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Ethnobotanical study of some medicinal species of the Mauritanian flora

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In Mauritania, herbal medicine is an integral part of the culture of the society. However, ethno-medicinal data remains scarce and fragmentary. In this work, the ethno-medicinal knowledge in five regions inhabited mainly by two Mauritanian ethnic groups: the "Maures" and the "Peulhs" was explored. These regions present the climatic stages of the country from hyper-arid to Sahelo-Saharan. This suggests that the use of plants by the population in their health care will depend on their presence in the environment. Our methodology consists of a diagnosis of the current situation of this herbal medicine through an ethno-medical survey of healers in the regions of *Tiris Zemmour*, *Inchiri*, *Adrar* (North), *Trarza* and *Brakna* (Southwest). seventy-six informants were enrolled in this study. Results showed that (93.42%) of the informants belong to the 'Maures' community and that women (64.45%) are more involved in this practice. The majority of traditional healers are married (97.38%). The older people and the least educated are the most present in the profession. The ethnobotanical study made it possible to inventory 56 medicinal species, used in phytotherapy, belonging to 25 families. The most cited are *Ziziphus lotus*, *Ziziphus mauritiana*, *Vachellia tortilis*, *Adansonia digitata*, *Gymnosporia senegalensis*, and *Senegalia senegal*. The modes of administration exhibit that the aerial part is the most used (53.50%). Most remedies are prepared as infusions (48%) and maceration (22%). Most medicines are administered orally (99.77%). Most of medicinal species in the five regions studied are prescribed for diseases of the digestive tract (53.50%). No difference has been observed in the use of this medicine among ethnic groups. these data will serve as a basis for researchers and as a reference for establishing action plans for the conservation of Mauritanian flora in general and traditional medicine in particular.

Keywords: Ethnobotanical study, Medicinal plants, Traditional healer, Mauritania

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INTRODUCTION

Traditional medicine includes all the knowledge, skills, and practices based on the conceptions and experiments of different cultures, whether explicable or unfounded, used to maintain health and to prevent, diagnose, and treat physical and mental illness (Dahmane et al., 2023). Herbal medicine is exceedingly used in the world, especially in underdeveloped countries. Humans have always considered plants as a source of therapeutic medicines, particularly in rural areas (Dahmane et al., 2023; Ginko et al., 2023; Irfan et al., 2023; Tabuti et al., 2003; Thirumalai et al., 2009). This plant-based medicine is still well-preserved by many communities (Ferrier et al., 2015; Heinrich & Gibbons, 2001; Mirzaman et al., 2023). In addition, it also offers significant economic benefits. Sales of herbal medicines in the United States amounted to \$15.5 billion (Nguyen et al., 2020). The precise value of global markets for herbal products is difficult to estimate, but this industry is growing rapidly at over 4% per year (Saroya, 2011). In this context, there has been a noticeable revival of interest in these traditional medicines (Bonokwane et al., 2022). The World Health Organization (WHO) has recognized the importance of medicinal plants as therapeutic resources (Belhaj & Zidane, 2023). As a result, it encourages the archiving and valorization of knowledge of traditionally used plants (Alalwan et al., 2019). This is to expand the scope of herbal medicine

and the development of new medicines (Khadim et al., 2023).

Africa has vast plant resources (Dibong et al., 2011). The vast majority of rural populations on our continent, where over 80% rely on it for healthcare due to poverty and the high cost of modern medicines (Jiofack et al., 2009; Ngbolua et al., 2021). Traditional healers are found in most indigenous rural societies. They usually enjoy a high social status in their communities. They therefore usually have considerable influence on local health practices. This may be of interest to explore the possibilities of engaging them in supporting primary health care (Belhaj & Zidane, 2023). In Africa, this knowledge is transmitted orally from generation to generation without the aid of a writing system, as many traditional healers do not keep written records (Kaido et al., 1997).

Ethno-botanical and ethno-pharmacological study is the first step in the identification and conservation of medicinal plants (Mahwasane et al., 2013; Süntar, 2020). Recently, many countries have become more interested in the study of medicinal plants (Nesrine et al., 2022). Contemporary science has recognized their active action and has included in modern pharmacotherapy a series of plant-based medicines known to ancient civilizations and used over millennia. The knowledge of the development of ideas related to the use of medicinal plants as well as the evolution of awareness have increased the ability

of pharmacists and doctors to respond to the challenges that have emerged with the spread of professional services in the facilitation of human life (Petrovska, 2012). The development of new drugs requires the integration of several sciences such as chemistry, pharmacology, and botany (Benarba, 2016). The practice of traditional medicine dates to an early period in the country's history.

Mauritania's flora is poor compared with the rest of the sub-region, with an estimated 1400 species, 88 of which are widely used in traditional medicine in Mauritania's various phytogeographical regions (Ould Mohamed Vall, 2009; Vall et al., 2011, 2015). Herbal medicine is an integral part of the culture of the country's inhabitants. Thus, it represents a socio-cultural heritage within the communities. However, there is little information on the flora of this country compared to that of the sub-region. We can note works, that remain incomplete and fragmentary on ethnobotanical studies in Mauritania; these are essentially the thesis of Yebouk (2021) and the publications of Ould Mohamed vall (2009), Vall et al. (2011, 2015). This study aims to provide an up-to-date inventory of Mauritania's flora, as well as the methodological aspects of the use of medicinal plants by the various ethnic groups in Mauritania.

