Ethnobotanical survey of medicinal plants used to manage anxiety insomnia and depression in the Daraa-Tafilalet region

Morad Hebi, Zakariae Mankour, Mohammed Ajebli, Ismail Bouadid, Mohamed Bhihi, Hazim Harouak, Driss Ousaaid, Salma Latique, Abderrahmane Moufid, Badreddine Moukafih, Abdeslam El Kartouti, Mohamed Eddouks

Correspondence

Morad Hebi[1]*, Zakariae Mankour[1], Mohammed Ajebli[2], Ismail Bouadid[2], Mohamed Bhihi[2], Hazim Harouak[3], Driss Ousaaid[1], Salma Latique[1], Abderrahmane Moufid[4], Badreddine Moukafih[1], Abdeslam El Kartouti[1], Mohamed Eddouks[2]

[1]Laboratory of Drug Sciences, Faculty of Medicine, Pharmacy and Dentistry, Sidi Mohamed Ben Abdellah University, Fez, Morocco.
[2]Team of Ethnopharmacology and Pharmacognosy, Faculty of Sciences and Techniques Errachidia, Moulay Ismail University of Meknes, Errachidia, Morocco. BP 509, Boutalamine, Errachidia, Morocco.
[3]Environment and Valorisation of Plant and Microbial Ressources Unit, Moulay Ismail University of Meknes, Morocco.
[4]Laboratory of Physiology and Physiopathology, Faculty of Sciences, University of Mohamed V, Rabat, Morocco.

*Corresponding Author: morad.hebi@usmba.ac.ma

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Research

Abstract

Background: Draa-Tafilalet is recognized as one of the most exceptional Moroccan regions in terms of traditional knowledge related to the use of plants for therapeutic purposes.

Methods: The objective of the present study is to collect, analyze, and evaluate ethnobotanical knowledge concerning medicinal plants employed by the local population in the management of psychological disorders, notably anxiety, insomnia, and depression.

Results: A total of 162 informants were interviewed within the framework of this research. Information was gathered through structured and semi-structured interviews with the local population. The data obtained from the informants were then analyzed by calculating certain indices of relative cultural importance (RCI) such as UV, FUV, ROP, and FL. Principal Component Analysis (PCA) was also used in this study to compare certain characteristics of the species. A total, of 57 plant species belonging to 50 genera and 25 families and used in folk medicine were identified. *Aliysia citrodora* Paláu exhibited the highest use value (UV: 0.35625), while the family Verbenaceae showed the highest Family Use Value (FUV 0.209375). Regarding FL values, *Allium sativum, Anisosciadium orientale, Atropa bella-donna, Cinnamomum cassia, Crataegus monogyna, Foeniculum vulgare, Herniaria fontanesii, Mentha × rotundifolia, Mentha viridis, Myrtus communis, Nigella sativa, Ocimum basilicum, Olea europaea, Pistacia atlantica,* and *Plantago akkensis* achieved a Fidelity Level (FL) of 100% for the treatment of anxiety. For depression, *Aconitum napellus, Capparis spinosa, Launaea arborescens,* and *Tetraclinis*

articulata each recorded a 100% Rank Order Priority (ROP). Finally, for insomnia, *Curcuma longa* and *Jasminum officinale* also recorded a 100% Rank Order Priority (ROP).

Conclusions: This survey revealed interesting botanical and cultural results related to ethnobotanical knowledge adopted by the local population of Daraa-Tafilalet in the management of psychological disorders such as anxiety, insomnia, and depression. However, several experimental and field studies remain necessary to strengthen the validity and reliability of this type of research, particularly concerning pharmacological efficacy, safety of use, and methods of preparation of traditional remedies.

Keywords: Ethnobotany, Insomnia, Anxiety, Depression, Medicinal plants

Background

Anxiety and depression are common mental disorders. According to the WHO, 5.7% (WHO 2025b) of adults suffer from depression, and anxiety affected 359 million people in 2021 (WHO 2025a). Regarding insomnia, a recent meta-analysis applying DSM diagnostic criteria reported an overall prevalence of 12.4% (van Straten *et al.* 2025). In addition to their prevalence, these disorders are also clinically distinct in their presentation. A depressed mood or a loss of pleasure or interest in daily activities over extended periods characterizes a depressive disorder. In individuals with anxiety disorders, fear and worry are frequent, intense, and excessive, often accompanied by physical tension and other behavioral or cognitive symptoms notably, anxiety disorders also increase the risk of developing depression (Motti & de Falco 2021). Insomnia, the third condition considered in this study, is defined as persistent difficulty initiating or maintaining sleep, or unwanted early awakening, occurring at least three days per week for a minimum of three months, despite adequate sleep conditions (van Straten *et al.* 2025).

Although progress has been made over the past decades in the treatment of these disorders, they remain among the most complex and debilitating conditions affecting humanity. Conventional treatments remain both clinically effective and limited, and even present adverse effects in some cases. Benzodiazepines are well known for their rapid efficacy in relieving acute anxiety symptoms, in managing insomnia, and in treating seizures. Yet, significant adverse effects and risks remain associated with their prolonged use, notably dependence, cognitive decline, and an increased risk of falls in the elderly (Encalada *et al.* 2025). Similarly, antidepressants demonstrate significant efficacy in reducing the severity of depressive symptoms in patients with moderate to severe major depressive disorder (MDD); that being said, approximately 30 to 40% of patients show an insufficient or absent response to conventional antidepressant treatment, and clinical improvement generally takes several weeks to manifest (Shah *et al.* 2025). To treat insomnia, while sedative-hypnotics, including benzodiazepines and non-benzodiazepines, remain effective for up to 12 months, their use is all the same not without risk. Short-term benzodiazepine use has been associated with next-day sedation, psychomotor and cognitive impairment, anterograde amnesia, and respiratory depression, whereas non-benzodiazepine agents are more commonly linked to headache, nausea, diarrhea, dizziness, and drowsiness (Chelsie B., 2014). Taken together, these results highlight that, despite their demonstrated efficacy, the limitations associated with conventional treatments continue to warrant growing interest in complementary therapeutic approaches.

Traditional medicine appears as an alternative approach widely adopted for these disorders, particularly in developing countries. The high cost of treatments, socio-economic constraints, lack of infrastructure in rural areas, and the high prevalence in Morocco (26.5% for major depressive disorder) promote this reliance(Oneib *et al.* 2015). Approximately 4.5% of the population suffers from anxiety and 5.5% from depression worldwide (Amaghnouje *et al.* 2020).

