0.12	Helibassou	Leaves/ fruits/ root/ stem/ flowers	Decoction	Stomachic

	Euphorbia resinifera L.	**45**	0.02	0.225	Loubane	Resin	Decoction/ cataplasm	Stomachic
	Mercurialis annua L.	**2**	0.005	0.01	Hrika Lmelssa	Leaves	Brewing	Fever; Headaches; digestive disorders
Fabaceae	0.085							
	Adenocarpus bacquei Batt, Pit.	**3**	0.005	0.015	Tagoultemt	Leaves	Decoction	Headaches
	Astracantha gummifera (Labill.) Podlech	**1**	0.005	0.005	Lktira	Resin	Decoction/brewing /cataplasm	Digestif disorders
	Astragalus lusitanicus L.	**26**	0.01	0.13	Fwila	Root	Decoction/brewing /cataplasm	Digestif disorders and headaches
	Cassia senna L.	**47**	0.005	0.235	Sanna	Leaves	Decoction	Stomachic
	Ceratonia siliqua L.	**48**	0.015	0.24	Kharoub/ Tikidit	Leaves/ fruit/ stem/flower / resin	Brewing/ powder	Anti-diarrhea and stomachic; Against bronchitis
	Medicago sativa L.	**2**	0.005	0.01	Lfessa	Leaves	Powder	Stomachic
	Retama sphaerocarpa L.	**5**	0.005	0.025	Rttem	Leaves/ leafy stem	EO	For rheumatic diseases
	Trigonellafoenum graecum L.	**46**	0.025	0.23	Helba	Seeds	Decoction/brewing /cataplasm/EO/ raw/ powder	Bronchitis, sedative of cough, chest,
	Quercus rotundifolia L.	**40**	0.005	0.2	Bellout/ Kerrouch	Leaves/ fruit /root	Decoction/brewing /cataplasm/EO/ raw/ powder	Stomachic (used by women after childbirth)
	Quercus suber L.	**1**	0.005	0.005	Elferchi	Glandes	Powder	Against sexual impotency
Iridaceae	0.01							
	Crocus sativus L.	**65**	0.01	0.325	Zaafrane	Stigmates	Cooked	Facilitate childbirth and use for skin with olive oil
Geraniaceae	0.01							
	Pelagronium asperum L.	**66**	0.01	0.33	Atercha	Leaves/ leafy stem	Decoction/brewing /cataplasm/EO/ raw/ powder	Against intestinal pain and stress
Lamiaceae	0.47							
	Ajuga iva L.	**32**	0.03	0.16	Chendgoura	Leaves/ root/ stem/ flowers	Decoction/ brewing/ EO	Anti-diabetic and cold, anti-rheumatic, stomachic, anti-diabetic

Clinopodium nepeta subsp. *glandulosum* (Req.) Govaerts	**31**	0.015	0.155	Manta	Leaves/ flowers	Decoction/ brewing/ EO	Anti-cold, antitussive, and stomachic
Hyssopus officinalis L.	**12**	0.03	0.06	Azoufa	Leaves/ flowers/root	Decoction/ brewing/ EO	Intestinal pain, intestinal gas, colic, and loss of appetite. It is also used for respiratory problems including coughs, the common cold, respiratory infections, sore throat, and asthma.
Lavendula officinalis L.	**70**	0.015	0.35	Khzama	Leaves/ stem / flower	Decoction/ brewing/ EO	Anti-cold and stimulator and hair
Lavendula dentata L.	**10**	0.04	0.05	Kohilla/ Tiguizite	Leaves/ stem / flower	Decoction/ brewing/ EO	For urinary tract disorders Bronchitis; Colds; digestive diseases, dermic problems
Lavendula stoechas L.	**12**	0.01	0.06	Lhalhal	Leaves/ stem / flower	Decoction/ brewing/ EO	Against anemia, anti-diarrhea for children
Marrubium vulgare L.	**76**	0.035	0.38	Mrriwa/ Mriwt/ Lfzi	Leaves/ flowers/root	Decoction/ brewing/ EO	Against headaches (insomnia) and ear diseases, bronchitis, antidiarrhea, cardiovascular diseases, digestive and dermic disorders
Mentha pulegium L.	**84**	0.02	0.42	Fliyo/ Taoukinit	Leaves/ stem / flower	Decoction/ brewing/ EO	Against body coldness and respiratory diseases
Mentha suaveolens L.	**69**	0.025	0.345	Marssita	Leaves/ stem / flower	Decoction/brewing /cataplasm/EO/ raw/ powder	Against body coldness, respiratory and digestive ailments
Mentha spicata L.	**66**	0.005	0.33	Naanaa/ Likama	Leaves/ stem / flower	Decoction/brewing /cataplasm/EO/ raw/ powder	Stomachic
Mentha x piperita L.	**45**	0.005	0.225	Naanaa Lbasatine/ Naana Labdi	Leaves/ stem / flower	Decoction/brewing /cataplasm/EO/ raw/ powder	Stomachic
Ocimum basilicum L.	**42**	0.01	0.21	Lahbek	Leaves/ stem / flower	Decoction/brewing /cataplasm/EO/ raw/ powder	Against eye irritation (eye drops) and hair loss
Origanum compactum L.	**79**	0.045	0.395	Zaater/ Azoukni	Leaves/ stem / flower	Decoction/brewing /cataplasm/EO/ raw/ powder	Against the cooling of the body and respiratory problems, digestive disorders against poisoning, and dandruff