MATERIALS AND METHODS

Study area

Mauritania is a country in West Africa with an area of 1,030,700 km². It borders Algeria to the northeast, Morocco to the north, Mali to the east and southeast, and Senegal to the southwest. The climate is generally very hot and dry desert. The people are multi-ethnic and multicultural (Maures, Peulh, Wolof, and Soninke). The survey was conducted in five regions of Mauritania (Fig. 1): *Tiris Zemmour*, *Inchiri*, *Adrar* (North), *Trarza* and *Brakna* (Southwest). The north of the country (*Tiris Zemmour*, *Inchiri*, *Adrar*) is mainly inhabited by the Arab-Berber community. As for the southwestern part (*Trarza* and *Brakna*), both ethnic components (Arab-Berbers and Black Mauritians) are found there.

Data collection

The survey targeted traditional healers in different villages and localities. Our approach consisted of interviews on medicinal plants and their use, using questionnaires according to Gedif & Hahn (2003) and Amiguet et al. (2005). The information requested is articulated around two points below:

- The first point concerns the informant: gender, age, ethnicity, marital status, education, and region.
- The second point deals with the plant material: species, part used, therapeutic use, preparation, and administration methods.

The interviews were conducted in 'Pulaar' and 'Hassaniya' in the *Brakna and Trarza* regions and in 'Hassaniya' in the remaining four regions (*Tiris Zemmour*, *Inchiri*, and *Adrar*). The survey was carried out over one year. The plateau of questionnaire information was reached after 76 sheets. The nomenclature of the plant species and the taxonomic system was carried out concerning the Tropicos® database (Tropicos 2017).

Data analysis

After The Survey, all data were entered into an Excel sheet. The collected data were statistically analyzed and the phytotherapeutic importance of each species was assessed by calculating indices of quantitative value such as, the frequency of citation (FC), the relative frequency of citation (RFC), and the family importance value (FIV).

Frequency of citation (FC): FC is the number of informants who mentioned the species

Relative frequency of citation (RFC)

The RFC was used to determine the degree of consensus among informants on which trees or shrubs were used for each "species use" category. The RFC was calculated as follows: $RFC = (FC) / N$ ($0 < RFC < 1$)

where FC is the number of informants who mentioned the species and N is the total number of informants (Khalid et al., 2022)

Family importance value (FIV): The FIV recognizes the importance of plant families. It was calculated using the formula (Molares & Ladio, 2009): $FIV = RFC / N_s$, where N_s is the total number of species in each family.

RESULTS AND DISCUSSION

An ethnobotanical survey was conducted in targeted regions representative of the distribution of ethnicities and the floral diversity imposed by the climatic gradient in the country.

Socio-demographic data

The survey was conducted among healers in the three northern regions (*Tiris Zemmour*, *Inchiri*, and *Adrar*)

and two southwestern regions (*Trarza* and *Brakna*). A total of 76 traditional informants were interviewed. This number allowed us to reach the plateau. This is defined by the repetition of information in the questionnaires. The results obtained showed a difference according to gender, age, ethnicity, etc.

Distribution by ethnicity

The results revealed that out of the 76 healers questioned, the majority belong to the 'Maure' community (93.42%). The 'Peulh' community came second with 6.57% (Figure 2a). The 'Peulh' society is characterized by rituals at the time of harvesting their samples. We note that 50% of this community only harvests on specific days of the week. In addition, they access the plant from a specific direction by reciting Koranic verses. This observed difference is due to the representativeness of these ethnic groups in the regions of our study. Indeed, regionally, the distribution of ethnic groups differs from the northern region (*Tiris Zemmour*, *Inchiri*, and *Adrar*) to the southwestern region (*Brakna* and *Trarza*) (Figure 2b). We note that the 'Maure' constitutes 100% of our sample in the regions of *Tiris Zemmour*, *Inchiri*, and *Adrar*. In *Brakna* and *Trarza*, the percentage of 'Peulh' is 23.52% and 3.44% respectively.

Distribution by gender

Our study shows that the two sexes engage in this practice differently. Indeed, women predominate with 64.45% against 35.52% for men (Figure 3). This superiority of women seems to be linked to their omnipresence in the home and their vigilance, as well as the scarcity of healthcare centers in the vicinity. These results are in agreement with those of (Arezki et al., 2010; Bencheikh et al., 2021; Eddouks et al., 2002; El Hafian et al., 2014; Mechaala et al., 2022; Salhi et al., 2010) Indeed, it is women, in particular rural women, who provide healthcare for their families in case of illness. In contrast, other studies in Togo (Damintoti Karou et al. 2011; Gbekley et al. 2015), Côte d'Ivoire (Gnagne et al., 2017), and Ghana (Essandoh et al., 2023) have shown that men are the most involved in this practice. This difference could be socio-cultural. Women are generally preferred in sales roles (Addo-Fordjour et al. 2013; Torres-Aviles et al. 2016).

Distribution by marital status

Figure 4 demonstrates that most healers are married (97.38%). Single healers are not significant (2.63%). These results support the above explanation suggesting that this profession is an economic source

for some families. Some authors suggest that the proximity of parents to their children, to help them, forces them to practice this profession professionally (Dougnon et al. 2017; El Hilah et al. 2015).