Medicinal plants constitute the main resource in complementary medicine for the management of anxiety, insomnia, and depression, in various forms of administration. According to the WHO, they are defined as natural plant substances used in local practices with little industrial processing (Tilburt and Kaptchuk, 2008). Belonging to the Mediterranean zone rich in biodiversity, Morocco and its Daraa-Tafilalet region possess an exceptional phytotherapeutic heritage with numerous medicinal species (Amaghnouje *et al.* 2020). This rich natural heritage is bolstered by extensive traditional knowledge, which has culminated in the development of a significant Moroccan pharmacopeia (Ajebli & Eddouks 2023). Elderly people, due to their rich experience accumulated over the years, occupy a particular place in ethnobotanical research and are valuable custodians of traditional medical knowledge. This group therefore constitutes a significant source of knowledge (Eddouks *et al.* 2017).

The objective of this ethnobotanical survey is to document the plants used by traditional healers in the Draa-Tafilalet region to treat anxiety, insomnia, and depression, as well as the associated techniques, methods, dosages, and forms of administration.

Materials and Methods

Study area

The Daraa-Tafilalet region, whose capital is Errachidia, is one of the twelve administrative regions of the Kingdom of Morocco and covers an area of 88,836 km², representing approximately 12.5% of the national territory. It includes five provinces (Errachidia, Ouarzazate, Zagora, Midelt, and Tinghir) and 125 municipalities, of which 16 are urban and 109 are rural (Fig. 1)(Eddouks *et al.* 2021). According to the 2024 General Population Census, the region has 1,643,144 inhabitants, representing about 4.46% of the national population, with an urban population estimated at 599,324 inhabitants (36.48%) (HCP, 2024).

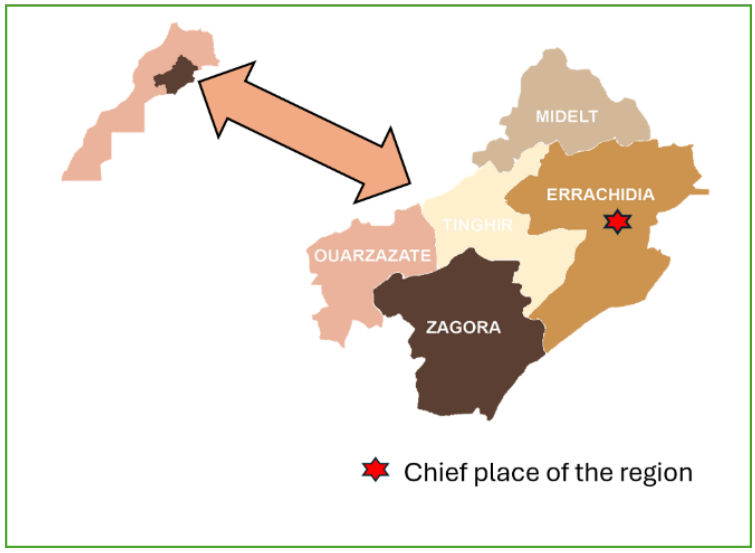

Figure 1. Map of the study area (Daraa-Tafilalet region) Adapted from the (HCP) (hcp.ma)

The region is dominated by oases, which cover nearly 88% of its area, and it is bordered to the north by the Fez-Meknes and Beni Mellal-Khenifra regions, to the west by Marrakech-Safi and Souss-Massa, to the east by the Oriental region and Algeria, and to the south by Algeria (Chlif *et al.* 2021). From a geographical and climatic perspective, Daraa-Tafilalet is characterized by a mountainous northern zone marked by the High Atlas massif, with altitudes exceeding 3,000 m and winter snowfall, and a southern oasis zone surrounded by the Anti-Atlas, where summer temperatures can reach 48 °C. The climate is generally semi-arid and irregular, characterized by low annual rainfall of less than 100 mm (Eddouks *et al.* 2017). These geographical and climatic conditions favor significant floristic diversity, with approximately 500 plant species, several of which are common or endemic to semi-arid and Saharan zones, constituting a major source of medicinal and aromatic plants used in traditional medicine by herbalists, experienced villagers, and local healers. The main activity of the population is agriculture, followed by livestock farming and beekeeping (Chlif *et al.* 2021).

Ethnobotanical survey

Fieldwork was carried out by adopting a quantitative consensus methodology, integrating structured and semi-structured individual interviews. Ethnobotanical data were collected from 162 informants aged 18 years and older, originating from five distinct areas or strata (Table 1) of the Daraa-Tafilalet region, including Errachidia, Tinghir, Midelt, Zagora, and Ouarzazate. In addition, 54 herbalists, locally referred to as “Achaba,” were also interviewed (supplementary material). The inclusion of herbalists as key informants reflects a well-established purposive sampling approach in ethnobotanical research, specifically targeting holders of specialized knowledge within a given cultural domain (Tongco, 2006). This subgroup represented approximately one third of the total sample (54 out of 162 participants). The same semi-structured interview protocol was applied uniformly to all participants, herbalists and lay informants alike, and their responses were not analyzed separately: all data were pooled together for the calculation of ethnobotanical indices (UV, FL, ROP). While this pooling approach is common in studies combining experts and the general population, it may introduce a potential bias of overrepresentation of uses reported by specialized practitioners. The ethnobotany of medicinal plants used in the Daraa-Tafilalet areas was

investigated through a survey involving 162 participants. Data collection was conducted by a group of students fluent in the local language.

For a sample to accurately reflect a population, it must include a sufficient number of cases. This number is also influenced by four key factors: the size of the original population, the chosen confidence level, the acceptable margin of error, and the percentage of occurrence of the phenomenon studied (Gil, 2008). A simple questionnaire was designed to record the information obtained from the interviewees, collecting the following data: socio-demographic characteristics, including age, sex, marital status, cultural and educational level, income, and economic status; botanical data, including the vernacular names of the plants used (in Arabic and/or Berber), their origin (local or imported), and their nature (cultivated or wild); the plant parts used, the form of use, and the method of preparation; therapeutic and traditional uses of the plants; and information on plant toxicity. The scientific names of all plants were verified on the website www.worldfloraonline.org. For each of the 57 recorded plant species, a voucher specimen was collected during the field survey. All voucher specimens were deposited at the Faculty of Sciences and Techniques, Errachidia, Moulay Ismail University, under the accession codes MPAID-FSTE-1 to MPAID-FSTE-57, as listed in Table 3. Oral and written consent was obtained from the study participants.

Table 1. Number of informants in each stratum.