	Origanum vulgare L.	**16**	0.02	0.08	Merou	Leaves/ stem / flower	Decoction/brewing /cataplasm/EO/ raw/ powder	Cough, fever, bronchitis and digestive problems
	Origanum majorana L.	**56**	0.04	0.28	Merdoudech	Leaves/ stem / flower	Decoction/brewing /cataplasm/EO/ raw/ powder	Against the cooling of the body and respiratory problems, digestive disorders against poison, ing, dandruff
	Rosmarinus officinalis L.	**80**	0.03	0.4	Azir	Leaves/ stem / flower	Decoction/brewing /cataplasm/EO/ raw/ powder	Stomachic, febrifuge, against cooling, facilitates childbirth, against foot eczema and antitussive pectoral
	Salvia officinalis L.	**80**	0.03	0.4	Salmiya	Leaves/ stem / flower	Decoction/brewing /cataplasm/EO/ raw/ powder	Anti-diabetic, abdominal pain, dermatological diseases, headache, toothache, and cold
	Salvia verbenaca L.	**12**	0.015	0.06	Hiyatta	Leaves/ stem / flower	Decoction/brewing /cataplasm/EO/ raw/ powder	Stomach pain, diabetes, natural baby talcum powder
	Sideritis incana L.	**12**	0.005	0.06	Agoultem	Leaves/ stem / flower	Decoction	Rheumatic diseases
	Teucrium fruticans L.	**2**	0.01	0.01	Miro	Leaves/ stem / flower	Decoction/brewing /cataplasm/EO/ raw/ powder	Diuretic; Depurative;
	Teucrium polium L.	**3**	0.005	0.015	Tayart /Jaada/ Ayrar	Leaves/ stem / flower	Decoction/brewing /cataplasm/EO/ raw/ powder	Anti-diarrhea
	Thymus zygis L.	**82**	0.025	0.41	Zaitra/ Azoukini	Leaves/ stem / flower	Decoction/brewing /cataplasm/EO/ raw/ powder	Against the cold of the body, respiratory and pulmonary problems, stomach ailments
	Ziziphora hispanica L.	**14**	0.005	0.07	Fliyo Barri	Leaves/ stem / flower	Decoction/brewing /cataplasm/EO/ raw/ powder	Against cold and flu
Lauraceae	0.04							
	Cinnamomum verum J. Presl	**53**	0.03	0.265	Karfa	Ecorce	Powder	Against nausea, improves intestinal transit, against dental and childbirth pain, antidiabetic, and alleviates fatigue