Age distribution

The practice of traditional medicine is present among both old and young people. However, the elderly still predominantly use it. People over 50 years of age represent 53%, followed by the age group [41-50] which represents 29%. The age groups [31-40] and [20-30] each account for 14% and 4% respectively (Figure 5). This gradual decrease with age reflects the reluctance of younger people. Manuel et al. (2020) have shown that this traditional knowledge, held by the older generation, is transmitted by practice often within the same family. For Mokgobi (2014) and Mechaala et al. (2022), older people are more selective in transmitting this knowledge within the family. Our results suggested that this knowledge is threatened by disappearance if it is not conserved and safeguarded (Anyinam, 1995; Benkhniqie et al., 2015; Mehdioui & Kahouadji, 2007).

Informants level of education

The survey revealed that a considerable percentage of the healers (76%) in its five regions have not attended modern education. These traditional healers limited themselves to the Koranic school. The remaining 23.67% attended modern education with 6.57% at primary and 17.1% at secondary level (Figure 6a). These results manifest that the reluctance of young people is probably due to their intellectual level. Figure 6b shows that this predominance of traditional practitioners who have not undergone modern education is noted in all the regions studied. It varies from 56.25% (*Adrar*) to 94.11% (*Brakna*).

Species surveyed

The ethnobotanical survey made it possible to inventory 56 medicinal species belonging to 25 botanical families (Table 1). Of the 25 families encountered (Figure 7), two families clearly dominate the use pattern, namely Fabaceae (16 species) and Malvaceae (7 species). Similar studies by Mhlongo and Van Wyk (2019) showed that Fabaceae are the most dominant in traditional medicine. However, Yaseen et al. (2015) showed a predominance of Amaranthaceae and Cucurbitaceae, in the Thar Desert (Sindh) of Pakistan and they explain the dominance of Amaranthaceae by the arid-desert habitat and its xerophilic conditions. This contrasts

Table 1. Ethnomedical uses of plant species in the Tiris Zemmour, Inchiri, Adrar, Brakna and Trarza regions (Hassaniya: language spoken by the Maure community; Pulaar: language spoken by the Fulani community).

Plant families and Botanical names	Voucher No.	Vernacular name		Parts Used	Condition	Disease category	Mode of preparation	Mode of administration
		Hassaniya	Pulaar					
Amaranthaceae								
<i>Achyranthesaspera</i> L.	HNM 1579	Beitlabde		L	Dry	Hypertension; gastrointestinal	Infusion	Oral
<i>Aerva javanica</i> Juss.	HNM 1589	Temayya		L	Dry	Toothache; migraine	Infusion Decoction Maceration	Oral
Anacardiaceae								
<i>Mangifera indica</i> L.	Exotic plant	Mangou	Mango	L, F, S	Fresh	Body pain; Hypotension	Nature Decoction	Oral
<i>Sclerocary birrea</i> Hochst.	HNM 1535	Dembou	Eiri	L, F, S	Dry Fresh	Gastrointestinal; Dysentery	Infusion Nature	Oral
Apocynaceae								
<i>Calotropis procera</i> (Aiton) Dryand.	HNM 2507	Tourje	Bamambi	L, F, La	Dry	Bone and joint pain	Cataplasme Infusion	Oral, Massage
<i>Leptadenia lanceolata</i> subsp. <i>lanceolata</i>	HNM 1548	Idar	Safati	L	Dry	Stomachache	Infusion	Oral
<i>Leptadenia pyrotechnica</i> (Forssk.) Decne.	HNM 1585	TitariktAssabayé	Selewlew	L, La, B, F, R	Dry	Jaundice; Constipation	Infusion Cataplasma Decoction	Oral, Massage
Arecaceae								
<i>Phoenix dactylifera</i> L.	Exotic plant	T'mar	Tamroki	F	Fresh	Gastrointestinal disorders	Infusion	Oral
Bignoniaceae								
<i>Stereospermum kunthianum</i> Cham.	HNM 1537	Varkake	Banni n'danéwi	R	Dry	Coughing; Stomach pains	Decoction	Oral
Brassicaceae								
<i>Anastatica hierochuntica</i> L.	HNM 2515	El kemche		L	Dry	Diabetes; Hypertension	Infusion	Oral
Burseraceae								
<i>Commiphora Africana</i> (A. Rich.) Engl	HNM 2408	Adriss	Baddi	L, E, W	Dry	Toothache; Weakness; Bone and joint pain	Infusion Decoction	Oral
Capparaceae								
<i>Boscia senegalensis</i> Lam.	HNM 2511	Eyzine	Guidjile/ Guidjili	L, S	Dry	Diabetes; Stomachache; Aphrodisiac	Infusion	Oral
<i>Capparis decidua</i> (Forssk.) Edgew.	HNM 2512	Eygnine	Guumi	L, E	Dry	Constipation	Infusion Decoction	Oral
<i>Maerua crassifolia</i> Forskal.	HNM 2513	Atil	Sogui	L, S	Dry, Fresh	Rheumatism; Loss of appetite	Nature Infusion Decoction	Oral
Celastraceae								
<i>Gymnosporia senegalensis</i> Loes.	HNM 2410	Eych	Gyalgoti	L	Dry	Dysentery; intestinal worms	Infusion Decoction	Oral
Cistaceae								
<i>Helianthemum lippii</i> (L.) Dum. Cours.	HNM 1583	Tirvasse		L	Dry	Inflammation	Infusion Maceration	Oral
Cleomaceae								
<i>Heliotropium ramosissimum</i> Sieber exDC.	HNM 1581	Limkhaynze		L	Dry	Inflammation	Cataplasme	Oral
Combretaceae								
<i>Combretum aculeatum</i> Vent.	HNM 1541	Ikik	Lawnande	L, R	Dry	Haemorrhoids; Body weakness	Decoction Infusion	Oral
<i>Combretum glutinosum</i> Perr. ex DC	HNM 2406	Tikiffit	Doki	L, S	Dry	Menstrual disorders ; Constipation ; Diabetes ; Anaemia; Hepatitis	Infusion Cataplasma	Oral
Cucurbitaceae								
<i>Citrullus colocynthis</i> (L.) Schrad.	HNM 1582	Hdejlihar	Denenale	L, F, La	Dry	Menstrual disorders; Diarrhea; Ashma; Anaemia; Constipation	Infusion Maceration	Oral
<i>Momordica balsamina</i> L.	HNM 2407	Tounbahrala	Demba harire	F	Fresh	Inflammation	Nature	Oral
Fabaceae								
<i>Bauhinia rufescens</i> Lam.	HNM 1547	Ndirn/Ndirr	Namaadi	L	Dry	Diuretic; fever	Infusion Maceration	Oral
<i>Dalbergia melanoxylo</i> Guill. & Perr.	HNM 1530	Sanghou	Dalamban	Fl, L	Dry	Migraine; Cough; Hernia	Infusion	Oral
<i>Faidherbia albida</i> (Delile) A. Chev.	HNM 1531	Avrar	Ccaski	L, S, Se	Dry	Eye inflammation; toothache; ulcers	Infusion	Oral
<i>Indigofera senegalensis</i> Lam.	HNM 1544	Tiguinguil		L, S	Dry	Headaches	Infusion Maceration	Oral
<i>Lotus torulosus</i> (Chiov.) Fiori	HNM 1586	Oumhallouss		L	Dry	Gastrointestinal disorders; Asthma	Infusion Maceration	Oral