Code stratum		Stratum	Number and percentage of informants	
			Number	Percentage (%)
Str	**1**	**Errachidia**	63	38.9
Str	**2**	**Tinghir**	24	14.8
Str	**3**	**Midelt**	22	13.6
Str	**4**	**Zagora**	28	17.3
Str	**5**	**Ouarzazate**	25	15.4
		Total	162	

Data analysis tools

The medicinal plants used were organized in a table in alphabetical order by family, and the following data were recorded: family, scientific name, local name, English name, plant part used, preparation method, plant origin, frequency of use, therapeutic use, and use value (UV) (Table 2). To strengthen the indicative value of the present ethnobotanical study, we chose to integrate quantitative methods adapted to the collection, processing, and interpretation of ethnobotanical data. Accordingly, the following specific quantitative techniques were adopted to analyze the data:

(UV): The determination of the use value (UV) of the species used was carried out by applying the following formula:

$$UV = \sum Ui/N$$

Where:
UV: Use value of species
Ui: The sum of all the distinct uses mentioned by each informant for that particular species
N: total number of informants
This method is used to illustrate the relative importance of each plant species locally recognized as a herbal remedy.
(FUV): The formula for determining the botanical family use value is as follows:

$$FUV = {\sum UV}/{n}$$

Where:
FUV: The value of family use, which is equivalent to the mean total use value for each species within the family
UV: Use value of the species belonging to the family
n: number of species in the family

(FL): *Fidelity level* is a measure used to identify the plant species most commonly employed by informants to address a specific category of ailments. The FL is determined using the following formula:

$$FL(\%) = {Np}/{N} \times 100$$

Where:
Np: refers to the count of use-reports mentioned for a specific species concerning a certain ailment category.
N: represents the complete count of usage reports mentioned for a particular species.

The rank order priority index (ROP) is a tool that evaluates how knowledge about species is distributed according to the abundance of resources mentioned within the analyzed use category (Da Silva *et al.* 2014). Rank order priority results from the combination of the fidelity level (FL), the previously calculated index, and relative popularity (RP). It is determined using the following formula:

$$ROP = FL \times RP$$

A simplified method for calculating RP (relative popularity) has been suggested (Amorozo & Gély, 1988), in which the ratio between the number of informants mentioning a given species and the number of informants citing the most frequently mentioned species is determined.

Principal component analysis (PCA)

Following standard methodological guidelines for PCA (Jolliffe and Cadima, 2016), principal component analysis (PCA) was performed to explore relationships among species based on four quantitative ethnobotanical indices: fidelity level (FL), rank order priority (ROP), use value (UV), and family use value (FUV), which constituted the input variables. The data matrix consisted of 57 plant species (observations) by 4 variables, with no missing values. Prior to analysis, all variables were standardized (mean-centered and scaled to unit variance), corresponding to a PCA performed on the correlation matrix. The first two principal components were retained for interpretation, accounting for 68.35% and 21.86% of the total variance, respectively (90.21% cumulative); retention was based on cumulative explained variance rather than a strict eigenvalue threshold, as the second component's eigenvalue (0.875) fell slightly below the conventional Kaiser criterion of 1. No rotation was applied to the extracted components. PCA was performed using JMP Pro (version 17.0.0; SAS Institute Inc., Cary, NC, USA). It aims to extract the essential information from the table, to reformulate it into a set of new orthogonal variables known as principal components, and to represent the similarity structure of observations and variables as points on maps or planes.

Table 2. Socio-demographic data of the informants.

Socio-demographic variables		**Percentage (%)**
Age (years)	<20	6.2
	20–40	43.8
	40–60	38.2
	>60	11.2
Gender	Mal	53.1
	Female	46.9
Habitat	Urban	66.7
	Rural	33.3
Study level	Illiterate	6.8
	Primary	30.2
	High school	19.1
	University	43.8
Source	Heritage	58.1
of acquisition	Reading	8.6
of knowledge	Personal experience	25.3
	Experience from other	7.4
	People others	0.6
Professional activity	With stable profession	51.2
	Without stable profession	48.7
Income	Low	37.7
	Very low	6.2
	Medium	43.2
	High	13

Results

Socio-demographic features of respondents

The total number of participants (informants) involved in this study was 162 (N = 162). Eight socio-demographic variables were considered in order to better understand the relationships between local populations and the use of medicinal plants. This ethnobotanical survey is part of the study of traditional therapeutic practices related to the management of anxiety, insomnia, and depression within the population of the Daraa-Tafilalet region. These variables were: age, sex, education level, origin, habitat, occupational status, source of knowledge acquisition, and income. The results related to these data are presented in Table 2. The age distribution of the participants was as follows: under 20 years (6.2%); 20–40 years (43.8%); 40–60 years (38.2%); and over 60 years (11.2%). Men predominated among the participants in this survey, accounting for 53.1%. All informants were native to the study area (Daraa-Tafilalet), and the majority (66.7%) were from urban areas. The education levels recorded in this survey were as follows: illiterate (6.8%), primary level (30.2%), secondary level (19.1%), and university level (43.8%). A slightly higher proportion of respondents were professionally active (51.2%), while 48.7% did not have stable employment, and their income was mainly at a medium level (43.2%). The sources of knowledge related to the traditional treatment of anxiety, insomnia, and depression were represented as follows: inheritance (58.1%), reading (8.6%), personal experience (25.3%), and experience transmitted by other people (7.4%). A total of 57 medicinal plants from 25 different botanical families were identified. The Lamiaceae family had the highest number of species, with 14, followed by the Apiaceae with 8 species, and the Asteraceae with 4 species (Figure 2). Leaves were the most frequently used plant part, accounting for 66%, followed by flowers at 24.1%, seeds at 14.8%, stems at 13.6%, and both fruits and whole plants at 6.2% (Figure 3). The study also revealed that the most common preparation methods were infusion (60.5%), decoction (29%), and cooked preparations (5.6%) (Figure 4). During this research, 57 medicinal plants traditionally used to treat anxiety, insomnia, and depression were documented (supplementary material). To evaluate the cultural and therapeutic significance of these species, several ethnobotanical indices were used, such as use value, use value by botanical family, fidelity level, and rank order priority.

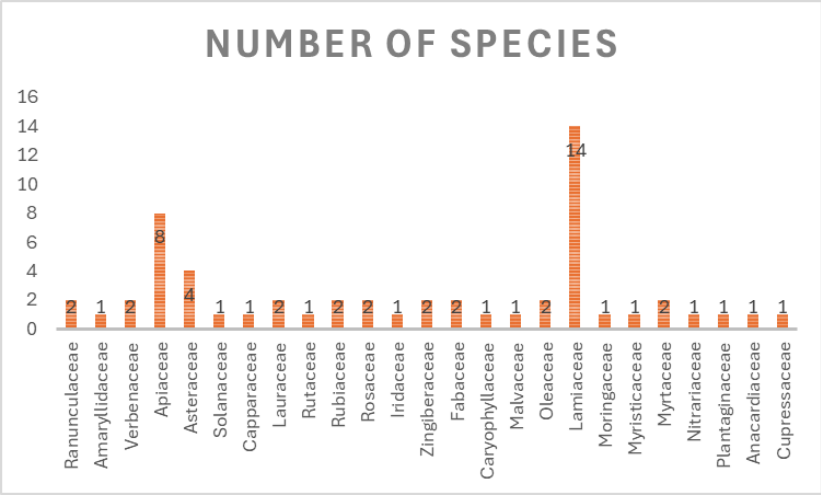

Figure 2. Most families used as natural remedies of insomnia and depression in Daraa-Tafilalt