	Laurus nobilis L.		52	0.01	0.26	Warkat Sidna Moussa/ Rand	Leaves/ stem / flower	Decoction/ brewing/ EO	For Genito-urinary diseases
Liliaceae		0.015							
	Asphodelus sp.		**13**	0.005	0.065	Barouak	Root	Decoction/brewing /cataplasm	Stomachic
	Urginea maritima L.		**11**	0.01	0.055	Bassila	Leaves/fruit /gra	Decoction	For immunity system and digestive disorders
Linaceae		0.01							
	Linum usitatissimum L.		**69**	0.01	0.345	Zaritin Lketan	Seeds	Brewing/ powder	Stomachic and use in case of bone fracture
Lythraceae		0.025							
	Lawsonia inermis L.		**25**	0.015	0.125	Henna	Leaves	Brewing/ powder	Against skin diseases (eczema), and dandruff
	Punica granatum L.		**15**	0.01	0.075	Reman	Ecorce de fruits	Brewing/ powder	Against ulcers and stomachic
Malvaceae		0.015							
	Malva sylvestris L.		**40**	0.015	0.2	Bekoula	Leaves/ leafy stem	Cooked	Against cold Constipation; Digestive ailments
Moraceae		0.02							
	Ficus carica L.		**18**	0.02	0.09	Karmouss	Fruits	Cooked/raw	Against cough when mixed with olive oil, against the cooling, for immunity system and digestive disorders
Myristicaceae		0.015							
	Myristic afragrans L.		**19**	0.015	0.095	Bssibisa/Gouza	Noix	Powder	Antitussive and sleeping pill and against abdominal pain
Myrtaceae		0.04							
	Eucalyptus globulus L.		**13**	0.01	0.065	Kaliptus/Safsaf/ Galito	Leafy stem	Fumigation	for respiratory problems and asthma
	Eugenia caryophyllata L.		**1**	0.025	0.005	Oudnouar/Krou nfl	Fruits	Decoction/brewing /cataplasm	Against toothache, menstrual pain, analgesic
	Myrtus communis L.		**69**	0.005	0.345	Rihan	Leaves	Decoction/ brewing/ EO	Anti-fall and hair detangler
Nitariaceae		0.01							

	Peganum harmala L.		**28**	0.01	0.14	Harmel	Seeds	Cataplasm/powder /fumigation	Haircare; Diabetes
Oleaceae		0.025							
	Olea europaea L.		**51**	0.025	0.255	Zitoun	Leaves/ fruit	Brewing	Against asthma, against hypertension and sedative, for respiratory diseases and antidiabetic
Papaveraceae		0.01							
	Papaver rhoeas L.		**15**	0.01	0.075	Belamen	Leaves	Decoction	Hair and digestive treatments
Pinaceae		0.005							
	Pinus halepensis L.		**19**	0.005	0.095	Tayda	Leaves	Decoction	For toothache
Poaceae		0.08							
	Arundo donax L.		**14**	0.01	0.07	Kseb	Stem	Decoction/brewing /cataplasm	Energetic and against gastritis
	Cynodon dactylon L.		**11**	0.06	0.055	Njem	Leaves/ leafy stem	Decoction	Laxative, brain and heart tonic, aphrodisiac, alexipharmic, emetic, emmenagogue, expectorant, carminative and useful against grippe in children, and for pains, inflammations, and toothache
	Panicum miliaceum L.		**60**	0.01	0.3	Illan/ Anili	Seeds	Decoction/brewing /cataplasm/EO/ raw/ powder	Use in case of fracture promotes bone development
	Sorghum vulgare L.		**21**	0.01	0.105	Douchen	Leaves/ leafy stem	Decoction	Energetic and stomachic
Portulacaceae		0.01							
	Portulaca oleracea L.		**22**	0.01	0.11	Rajla	Leaves/ leafy stem	Brewing/decoction /cooked	Energetic and stomachic
Ranunculaceae		0.045							
	Clematis flammula L.		**2**	0.005	0.01	Azenzou	Leaves	Cataplasm	for skincare
	Delphinium staphisagria L.		**21**	0.005	0.105	Hebetras	Seeds	Powder	Used for hair care
	Nigella sativa L.		**43**	0.02	0.215	Sanouj	Seeds	Powder	Stomachic, against cold, against respiratory diseases, and sexual impotence