<i>Mimosa pigra</i> L.	HNM 2412		Gagnangi	L	Dry	Stomach pain; Sexual impotence	Infusion Maceration	Oral
<i>Piliostigma reticulatum</i> (DC.) Hochs	HNM 1553	Tezzikre	Barkewi	L, W	Fresh	Haemorrhoids; Stomach disorders	Decoction	Oral
<i>Psoralea plicata</i> Delile.	HNM 2510	Tatrarite		L	Dry	Diarrhea	Infusion	Oral
<i>Senegalia senegal</i> (L.) Willd.	HNM 2517	Eyrwar	Patouki	L, E, G, P	Dry	Toothache; malaria; jaundice	Infusion Maceration	Oral
<i>Senna tora</i> (L.) Roxb.	HNM 1540		Youle/ Ulo	L	Dry	Inflammation; Eye pain	Infusion	Oral
<i>Senna italica</i> Mill.	HNM 1580	Evellejit	Faladje	L	Dry	Diarrhea	Maceration	Oral
<i>Vachellia ehrenbergiana</i> Hayne	HNM 2516	Temat	Bakanthili	L	Dry	Gastrointestinal; Asthma; Sexual weakness	Infusion	Oral
<i>Vigna unguiculata</i> (L.)	Exotic plant	Adlegane	Niebe	L, F	Fresh	Anemia	Decoction	Oral
<i>Vachellia nilotica</i> (L.) Willd. exDel.	HNM 2409	Emour	Gawdi	L, F, E, S	Dry	Toothache; female infertility	Infusion	Oral
<i>Vachellia seyal</i> Delile.	HNM 2411	Essadra El beidha	Bulbi	L	Dry	Diabetes; Aphrodisiac; Bronchial difficulties	Decoction	Oral
<i>Vachellia tortilis</i> (Forssk.) Hayne	HNM 2518	Etalh	Cilluki	L, E, F, W	Dry	Stomach disorders; diarrhea	Maceration	Oral
Heliotropiaceae								
<i>Heliotropium ramosissimum</i> Sieber exDC.	HNM 1584	Lihbaliyye		L	Dry	Sore eyes; Headaches	Infusion	Oral
Lithraceae								
<i>Lawsonia inermis</i> L.	Exotic plant	Henne	Puudi	L	Dry	Rheumatism	Maceration Nature	Massage
Malvaceae								
<i>Adansonia digitata</i> L.	HNM 2413	Teydoum	Bokki	L, F, Br, S	Dry, Fresh	Bronchitis; rheumatism; body weakness; diabetes; dizziness; menstrual disorders; ulcers	Infusion Nature Maceration	Oral
<i>Corchorus depressus</i> (L.) C. Chr.	HNM 2509	Taghyitrab	Laalo	L	Dry	Diarrhea; dysentery	Maceration	Oral
<i>Corchorus tridens</i> L.	HNM 1542	Lsanth'or	Laalowalo	L	Dry	Anaemia; diarrhea; dysentery	Maceration	Oral
<i>Grewia bicolor</i> Juss.	HNM 1532	Imijij	Kellibalewi	L	Dry	Asthma; Eye inflammation	Maceration	Oral
<i>Grewia tenax</i> (Forssk.) Fiori	HNM 1543	Ligleyye	Kellindanewi	L	Dry	Digestive tonic; Loss of appetite	Maceration	Oral
<i>Hibiscus sabdarifa</i> L.	Exotic plant	Velere/ bissam	Folere	L	Dry, Fresh	Tiredness; Aphrodisiac	Maceration Decoction	Oral
<i>Sida spinosa</i> L.	HNM 1536	Wouznen' aaje		L	Dry	Loss of appetite; cough	Infusion Maceration	Oral
Meliaceae								
<i>Azadirachta indica</i> A. Juss	Exotic plant	Sidrayitkini	Nouvakini	L, F	Fresh	Malaria; Tiredness; Skin irritation	Infusion Decoction	Oral, Massage
<i>Khaya senegalensis</i> A. Juss	HNM 1533	Tabaliya	Kahi	L, B, R, Se	Dry	Anaemia; Malaria; Intestinal worms; Jaundice	Infusion Decoction	Oral
Moringaceae								
<i>Moringa oleifera</i> Lam.	Exotic plant		Niebedaye	L	Dry	Skin irritation; anaemia; hypertension; sterility; diabetes; sexual dysfunction	Maceration Infusion	Oral
Nyctaginaceae								
<i>Boerhavia diffusa</i> L.	HNM 1538	Rukbit j'mel		L	Dry	Inflammation; Sexual dysfunction; Influenza	Infusion	Oral
Pedaliaceae								
<i>Rogeria adenophylla</i> Gay ex Delile	HNM 1534	Sawabrassou		L, Fl	Dry	Inflammation	Maceration Decoction	Oral
Poaceae								
<i>Stipagrostis pungens</i> (Desf.) De Winter	HNM 1587	Essbat		L, S	Dry	Aphrodisiac; Diuretic	Infusion Decoction Maceration	Oral
Rhamnaceae								
<i>Ziziphus lotus</i> (L.) Lam.	HNM 1588	Sdirhreytik	Diabe	L, F, S	Dry, Fresh	Diabetes; Intestinal worms; Gastrointestinal infection	Infusion Maceration	Oral
<i>Ziziphus mauritiana</i> Lam.	HNM 1546	S'dir	Diabedieri	L, F, W	Dry, Fresh	Diabetes; Intestinal worms; Gastrointestinal infection	Infusion Maceration	Oral
Rubiaceae								
<i>Mitragynainermis</i> (Willd.) Kuntze	HNM 2449	Aglal	Koyli	L	Dry	Rheumatism; Headaches; Pneumonia	Maceration	Oral
Zygophyllaceae								
<i>Tribulus terrestris</i> L.	HNM 1545	Timouglost	Tupeere	L	Dry	Tingling in fingers, feet, toes, Muscle pain, Bronchitis	Maceration Nature	Oral