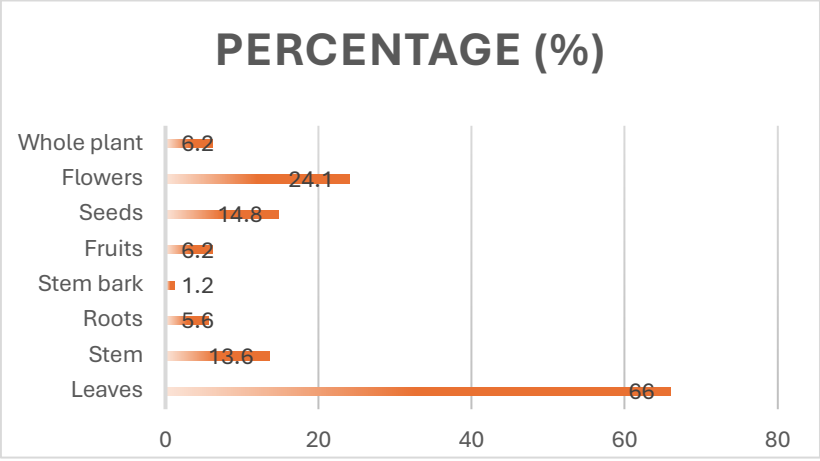

Figure 3. Plant parts used

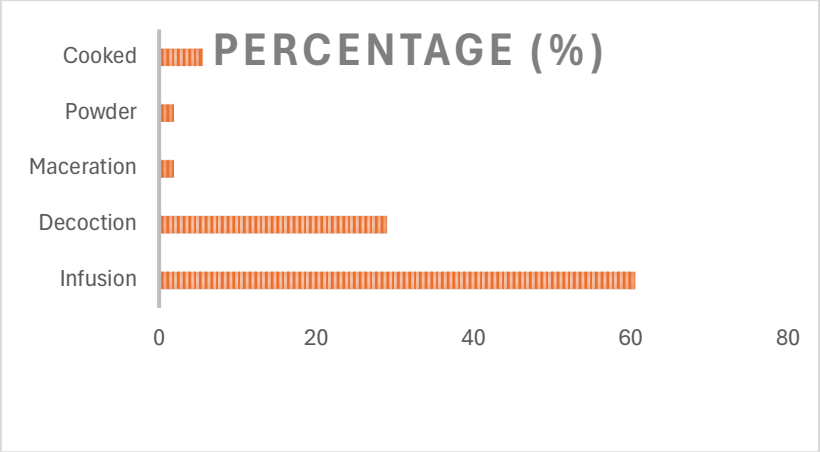

Figure 4. Modes of preparation of herbal remedies

The use value and the botanical use value

Table 3 presents all the ethnobotanical properties of the medicinal plants mentioned in this survey. Each species was characterized by its use value (UV) as well as by a botanical use value index. Regarding the importance of medicinal plants in the management of anxiety, insomnia, and depression, the twenty most frequently cited species, based on their use values, are as follows: *Aloysia citrodora* Paláu (0.35625); *Matricaria chamomilla* L. (0.2375); *Salvia officinalis* L. (0.06875); Thymus vulgaris L. (0.06875); *Artemisia absinthium* L. (0.05625); *Lavandula angustifolia* Mill. (0.05625); *Origanum majorana* L. (0.05); *Zingiber officinale* Roscoe (0.05); *Moringa oleifera* Lam. (0.0375); *Trigonella foenum*-graecum L. (0.0375); *Ammodaucus leucotrichus* Coss. & Durieu (0.03125); *Coffea arabica* L. (0.03125); *Glycyrrhiza glabra* L. (0.03125); *Melissa officinalis* L. (0.03125); *Pimpinella anisum* L. (0.03125); *Rosmarinus officinalis* L. (0.025); *Carum carvi* L. (0.025); *Verbena officinalis* L. (0.0625); *Cinnamomum verum* J. Presl (0.01875); and *Coriandrum sativum* L. (0.01875). The ten botanical families most frequently cited in this survey, ranked in ascending order of their botanical family use value (BFUV), are as follows: Verbenaceae (0.209375), Asteraceae (0.078125), Moringaceae (0.0375), Fabaceae (0.034375), Lamiaceae (0.02946), Zingiberaceae (0.028125), Rubiaceae (0.021875), Apiaceae (0.01875), Rosaceae (0.0125), and Lauraceae (0.0125).

Fidelity level (%) and rank Order Priority of medicinal plants

The fidelity level (FL) corresponds to the percentage of informants reporting the use of a given plant for the same main therapeutic purpose (1). The fidelity level of the medicinal plants is most frequently cited for the traditional treatment of anxiety, insomnia, and depression. The species showing the highest fidelity level are *Allium sativum, Anisosciadium orientale, Atropa bella-donna, Cinnamomum cassia, Crataegus monogyna, Foeniculum vulgare, Herniaria fontanesii, Mentha × rotundifolia, Mentha viridis, Myrtus communis, Nigella sativa, Ocimum basilicum, Olea europaea, Pistacia atlantica*, and *Plantago akkensis*, all cited at 100% for the treatment of anxiety. Regarding depression, the species cited with an FL of 100% are *Aconitum napellus, Capparis spinosa, Launaea arborescens*, and *Tetraclinis articulata*. For the management of insomnia, Curcuma longa and Jasminum officinale present an FL of 100%, indicating strong informant consensus.

Concerning rank order priority *Aloysia citrodora* Paláu (47.39%) and *Matricaria chamomilla* L. (31.34%) had the highest ROP values (Table 3). In contrast, other species, such as *Lavandula angustifolia* Mill. (10.53%) and *Verbena officinalis* L. (10.52%), showed lower priorities among the medicinal plants traditionally used by the local population to treat anxiety, insomnia, and depression.

Principal component analysis

Principal component analysis (PCA) was performed to explore differences among species using the four studied variables (FL, ROP, UV, and FUV). The projection of the variables on the factor plane (Table 4) shows that the first and second principal components explain 68.35% and 21.86% of the total variance, respectively, accounting for a cumulative total of 90.21%.

As shown in (Figure 5), which illustrates the projection of the four variables on the plane defined by the first two principal components, PC1 is mainly associated with the UV, FUV, and ROP indices, whose values increase along this axis. The proximity and similar orientation of these variables indicate a strong positive correlation among them.

Table 3. Fidelity level values for the twenty first species.