	Paeonia corallina L.		**1**	0.01	0.005	Heb Rassis	Leaves/ root	Decoction	Headaches and digestive problems
	Ranunculus bullatus L.		**2**	0.005	0.01	Wden Lhellouf	Root	Powder	digestive problems
Rhamnaceae		0.025							
	Rhamnus alaternus L.		**2**	0.015	0.01	Mliliz	Leafy stem	Decoction	Anemia and jaundice; liver infection
	Ziziphus lotus L.		**18**	0.01	0.09	Nbeg/ Nbek	Leaves/ fruit	Powder	Digestive diseases; antidiabetic
Rosaceae		0.04							
	Agrimonia eupatoria L.		**1**	0.01	0.005	Kebba	Leaves/ flowers/root	Decoction	Diuretic and stomachic
	Crataegus monogyna Jacq.		**20**	0.01	0.1	Admmam/ Zaarour	Leaves/ stem / flower	Decoction	Stomachic and hypotensor
	Rosa canina L.		**23**	0.02	0.115	Werd Lbeldi/ Tighfert	Leaves/ flowers/root	Brewing/ powder	Stomachic, for the erectile dysfunction, headache, and hair care
Rubiaceae		0.005							
	Rubia tinctorum L.		**56**	0.005	0.28	Fouwa	Leaves/ stem / flower	Decoction/brewing /cataplasm/EO/ raw/ powder	stomachic
Rutaceae		0.02							
	Citrus aurantium L.		**21**	0.02	0.105	Zher	Leaves/ flowers	Brewing	Against respiratory and heart diseases, sore throat, and angina
		0.005							
	Ruta montana L.		**12**	0.005	0.06	Awermi	Leaves/ root/ stem/ flowers	Decoction/brewing /cataplasm/EO/ raw/ powder	against anemia
Salicaceae		0.005							
	Salix alba L.		**3**	0.005	0.015	Oud Alma	Leaves	Decoction	Anti-diabetic
Schisandraceae		0.005							
	Illicium verum Hook.f.		**16**	0.005	0.08	Badiana	Leaves/ flowers	Decoction	For asthma
Scrophulariaceae		0.01							
	Digitalis mauretanica L.		**1**	0.005	0.005	Adabbi	Leaves	Decoction	Anti-diarrhea;

	Verbascum sinuatum L.		**3**	0.005	0.015	Salhndar	Leaves/ root/ stem/ flowers	Decoction/brewing /cataplasm	Abdominal pain
Solanaceae		0.005							
	Datura stramonium L.		**5**	0.005	0.025	Chdekjmal	Leaves/ seeds	Decoction/ brewing	Used for a child to sleep well
Taxaceae		0.02							
	Taxus baccata L.		**1**	0.02	0.005	Dahss	Leaves/ root/ stem/ flowers	Decoction/ brewing	Cold, cough, fever, and pain.
Tymelaeaceae		0.02							
	Daphne gnidium L.		**36**	0.01	0.18	Alezzaz/ Lezaz	Leaves	Powder	Against scabies and for hair treatment
	Thymelaea hirsute (L.) Endl.		**34**	0.01	0.17	Metnan	Leaves/ leafy stem	Brewing	Against scabies and for hair treatment
Urticaceae		0.02							
	Urtica pilulifera L.		**85**	0.02	0.425	Heriga/ Heriga Lmelssa	Leaves/ root/ stem/ flowers	Decoction/brewing /cataplasm/EO/ raw/ powder	Anti-diarrhea; abdominal pain, eczema, and diabetes
Verbenaceae		0.015							
	Aloysia citrodora L.		**64**	0.015	0.32	Lwizza	Leaves	Brewing	Used to treat insomnia and abdominal pain. it's also hypotension.
Zingiberaceae		0.055							
	Alpinia officinarum Hance		**42**	0.02	0.21	Lkhoudenjal	Rhizome	Brewing/ powder	Stomachic. Febrifuge, against cold and flu and burns
	Elettaria cardamomum (L.) Maton		**21**	0.005	0.105	Karkalla	Seeds	Decoction	For toothache
	Zingiber officinale Roscoe		**43**	0.03	0.215	Skinjbir	Rhizome	Decoction/ brewing/ EO	Antarthritic, anti-inflammatory, antidiabetic, antibacterial, antifungal, anticancer

*****EO: Essential oil

Medicinal and family use value

Used medicinal plants in the study area are presented in Table 2. In total, 154 medicinal plants belonging to 56 groups were identified in the study area. The Lamiaceae (FUV 0.47), Asteraceae (0.30), and Apiaceae families were, respectively, the most utilized and the most represented by the investigated population (0.15).