Keys: L-leaf, Br-branch, W- whole plant, B-bark, R-root, Fr-fruit; S-stem, P-pod, G-gum, La-latex, Se-seed, Fl-flower

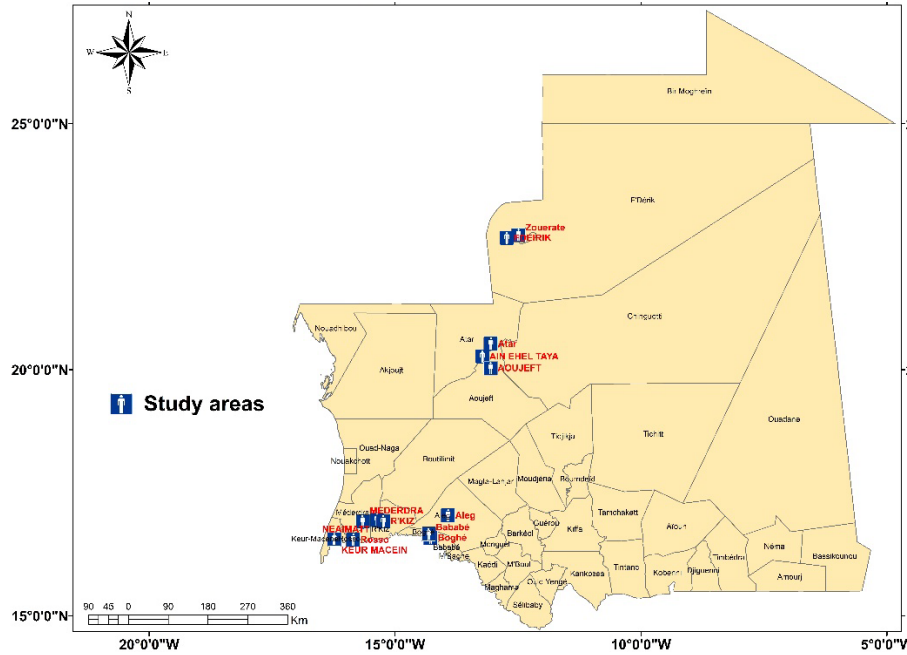


Figure 1. Map of the study area for the location of the Wilaya surveyed (Tiris Zemmour, Inchiri, Adrar, Trarza, and Brakna).