Family	Species	Local name(s)	Voucher No.	Part used	Medicinal uses	Iu	RP	FL (%)	ROP (%)
Ranunculaceae	*Aconitum napellus* L.	Khanaq ad-dib	MPAID-FSTE-1	Leaves	Depression	1	0.0175	100	1.75
	Nigella sativa L.	Sanouj	MPAID-FSTE-2	Seeds	Anxiety	1	0.0175	100	1.75
Amaryllidaceae	*Allium sativum* L.	Touma	MPAID-FSTE-3	Fruit	Anxiety	1	0.0175	100	1.75
Verbenaceae	*Aloysia citrodora*	Louiza	MPAID-FSTE-4	Leaves/Flower	Anxiety	57	1	47.39	47.39
	Verbena officinalis	Lwayza el-horra	MPAID-FSTE-5	Leaves	Anxiety/ Insomnia	10	0.1754	60	10.52
Apiaceae	*Ammodaucus leucotrichus* Coss. & Durieu	Kamoun es-sofi	MPAID-FSTE-6	Fruit	Insomnia	5	0.0877	40	3.51
	Anisosciadium orientale DC.	Kamoun el-khla	MPAID-FSTE-7	Fruit	Anxiety	1	0.0175	100	1.75
	Apium graveolens L.	Krafes	MPAID-FSTE-8	Stem	Anxiety	2	0.0351	50	1.76
	Carum carvi L.	karwiya	MPAID-FSTE-9	Seeds	Anxiety	4	0.0702	50	3.51
	Coriandrum sativum L.	Kezbour	MPAID-FSTE-10	Seeds	Insomnia	3	0.0526	66.67	3.51
	Foeniculum vulgare Mill.	Nafiâ	MPAID-FSTE-11	Fruit	Anxiety	2	0.0351	100	3.51
	Petroselinum crispum (Mill.) Fuss	Maâdnous	MPAID-FSTE-12	Leaves	Anxiety	2	0.0351	50	1.76
	Pimpinella anisum L.	Habat el-Hlouwa	MPAID-FSTE-13	Seeds / Leaves	Insomnia	5	0.0877	100	1.75
Asteraceae	*Artemisia absinthium* L.	Chiba	MPAID-FSTE-14	Leaves	Anxiety	9	0.1579	44.44	7.02
	Chamaemelum nobile (L.) All.	Babounj l-Horr	MPAID-FSTE-15	Leaves	Anxiety	2	0.0351	50	1.76
	Launaea arborescens (Batt.) Murb.	Asekkou	MPAID-FSTE-16	Leaves	Depression	1	0.0175	100	1.75
	Matricaria chamomilla L.	Babounj	MPAID-FSTE-17	Leaves/ Flower	Insomnia	38	0.6667	47.37	31.34
Solanaceae	*Atropa bella-donna* L.	Belladone	MPAID-FSTE-18	Fruit	Anxiety	2	0.0351	100	3.51
Capparaceae	*Capparis spinosa* L.	Kebbar	MPAID-FSTE-19	Fruit	Depression	1	0.0175	100	1.75
Lauraceae	*Cinnamomum cassia* (L.) J.Presl	Qerfa	MPAID-FSTE-20	Stem	Anxiety	1	0.0175	100	1.75
	Cinnamomum verum J.Presl	Qerfa bldia	MPAID-FSTE-21	Leaves	Anxiety	3	0.0526	33.33	1.75
Rutaceae	*Citrus limon* (L.) Osbeck	L-Hamid	MPAID-FSTE-22	Fruit	Anxiety	2	0.0351	50	1.76
Rubiaceae	*Coffea arabica* L.	Qahwa	MPAID-FSTE-23	Seeds	Depression	5	0.0877	40	3.51
	Rubia tinctorum L.	Fouwa	MPAID-FSTE-24	Roots	Anxiety	11	0.1930	45.45	8.77
Rosaceae	*Crataegus monogyna* Jacq.	Za'rour	MPAID-FSTE-25	Fruit	Anxiety	1	0.0175	100	1.75
	Rosa damascena Mill.	L-Ward	MPAID-FSTE-26	Flower	Anxiety/ Insomnia	3	0.0526	66.67	3.51
Iridaceae	*Crocus sativus* L.	Zaâfrane	MPAID-FSTE-27	Flower	Insomnia	2	0.0351	50	1.76
Zingiberaceae	*Curcuma longa* L.	Kharkoum	MPAID-FSTE-28	Roots	Insomnia	1	0.0175	100	1.75
	Zingiber officinale Roscoe	Skinejbir	MPAID-FSTE-29	Rhizome	Depression	5	0.1404	50	7.02
Fabaceae	*Glycyrrhiza glabra* L.	Arqsous	MPAID-FSTE-30	Stem	Anxiety	5	0.0877	40	3.51
Caryophyllaceae	*Herniaria fontanesii* J.Gay	Hricha	MPAID-FSTE-32	Leaves	Anxiety	2	0.0351	100	3.51