Similar results were recorded by Bachar *et al.* (2020), who demonstrated that the Lamiaceae (1.87), Apiaceae (0.46), and Asteraceae families received the most citations (0.42). In their inventory of the Moroccan vascular flora, Fennane & Tattou, (2012) mentioned that Asteraceae, Fabaceae, and Poaceae are the most dominant families, which explains their abundant use among the interviewed population. In another study, Najem *et al.* (2019) revealed that Rutaceae (2.293), Urticaceae (1.914), and Aristolochiaceae (1.241) were the families with the highest UV in the Central Middle Atlas Region.

The range for families with many species is 0.005 to 0.06. Further, *Artemesia herba alba* was shown to have the highest value, which is in contradiction with results recorded by Bachar *et al.* (2020), who demonstrated that *Mentha pulegium* had the highest value of MUV ranging from 0.01 to 0.32. this is in contradiction with Najem *et al.* (2019), who recorded the highest values in *Ruta montana* L, *Urtica urens*, and *Ammi visnaga* (L.).

Relative Frequency Citation

Relative Frequency Citations varied according to the species studied (Table 2). *Urtica pilulifera* L. was mentioned by 42.5% of respondents, followed by *Mentha pulegium* L. with 42%, and *Thymus zygis* L. with 41%. Additionally, 40% of the informants cited *Salvia officinalis* L, *Rosmarinus officinalis* L, and *Herniaria glabra* L, followed by *Corrigiola telephiifolia* L. and *Origanum compactum* L. with 39.5% of the citations each. These findings are similar to those mentioned in different regions of Morocco. A recent study conducted in the Rif revealed that *Mentha pulegium* L, *Origanum compactum* L, *Rosmarinus officinalis* L, and *Salvia officinalis* L. have the highest values with 84%, 71%, 58% and 42% respectively (Bachar *et al.* 2020), which agrees with our results.

Used parts of plants

Different parts of medicinal plants, including the root, stem, flower, leaf, resin, fruit, seed, stigma, rhizome, bark, bulb, nut, aerial part (A.P.), and entire plant were used by participants with various percentages (fig. 7). The most used parts were leaves with a portion of 33%, followed by stems (17%), and flowers (16%). These findings are consistent with those of other ethnobotanical studies conducted in Morocco (Bachar *et al.* 2020; Bouayyadi & Zidane, 2020; Hayat *et al.* 2020), including that of Fez-Meknes region in which leaves, stems, and flowers were the most used to treat asthenia, insomnia, oral and gum infections (Beniaich *et al.* 2022). The frequent use of these parts can be explained by the simplicity of leaf, stem, and flowers collection, as well as by the fact that leaves serve as both a photosynthetic and secondary metabolite storage site (Bachar *et al.* 2020; Bouayyadi & Zidane, 2020; Hayat *et al.* 2020).