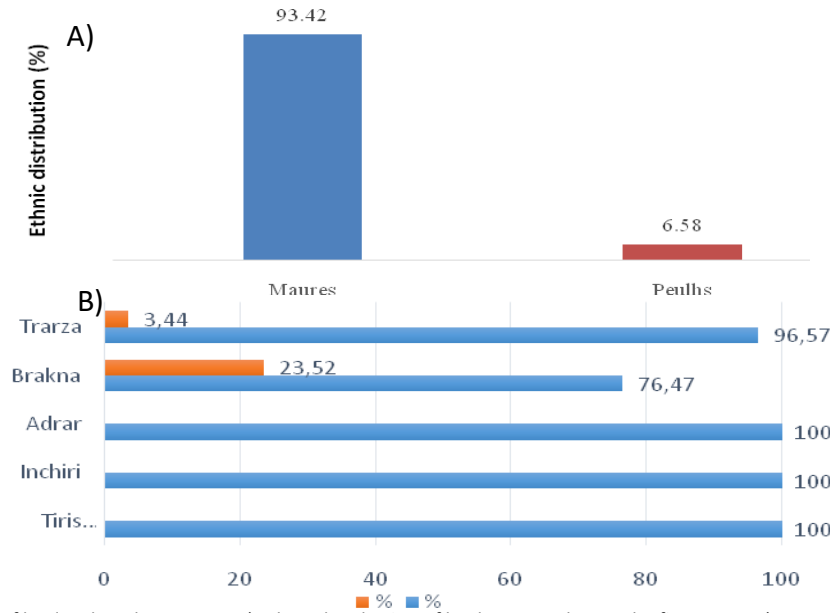


Figure 2. A) Distribution of healers by ethnic group. B) Ethnic distribution of healers according to the five regions (Tiris Zemmour, Inchiri, Adrar, Brakna, and Trarza)

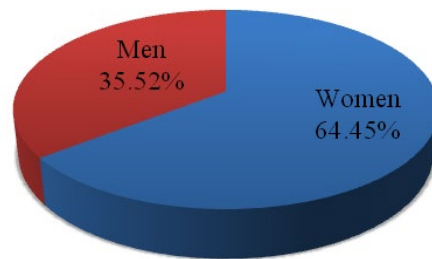


Figure 3. Distribution of healers by gender (men, women)

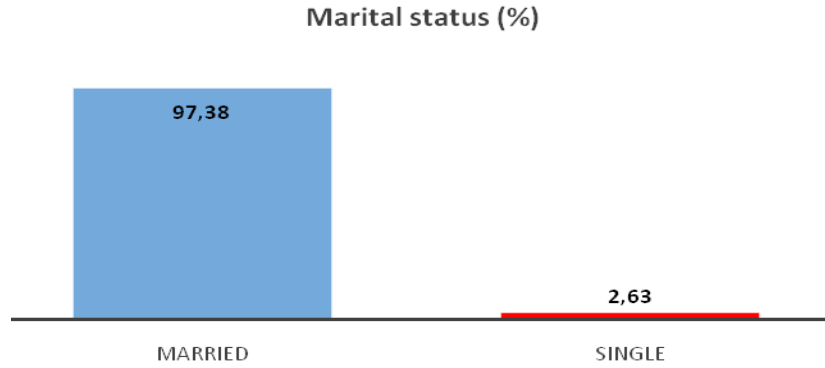


Figure 4. Representation of the family situation of healers in the five regions (Tiris Zemmour, Inchiri, Adrar, Brakna, and Trarza)

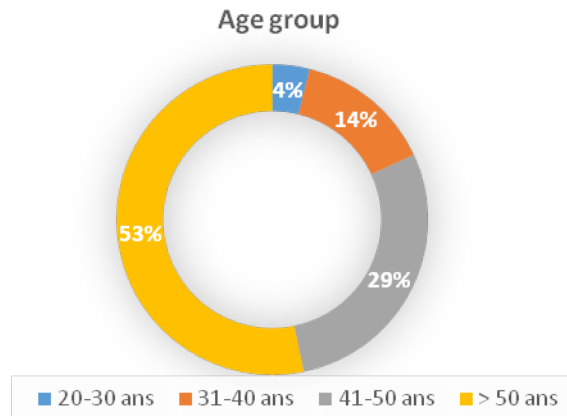
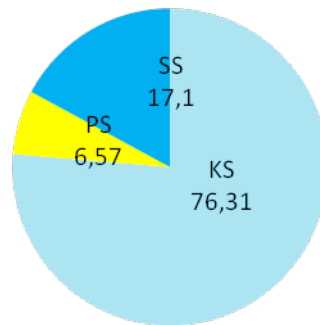


Figure 5. Distribution of healers by age group [20-30], [31-40], [41-50], [>50]

A) Level of education(%)



B) Level of education (%)

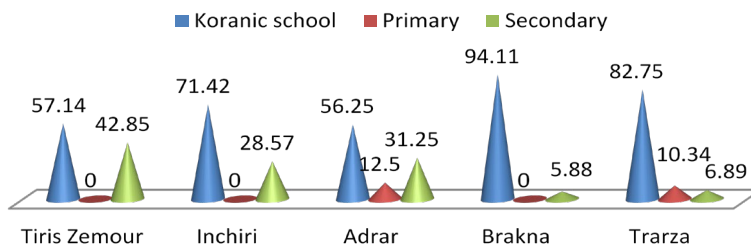


Figure 6. A). Overall frequency by school level. KS: Koranic school; PS: primary school; SS: secondary school. B) Distribution of education levels by region (Tiris Zemmour, Inchiri, Adrar, Brakna, and Trarza).

with our results where only two species were recorded in each of these two families.