Malvaceae	*Hibiscus sabdariffa* L.	Karkadé	MPAID-FSTE-33	Flower	Anxiety	3	0.0526	66.67	3.51
Oleaceae	*Jasminum officinale* L.	L-Yasmine	MPAID-FSTE-34	Flower	Insomnia	2	0.0351	100	3.51
	Olea europaea L.	Zitoun	MPAID-FSTE-35	Leaves	Anxiety	1	0.0175	100	1.75
Lamiaceae	*Lavandula angustifolia* Mill.	L-Khouzama	MPAID-FSTE-36	Leaves/ Whole plant	Anxiety/ Insomnia	9	0.1579	66.67	10.53
	Lavandula multifida L.	Khouzama l-Khla	MPAID-FSTE-37	Leaves/ Flower	Anxiety	3	0.0526	66.67	3.51
	Melissa officinalis L.	Mellisa	MPAID-FSTE-38	Leaves	Anxiety/ Insomnia	5	0.0877	80	7.02
	Mentha pulegium L.	Fliou	MPAID-FSTE-39	Leaves	Insomnia	3	0.0526	33.34	1.75
	Mentha × rotundifolia (L.) Huds.	Timrsad	MPAID-FSTE-40	Leaves	Anxiety	1	0.0175	100	1.75
	Mentha spicata L.	Naânaâ	MPAID-FSTE-41	Leaves	Anxiety	3	0.0526	33.34	1.74
	Mentha viridis (L.) L.	Naânaâ el-Mels	MPAID-FSTE-42	Leaves	Anxiety	1	0.0175	100	1.75
	Ocimum basilicum L.	L-Hbaq	MPAID-FSTE-43	Leaves	Anxiety	2	0.0351	100	3.51
	Origanum majorana L.	Merdadouch	MPAID-FSTE-44	Leaves	Anxiety/ Insomnia	8	0.1404	75	10.53
	Origanum vulgare L.	Zaâtar	MPAID-FSTE-45	Leaves	Anxiety	2	0.0351	50	1,76
	Rosmarinus officinalis L.	Azir	MPAID-FSTE-46	Leaves	Anxiety	4	0.0702	50	3.51
	Salvia officinalis L.	Salmiya	MPAID-FSTE-47	Leaves	Anxiety	11	0.1930	45.45	8.77
	Salvia rosmarinus Spenn.	Azir	MPAID-FSTE-48	Leaves	Depression	3	0.0526	33.33	1.75
	Thymus vulgaris L.	Zaâtra	MPAID-FSTE-49	Leaves	Anxiety	11	0.1930	54.54	10.53
Moringaceae	*Moringa oleifera* Lam.	Moringa	MPAID-FSTE-50	Leaves	Anxiety	6	0.1053	66.67	7.02
Myristicaceae	*Myristica fragrans* Houtt.	Gouza	MPAID-FSTE-51	Seeds	Anxiety/ Insomnia	3	0.0526	66.67	3.51
Myrtaceae	*Myrtus communis* L.	Rihane	MPAID-FSTE-52	Leaves	Anxiety	1	0.0175	100	1.75
	Syzygium aromaticum (L.) Merr. & L.M.Perry	Qronfel	MPAID-FSTE-53	Flower	Anxiety/Depression	2	0.0351	100	3.51
Nitrariaceae	*Peganum harmala* L.	Harmal	MPAID-FSTE-54	Seeds	Anxiety	2	0.0351	50	1.76
Anacardiaceae	*Pistacia atlantica* Desf.	Akwawch	MPAID-FSTE-55	Seeds	Anxiety	1	0.0175	100	1.75
Plantaginaceae	*Plantago akkensis* Coss. & Murb.	talma	MPAID-FSTE-56	Whole plant	Anxiety	1	0.0175	100	1.75
Cupressaceae	*Tetraclinis articulata* (Vahl) Mast.	Arâr	MPAID-FSTE-57	Seeds/ Leaves	Depression	1	0.0175	100	1.75

Table 4. Eigenvalues and percentages of explained variability.

Component	Initial eigen values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.734	68.35	68.35	2.734	68.35	68.35
2	0.875	21.86	90.21	0.875	21.86	90.21
3	0.385	9.63	99.84			
4	0.006	0.16	100			

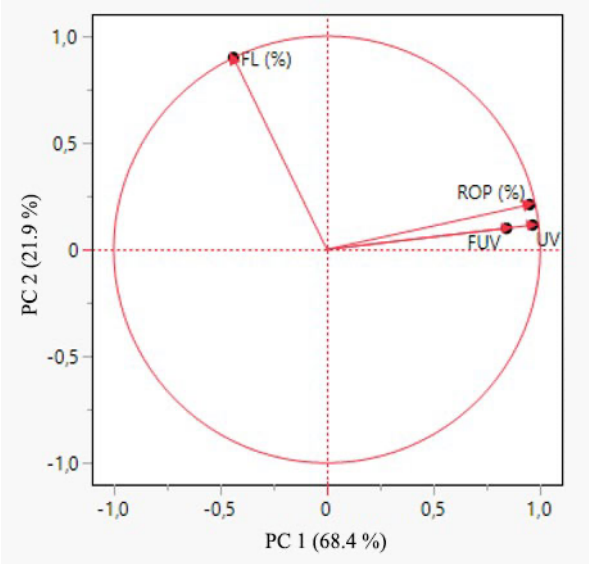

Figure 1. Loading Plot

Method of extraction: Principal components analysis (PCA)

In contrast, PC2 is mainly related to the FL variable, whose contribution increases along this axis. The almost orthogonal position of FL relative to UV, FUV, and ROP indicates the absence of a significant correlation, suggesting that FL describes an independent dimension in the data structure. Figure 6 reveals that most species are located near the origin of the factor plane, suggesting that they are not strongly correlated with either component 1 or component 2. Some species, such as species no. 3 as well as individuals 28 and 56, show a positive correlation with component 1, distinguished by their high values along this axis. Other species display a negative or positive correlation with component 2, indicating differentiation according to the variables associated with this axis. In addition, individuals far from the origin play an important role in structuring the factor plane. Individuals located close to one another on the figure have similar profiles, particularly those clustered around the origin of the plane.

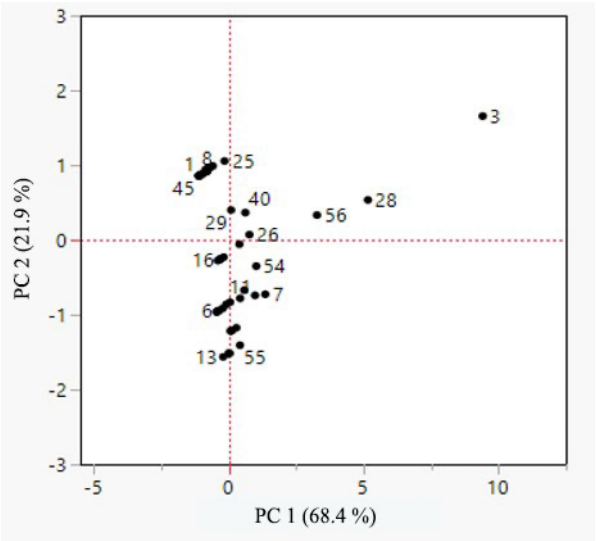

Figure 6. Loading Plot

Discussion

The World Health Organization (WHO 2013) describes traditional medicine as a set of knowledge, skills, and practices based on the theories, beliefs, and experiences specific to various cultures, used to maintain health, as well as to prevent, diagnose, improve, or treat physical and mental illnesses. In many Asian and African countries, approximately 80% of the population relies on traditional medicine for primary healthcare. Globally, about 85% of traditional remedies used for primary healthcare are derived from plant sources (Eddouks *et al.* 2021). Natural remedies are not only more economical than modern medicines, but they often represent the only option available in remote rural areas. This study focused on the perception and use of medicinal plants by local populations for the treatment of anxiety, insomnia, and depression. The results provided relevant information on the botanical, socio-economic, cultural aspects, and local know-how related to the traditional use of medicinal plants for managing these mental health disorders in the Daraa-Tafilalet region.

Socio-demographic and cultural features of respondents

In this study, the majority of participants were aged 20–40 years (43.8%) and 40–60 years (38.2%). Approximately 53.1% of the participants were men and 46.9% were women. In a similar survey conducted in the Fès-Meknès region, about 74% of the respondents were women and 26% were men. Depression and anxiety are more common in women than in men (Amaghnouje *et al.* 2020). In some contexts, women hold advanced levels of knowledge about plants, whereas in others, men possess greater knowledge. More specifically, gender also influences botanical knowledge according to the type of habitat, biological form, and plant use (Eddouks *et al.* 2021).