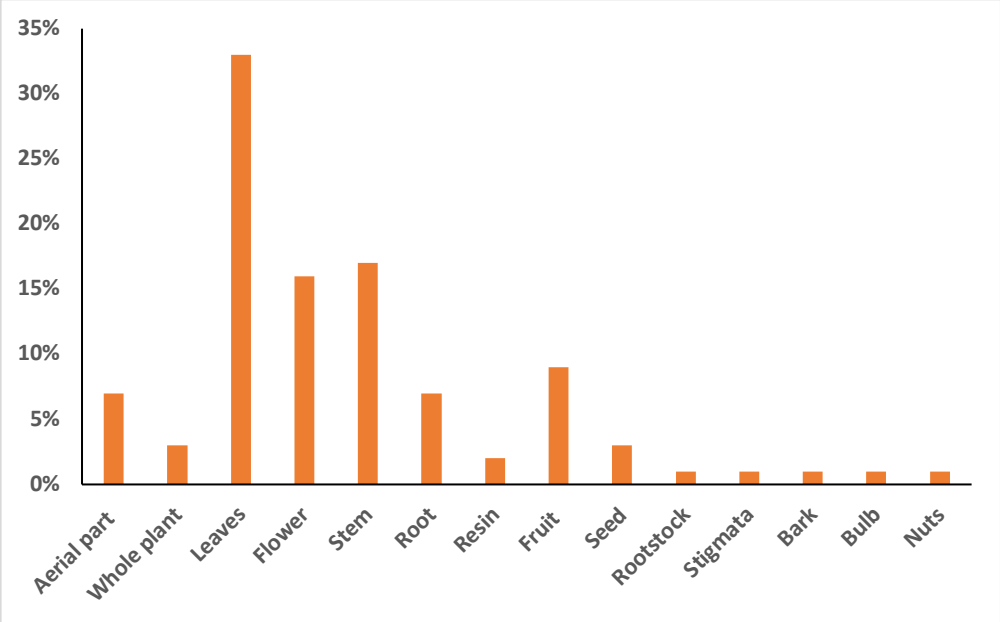

Figure 7. Percentage of the parts used in the traditional medicine

Mode of preparation and administration

Methods of preparation of medicinal plants are presented in Fig 8. The infusion was the most used method by the local community to prepare plants, with a percentage of 23%, followed by decoction at 22%, and poultice at 14% (Fig. 8). The majority of the derived products were taken orally (Fig. 9). Similar outcomes were obtained by other investigations conducted by (Barkaoui *et al.* 2017; Hayat *et al.* 2020) in Chtouka Ait Baha and Tiznit located in the Western Anti-Atlas (South Morocco), and Oulad Daoud Zkhanine located in Nador Province (Northeastern Morocco).