Frequency of use of the most used plants

Six species out of the total were reported as the most used by the healers (Fig. 8). The species *Ziziphus lotus* (FC = 75) and *Ziziphus mauritiana* (FC = 75) occupy the top percentage of use by the healers i.e. 12.36% each, followed by *Vachellia tortilis* (9.54% and FC = 73), *Adansonia digitata* (5.3% and FC = 74), *Gymnosporia senegalensis* (5.3%) and *Senegalia Senegal* (4.59% and FC = 75). The calculation of the relative frequency of citation (RFC) revealed that *Ziziphus lotus*, *Ziziphus mauritiana*, *Senegalia senegal* (RFC= 0.98), *Adansonia digitata*, *Gymnosporia senegalensis* (RFC= 0.97) and *Vachellia tortilis* (RFC= 0.96), have the greatest local importance (Table 2). The range of FIV in the current study was 0.0008-0.65. *Commiphora africana* (A. Rich.) Engl had the highest value 0.65 followed by 0.49 for *Ziziphus lotus* (L.) Lam. and *Ziziphus mauritiana* Lam., 0.47 of *Gymnosporia senegalensis* Loes., Use value of *Lotus torulosus* (Chiov.) Fiori and *Psoralea plicata* Delile. was 0.0008 (Table 2).

Therapeutic use of medicinal plants according to the part used

Leaves are the most used part in traditional herbal medicine with a percentage of 56.34%, followed by fruits (20.10%) and then gum (9.78%). The other parts of the plant are rarely used (Figure 9). The frequent use of leaves was also observed in other ethnobotanical studies (Dahmane et al., 2023; Belhaj & Zidane 2021; Jaadan et al., 2020; Jeddi et al., 2021; Kaboré et al., 2023; Mir et al., 2021; Ogbe et al., 2009; Rahmatullah et al., 2012). it could be justified by the ease and speed of harvesting and the simplicity of handling for the preparation of medicines (Salhi et al., 2010). As well as preserving biodiversity. In addition, they are the site of photosynthesis and sometimes the storage of secondary metabolites (Bigendako-Polygenis & Lejoly, 1990).

Therapeutic use of medicinal plants according to the method of preparation

To facilitate the administration of the active ingredient, several therapeutic practices are utilized: infusion, cataplasm, decoction, powder, or maceration. We found that infusion is the most method of preparation used by these traditional practitioners (48%), followed by maceration (22%) and decoction (16%). Nevertheless, cataplasm is the least used (1%) (Figure 10). Different results have been published by other researchers, have shown

that decoction is the most used mode (Benaiche et al., 2019; Belhaj & Zidane, 2023; Kimpouni et al., 2019; Nguyen et al., 2020; Tchicaillat-Landou et al., 2018).

Therapeutic use of medicinal plants according to the mode of administration

Oral administration is the main mode (99.77%) (Figure 11). It was reported that between 30 and 65% of traditional medicines were administered orally (Adjanohoun & Aké-Assi, 1979; Adjanohoun et al., 1993; Bhandari et al., 2021; Benarba et al., 2015; Makambila, 2015; N'Guessan et al., 2009; Ouattara, 2006; Sangaré et al., 2012).

Therapeutic use of medicinal plants according to the conditions treated

The results (Figure 12) point that most medicinal species are used in the treatment of digestive tract diseases with a percentage of 53.50%, followed by metabolic diseases (8%), osteoarticular diseases (6%), genitourinary diseases (6%), dermatological diseases (4%) and respiratory diseases (4%). These results are consistent with those of other researchers (Kimpouni et al., 2019).

CONCLUSION

This work is part of the project to promote of Mauritanian medicinal plants through ethnobotanical study. Despite drought and desertification, this country has significant plant resources that deserve to be better known for better use and protection. The ethnobotanical survey carried out in the five regions of Mauritania (Tiris Zemmour, Inchiri, Adrar, Brakna, and Trarza) enabled us to summarize a certain amount of information relating to the use of plants in traditional medicine. Traditional healers, whether Maures or Peulhs use the same plant species. Women, married people, and those with low levels of predominate among this category of healers. This type of medicine is essentially aimed at exploiting and developing local species. Diseases of the digestive and metabolic tracts are the most common in the recipes. Medicines in the form of plant drugs from the leaves are administered orally.

LIST OF ABBREVIATIONS

WHO: World Health Organization; **KS:** Koranic school; **PS:** Primary school; **SS:** Secondary school; **L:** Leaf; **Br:** Branch; **W:** whole plant; **B:** Bark; **R:** Root; **Fr:** Fruit; **S:** Stem; **P:** Pod; **G:** Gum; **La:** Latex; **Se:** Seed; **Fl:** Flower.