All informants were native to the study area (Daraa-Tafilalet), and the majority of them (66.7%) were from urban areas. Among the hypotheses that may explain this high proportion of informants included in the study is the fact that the survey was conducted by university students, and most of these students originate from urban areas, even though rural areas constitute the majority of the population of the Daraa-Tafilalet region, representing 63.52% according to the latest national census (2024). Moreover, rural populations rely more heavily on traditional plant-based medicine. An early WHO publication estimated that "in many countries, 80% or more of the population living in rural areas is cared for by traditional practitioners and traditional birth attendants" (Bannerman, 1983). This widely-cited figure should, however, be interpreted with caution: the original data underlying this estimate can no longer be traced, and more recent multi-country survey evidence indicates that actual reliance on traditional medicine varies considerably and is often substantially lower than this historical estimate (Oyebode *et al.* 2016). Nonetheless, traditional medicine continues to play a substantial role in primary healthcare in rural and under-resourced settings, particularly in the Moroccan context relevant to the present study.

The socio-demographic, economic, and cultural characteristics of a given population undeniably influence its interactions with surrounding natural resources, particularly with regard to their use in treating common mental health conditions such as anxiety, insomnia, and depression. Indeed, cultural factors combined with limited access to standard mental healthcare have been shown to drive continued reliance on traditional medicine for the management of mental disorders in various developing-country contexts (Amoateng *et al.* 2018). The education levels observed in this survey were distributed as follows: university level (43.8%), primary level (30.8%), secondary level (19.1%), and illiteracy (14%). It is evident that individuals with a university level of education represented the majority of participants in this study. The level of education partly reflects the cultural level, and those with higher educational attainment generally have more information about primary healthcare and modern medicine. However, this does not mean that this segment of society has more in-depth knowledge of traditional medicine or medical ethnobotany. On the contrary, several previous studies have shown that individuals with a low level of formal education often possess greater expertise in the field of traditional medicine and medical ethnobotany (Eddouks *et al.* 2017).

The results show that inheritance is the main source of knowledge acquisition among the inhabitants of Daraa-Tafilalet (more than 58.1%), followed by personal experience (25.3%), literature (8.6%), and experience acquired from other people (7.4%) (Table 2). Inheritance represents an essential tool for the transmission of knowledge that is not recorded in written sources from one generation to the next. According to the informants, family members, friends, and neighbors also play a crucial role in the transmission of this information (Eddouks *et al.* 2017).

Nearly half of the participants did not have stable employment (48.7%), and their income ranged between a medium level (43.2%) and a low level (37.7%). The Daraa-Tafilalet region is characterized by a certain socio-economic vulnerability, particularly due to a lack of healthcare infrastructure and qualified medical personnel. Residents of Daraa-Tafilalet remain strongly attached to traditional medicine for the treatment of anxiety, insomnia, and depression. It is likely that local populations prefer to use medicinal plants as a complement to conventional treatments, including modern pharmacological

approaches. Moreover, modern medicine is sometimes limited by economic, social, and cultural constraints. In Moroccan communities, particularly in the Daraa-Tafilalet region, it is common—especially among elderly people—to observe a certain reluctance toward conventional medicine, accompanied by a strong attachment to traditional healthcare practices for managing anxiety, insomnia, and depression.

Traditional healthcare practices in the Daraa-Tafilalet region remain largely undocumented, except for a few ethnobotanical studies. Ethnobotanical knowledge differs among groups and even within the same group. However, although this study was conducted across five distinct strata, no notable differences were observed. This can probably be explained by the ethnic, religious, and cultural homogeneity that characterizes this region, as is often the case in Morocco. Nevertheless, this does not exclude the possibility that local knowledge and the use of ethnomedicines are part of broader systems and are influenced by numerous individual factors, particularly socio-economic and cultural ones. Several recent ethnobotanical studies conducted in the Daraa-Tafilalet region highlight its rich folklore and the significance of local herbal medicine in managing various health disorders (Eddouks *et al.* 2020).

Ethnomedicinal flora for the treatment of anxiety, insomnia and depression

The use of natural products, particularly medicinal plants, represents an increasingly attractive therapeutic approach for the management of anxiety, insomnia, and depression, especially among individuals presenting with mild to moderate symptoms. In recent years, the use of natural remedies and phytotherapeutic preparations as a form of self-medication for stress-related disorders and emotional imbalances has increased considerably, particularly in Western societies. In this context, phytotherapy has emerged as one of the most frequently used complementary or alternative treatments, especially in the management of sleep disorders (Motti & de Falco 2021). Furthermore, various compounds derived from traditional, complementary, and alternative medicine have been used for the treatment of insomnia, anxiety, and depression. Available scientific evidence indicates that the active principles of medicinal plants with sedative effects generally exert their action through modulation of the GABAergic system, although other neurobiological mechanisms are also involved, including regulation of the dopaminergic pathway, thereby contributing to their anxiolytic, hypnotic, and antidepressant effects (Borrás *et al.* 2021).

The present survey made it possible to identify 57 medicinal plants frequently used in the traditional treatment of anxiety, insomnia, and depression in the Daraa-Tafilalet region, belonging to 25 botanical families. Several indices of relative cultural importance (RCI), such as use value, value by botanical family, and fidelity level, were employed to assess the ethnobotanical importance of these species. A recent ethnobotanical survey carried out in Algeria identified a diverse assemblage of 82 plant species, representing 69 genera and 38 distinct botanical families used against psychological and neurological conditions (Larit & León 2023). In the same context, a total of 2,544 use reports were analyzed regarding the treatment of mental disorders in the Central Lesser Atlas. These reports encompass 183 taxa distributed across 64 botanical families (Irún *et al.* 2023).

Fidelity level (%)

The fidelity level (FL %) is used to identify the species most preferred by the inhabitants for the treatment of certain ailments. This index also makes it possible to determine the degree of consensus among the interviewees regarding the main therapeutic indication of a given species. Medicinal species with high FL values are presented in Table 3. Allium sativum, *Anisosciadium orientale, Atropa bella-donna, Cinnamomum cassia, Crataegus monogyna, Foeniculum vulgare, Herniaria fontanesii, Mentha × rotundifolia, Mentha viridis, Myrtus communis, Nigella sativa, Ocimum basilicum, Olea europaea, Pistacia atlantica*, and *Plantago akkensis* all obtained a value of 100 % for anxiety. Similarly, a study conducted in Morocco revealed that Crataegus monogyna, Foeniculum vulgare, and Ocimum basilicum are used as co-therapy in the treatment of anxiety (Doukkali *et al.* 2015).