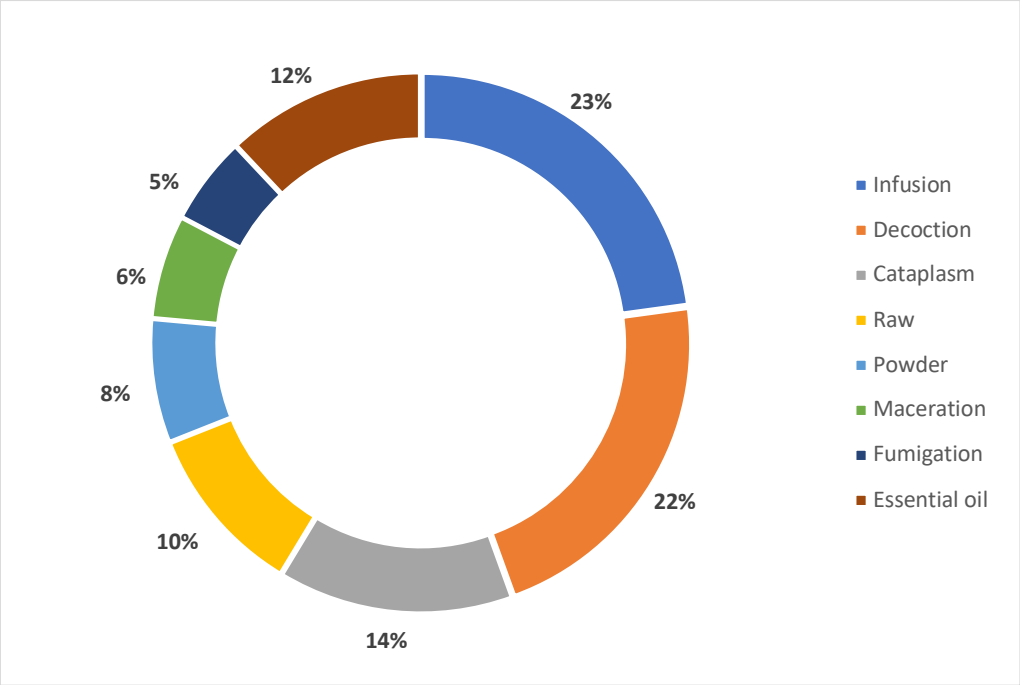

Figure 8. Percentage of preparation modes

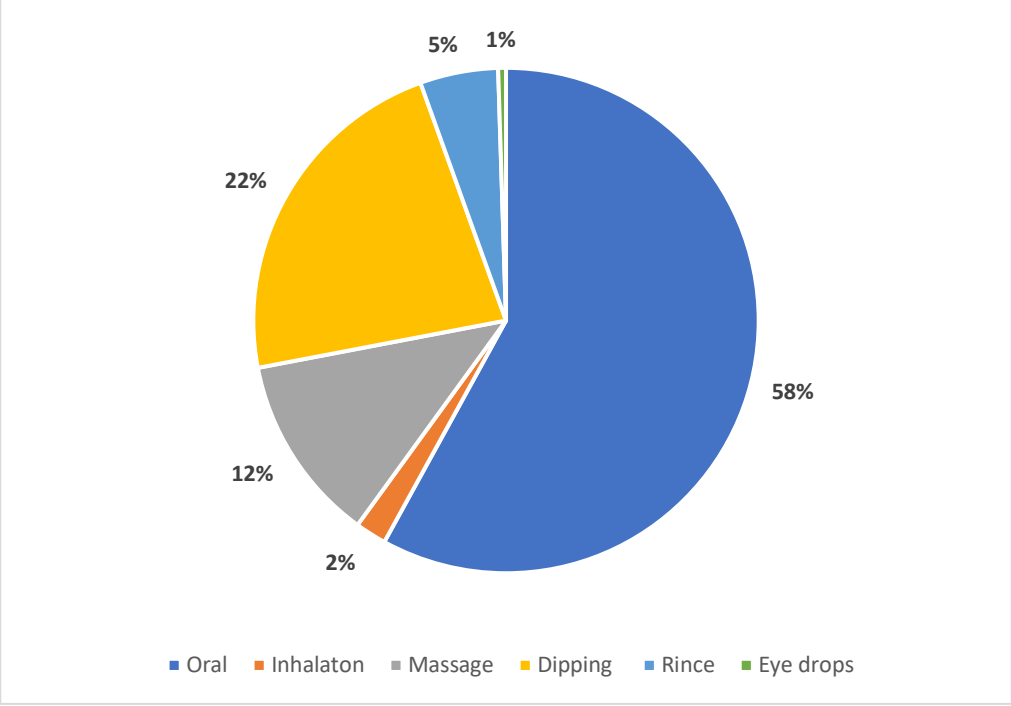

Figure 9. Percentage of the administration methods

Informant Consensus Factor (ICF)

The ICF represented the uniformity of information given by several informants regarding the use of medication to treat a particular class of illnesses. Based on the data acquired from the interviews, the reported diseases were divided into 21 groups. According to Table 3, the ICF values for each use category ranged from 0.53 to 0.97. Cancer (0.97), Fever (0.96), Cardiovascular (0.95), Anemia (0.94), and Aphrodisiac (0.94) were the categories with the highest ICF values (0.93). These high ICF values showed that natural medicines are thought to be very successful and reflect the reasonable dependability of informants regarding the usage of herbal species, as mentioned by Lin *et al.* (2002). In order to find new active compounds, species with a high ICF should be given priority for additional pharmacological and phytochemical research. The last citations of the ranking were reported for plants with ICF values of 0.67 and 0.53 that were used to cure digestive and dermatological conditions, respectively. These numbers demonstrated a notable absence of uniformity in the categories' consensus and may point to a lack of specificity for a group of species.

Table 3. Informant Consensus Factor (ICF) values of the category of ailments

Ailments	Total number of species	Use citations	ICF
Blood pressure	9	30	0.72
Immunity system	3	15	0.86
Digestive disorders	84	178	0.53
Ophthalmologic	2	12	0.91
Fever	5	96	0.96
Otorhinolaryngology	12	98	0.89
Neurological	7	71	0.91
Cardiovascular	5	80	0.95
Urogenital	16	67	0.77
Oral	12	58	0.81
Rheumatology	19	92	0.80
Pulmonary and respiratory	31	110	0.72
Dermatological	35	103	0.67
Diabetes	24	99	0.77
Appetizer	4	40	0.92
Anemia	3	35	0.94
Insomnia	6	27	0.81
Antiinflammatory	9	40	0.79
Aphrodisiac	3	31	0.93
Headache	9	88	0.91
Cancer	3	74	0.97

Conclusion

The current study has brought to light the various ethnobotanical aspects of the Middle Atlas region's utilization of therapeutic plants. The most important fact was that using traditional herbal remedies is now the norm rather than the exception. In addition, local populations in Middle Atlas and the Saiss Plain are slowly returning to a renewed interest in medicinal plants. We were able to compile a very thorough list of the medicinal plants used by the people in the study regions and learn more about the therapeutic uses that are common there thanks to the ethnobotanical field survey. According to the findings of the ethnobotanical questionnaire study, the Lamiaceae family was the most represented, with 56 identified plants. The most often utilized component was the leaf, and the infusion was the most commonly used galenic form. The ethnobotanical survey, which also focused on the disorders treated by these plants, revealed that digestive problems were the most common condition treated by these plants. Additionally, this research has helped us to understand the customs followed by the Middle Atlas and Saiss communities. The outcomes showed how comprehensive this knowledge is. However, it is crucial to expand this type of research to many regions of the nation in order to convert common knowledge into scientific knowledge and to experimentally confirm the treatments found by meticulous scientific methods. Equally, it is necessary to analyze the chemical components of the recorded plants or at least the most potent species, in order to purify the

benefic constituents and test them against the most devastating diseases and microbes. This scientific valorization is suggested to increase the economic importance of natural resources, and then the incomes to rural and poor populations.