Aconitum napellus, Capparis spinosa, Launaea arborescens, and *Tetraclinis articulata* (100%) are employed in the treatment of depression. Additionally, research conducted in Morocco has shown that *Rosmarinus officinalis*, *Lavandula angustifolia* , and *Anthemis nobilis* have antidepressant properties (Amaghnouje *et al.* 2020). *Curcuma longa* and *Jasminum officinale* (100%) are used for managing insomnia. According to a study by (Borrás *et al.* 2021), various medicinal plants are also utilized to address insomnia, including *Valeriana officinalis* L., *Passiflora edulis* Sims, *Piper methysticum* L.f., *Galphimia glauca* Cav., *Withania somnifera* (L). Dunal, and *Melissa officinalis* L. According to a recent ethnopharmacological survey carried out in Meknes region. The data shows that people in the area use a wide variety of plants to treat insomnia, with verbena, chamomile, basil, lettuce, saffron, white horehound, and marjoram being the most popular. A more in-depth look at the taxonomy shows that the Lamiaceae family is the most important in the regional pharmacopeia (Beniaich *et al.* 2022). This

family, which includes aromatic staples like basil, marjoram, and white horehound, is likely the most popular because it has a lot of essential oils and terpenes that are known to be calming and relaxing. While a recent Ethno-botanical survey of medicinal plants used traditionally in the treatment of mental disorders (including anxiety, insomnia, and depression) in Nigeria reported that the most frequently stated medicinal species were *Securidaca longepedunculata, Jatropha curcas*, *Solanum aethiopicum, Artemesia annua, Terminalia macroptera, Aristolochia albida, Nigella sativa*, and *Andira inermis* (Abubakar *et al.* 2022).

Rank Order Priority

The Rank Order Priority (ROP) is an index calculated to explain the distribution of knowledge related to species according to the richness of resources cited in the studied usage category (2). The results of the present survey showed that *Aloysia citrodora* Paláu (47.39%) and *Matricaria chamomilla* L. (31.34%) present the highest ROP values, which means that these species are the most popular in Daraa-Tafilalet for the management of psychological disorders such as anxiety, insomnia, and depression (Table 3). Clinical studies have revealed that *M. chamomilla* may be effective in treating anxiety and depression, as well as improving sleep quality (Ebrahimi *et al.* 2022, Sorme *et al.* 2019).In comparison, the survey by Nadaf *et al.* (2019) reported that *Aloysia citrodora* had the highest rate of use report. While *Echium amoenum* and *Melissa officinalis* had the highest ROP.

However, certain plants such as *Lavandula angustifolia* Mill. (10.53%) and *Verbena officinalis* L. (10.52%) have a lower priority among the medicinal plants used by the local population for the treatment of these conditions. This finding suggests that there are certain reasons limiting the popularity of these latter species as psychoactive remedies in the Daraa-Tafilalet region. Among these reasons are perceived limited efficacy, possible toxicity, lack of knowledge about their traditional uses, as well as insufficient information regarding the methods of preparation and administration of the remedies, etc.

Principal component analysis

Principal Component Analysis (PCA) is an extremely valued and useful tool in the field of exploratory analysis. It provides a global perspective on the studied subject, highlighting the relationships between the objects (species) as well as between the objects and the variables (FL, ROP, UV, and FUV). One of the main strengths of PCA lies in its ability to visually represent data concerning objects described by more than three variables. Indeed, PCA simplifies the study and understanding of these systems, helping the human eye to perceive in two or three dimensions systems that would otherwise require representation in more than three dimensions to be analyzed (Kucharczyk *et al.* 2012).

Furthermore, the first principal component (PC1) best explains the variability of the UV, FUV, and ROP indices, and these values increase with the rise of PC1; in fact, these variables are strongly correlated with each other. Thus, the species distributed along this axis represent those that are widely recognized and frequently used in the Daraa-Tafilalet region for the management of psychological disorders such as anxiety, insomnia, and depression. These plants are generally cited by a large number of informants and are associated with several categories of nervous disorders, which demonstrates their integration into the local traditional pharmacopoeia.

In contrast, the second principal component (PC2) is mainly related to the FL variable, whose contribution increases with the rise of this axis. The almost orthogonal position of FL in relation to the other indices indicates the absence of significant correlation, suggesting that this variable reflects an independent dimension in the data structure. In reality, species associated with a high fidelity level are often used in a targeted manner, for a specific disorder (for example insomnia or anxiety), and their use is limited to a small number of informants. Consequently, these plants are recognized for their particular role in the management of a precise form of psychological disorder, and not for generalized use.

Figure 3 shows that the majority of individuals are grouped around the origin of the factorial plane, which indicates that they are not strongly correlated either with the first principal component (PC1) or with the second (PC2). This arrangement suggests that these individuals present similar profiles, particularly with regard to the variables associated with the survey, and that they do not contribute significantly to the overall structuring of the plane. Certain individuals, such as numbers 3, 28, and 56, are positively correlated with component PC1, as evidenced by their distance along this axis. This positioning indicates that these profiles are particularly influenced by the variables strongly associated with PC1, and that they stand out from the rest of the sample due to specific characteristics. Other individuals show a positive or negative correlation with PC2, reflecting a differentiation according to the variables specific to this axis. In reality, individuals distant from the origin play an important role in structuring the factorial plane, as they help highlight contrasts and dominant trends within the dataset.

A critical concern regarding the use of medicinal plants in healthcare is their potential toxicity. Although these species are frequently perceived as 'natural' and inherently safe, their application in traditional medicine poses significant toxicological risks if not rigorously managed. The therapeutic efficacy of these plants is largely driven by secondary metabolites; however, these compounds can transition into potent toxins through excessive dosage or improper preparation (Eddouks *et al.* 2019).

Conclusion

The objective of this survey is to highlight ethnobotanical knowledge concerning the plants used to treat anxiety, insomnia, and depression in the Daraa-Tafilalt region. The study demonstrated that traditional medicine continues to occupy a significant place in the Moroccan healthcare system. It also emphasized the link between cultural and botanical aspects through the use of specific statistical analyses. It was discovered that the studied area possesses a specific richness of 57 plants used by the local population to manage psychological disorders, notably anxiety, insomnia, and depression. This floristic diversity illustrates the importance of traditional knowledge and its central role in the local pharmacopoeia, where cultural practices and botanical knowledge converge to provide therapeutic solutions adapted to the needs of the community.

Declarations

Ethics approval and consent to participate: All participants provided Prior Informed Consent
Consent for publication: Not applicable
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Author contributions: M.H. collected the data, analyzed, and wrote the text. Z.M., M.A., I.B, M.B, H.H, D.O., S.L., A.M, B.M, A.EK and M.E participated in the theoretical background, monitoring data collection and analysis, helping with discussions, and wrote the final version of the text.

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