Declarations

Ethics approval and consent to participate: Before conducting interviews, prior informed consent was obtained from all participants. No further ethics approval was required.
Consent for publication: Not applicable
Conflicts of interest: The authors declare that there is no conflict of interests regarding the publication of this paper
Data Availability Statement: : The data used to support the findings of this study are included within the article
Author's contributions: Conceptualization, W.E.Y. and M.S.; methodology, W.E.Y, M.S and L.E.G.; Software, validation, formal analysis S.E, and S.B, Writing—original draft preparation, W.E.Y, M.S, Writing—review and editing, S.B. and S.E.; Visualization, L.E.G, M.S. and S.B.; supervision, W.E.Y. and L.E.G.

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Appendix 1. Questionnaire sheets: Ethnobotanical and economic study of medicinal plant.

Ethnobotanical study of medicinal plants at the level of:
Commune:_____**DISTRICT**: _____

Survey **N°**____/_____ Date:

Informant :
Name : **Village**
– Sex: Male □ Female □
– Family situation: Single □ Married □ Divorced □
– Level of study: Illiterate □ Koranic school □ Primary □ Secondary □ University □
Material vegetal:
– When you feel sick, you address:
Experiences of others □ Herbalist □ Pharmacy □ Books □ Others □ _____
– Vernacular name: _____
- Spontaneous □ or Cultivated □ **/** - Local □ or Introduced from other regions □

_____
Scientific name:

– **Use of the plant**: Therapeutic □ Cosmetic □ Aromatic □ Others □

– Used part: Stem □ Flower □ Fruit □ Seed □ Bark □ Rhizome □ Bulb □ Leaf □ Whole plant □ Root □
– Only plant □ Other combination (with plants) □:

– Use of the plant: + Fresh □ + Desiccated □
+ Raw □ + Cooked □
+ After traditional treatment □ (*which treatment is undergone by the plant before its use*
_____

– **Form of employment**: Tisane □ Powder □ EO □ Oily oil □ Extract (juices, tincture, solution, capsule) □:

– **Method of preparation:** Infusion □ Decoction □ Maceration □ Cataplasm □
Fumigation □ Friction □Injection □ Powder □ Raw □ Cooked □ Others:
_____

- Administration mode: Oral □ Inhalation □ Massage □ Rinse □ Bain □ Swabbing □ Others □:
_____

- **Dose used**:
- Do you use the plants with precise doses? Yes □ No □
* If yes: Pinch □ Handle □ Spoonful □ Others □: _____
Another specific dose: Quantity in g/cup:_____or g/liter: _____
– Dosage:
+ Number of catches per day:
- Dosage for children: 1 time/day □ 2 times/day □ 3 times/day □ Others □: _____
- Dosage for adults: 1 time/day □ 2 times/day □ 3 times/day □ Others □: _____
- Dosage for older people: 1 time/day □ 2 times/day □ 3 times/day □ Others □: _____
+ Time of use: Morning (before □; or at the time □); Lunch □; Evening (with dinner □; or at bedtime □)
+ Length of Use: One day □ One week □ One month □ Until healing □

-Uses:
- **Types of diseases**:
- Dermatological conditions □
- Respiratory diseases □
- Cardiovascular diseases □
- Urogenital and urinary disorders □
- Osteoarticular affections □

- Metabolic disorders □
- Digestive tract disorders □
- Neurological disorders □
- Dental care □
- Kidney diseases □
- **Diagnosis By**: Himself □ Doctor □ Herbalist □ Others □: _____
- **Results**: Healing □ Improvement □ Ineffective □
  - Side Effects □ *If yes, then* _____
    - *Just undesirable* □: _____
    - Toxic □: _____
- **Precaution of use**: _____
- **Harvest place**: _____
- **Harvest time**: _____
- **Technique of conservation**: _____