Table 2. Use values and Relative frequency citations for trees and shrub species in five regions (Tiris Zemmour, Adrar, Brakna, Inchiri, and Tarza)

No	Scientific name	Medicinal uses	FC	RFC	FIV
1	<i>Achyranthes aspera</i> L.	Hypertension; gastrointestinal	1	0.01	0.005
2	<i>Aerva javanica</i> Juss.	Toothache; migraine	5	0.06	0.03
3	<i>Mangifera indica</i> L.	Body pain; Hypotension	1	0.01	0.005
4	<i>Sclerocary birrea</i> Hochst.	Gastrointestinal; Dysentery	10	0.13	0.065
5	<i>Calotropis procera</i> (Aiton) Dryand.	Bone and joint pain	1	0.01	0.003
6	<i>Leptadenia lanceolata</i> subsp. <i>lanceolata</i>	Stomachache	6	0.07	0.023
7	<i>Leptadenia pyrotechnic</i> (Forssk.) Decne.	Jaundice; Constipation	7	0.09	0.03
8	<i>Phoenix dactylifera</i> L.	gastrointestinal disorders	16	0.21	0.21
9	<i>Stereospermum kunthianum</i> Cham.	Coughing; Stomach pains	4	0.05	0.05
10	<i>Anastatica hierochuntica</i> L.	Diabetes; Hypertension	1	0.01	0.01
11	<i>Commiphora africana</i> (A. Rich.) Engl	Toothache; Weakness; Bone and joint pain	50	0.65	0.65
12	<i>Boscia senegalensis</i> Lam.	Diabetes; Stomachache; Aphrodisiac	70	0.92	0.03
13	<i>Capparis decidua</i> (Forssk.) Edgew.	Constipation	17	0.22	0.07
14	<i>Maerua crassifolia</i> Forskal.	Rheumatism; Loss of appetite	29	0.38	0.12
15	<i>Gymnosporia senegalensis</i> Loes.	Dysentery; intestinal worms	36	0.47	0.47
16	<i>Helianthemum lippii</i> (L.) Dum. Cours.	Inflammation	2	0.02	0.02
17	<i>Heliotropium ramosissimum</i> Sieber ex DC.	Inflammation	1	0.01	0.01
18	<i>Combretum aculeatum</i> Vent.	Haemorrhoids; Body weakness	4	0.05	0.025
19	<i>Combretum glutinosum</i> Perr. ex DC	Menstrualdisorders, Constipation; Diabetes; Anaemia; Hepatitis	4	0.05	0.025
20	<i>Citrullus colocynthis</i> (L.) Schrad.	Menstrual disorders; Diarrhoea; Ashma; Anaemia; Constipation	10	0.13	0.06
21	<i>Momordica balsamina</i> L.	Inflammation	2	0.02	0.01
22	<i>Bauhinia rufescens</i> Lam.	Diuretic; fever	9	0.11	0.007
23	<i>Dalbergia melanoxylon</i> Guill. & Perr.	Migraine; Cough; Hernia	2	0.02	0.001
24	<i>Faidherbia albida</i> (Delile) A. Chev.	Eye inflammation; toothache; ulcers	5	0.06	0.004
25	<i>Indigofera senegalensis</i> Lam.	Headaches	2	0.02	0.001
26	<i>Lotus torulosus</i> (Chiov.) Fiori	Gastrointestinal disorders; Asthma	1	0.01	0.0008
27	<i>Mimosa pigra</i> L.	Stomach pain; Sexual impotence	4	0.05	0.003
28	<i>Piliostigma reticulatum</i> (DC.) Hochs	Haemorrhoids; Stomach disorders	15	0.19	0.012
29	<i>Psoralea plicata</i> Delile.	Diarrhoea	1	0.01	0.0008
30	<i>Senegalia senegal</i> (L.) Willd	Toothache; malaria; jaundice	75	0.98	0.06
31	<i>Senna tora</i> (L.) Roxb.	Inflammation; Eye pain	7	0.09	0.005
32	<i>Senna italica</i> Mill.	Constipation	20	0.26	0.016
33	<i>Vachellia ehrenbergiana</i> Hayne	Gastrointestinal	30	0.39	0.024
34	<i>Vigna unguiculata</i> (L.)	Anemia	3	0.039	0.002
35	<i>Vachellia nilotica</i> (L.) Willd. ex Del.	Toothache; female infertility	3	0.039	0.002
36	<i>Vachellia seyal</i> Delile.	Diabetes; Aphrodisiac; Bronchial difficulties	20	0.26	0.016
37	<i>Vachellia tortilis</i> (Forssk.) Hayne	Stomach disorders; diarrhea	73	0.96	0.060
38	<i>Lawsonia inermis</i> L.	Rheumatism	1	0.01	0.01
39	<i>Adansonia digitata</i> L.	Bronchitis; rheumatism; body weakness; diabetes; dizziness; menstrual disorders; ulcers	74	0.97	0.13
40	<i>Corchorus depressus</i> (L.) C. Chr.	Dysentery	2	0.02	0.002
41	<i>Corchorus tridens</i> L.	Anaemia; diarrhea; dysentery	2	0.02	0.002
42	<i>Grewia bicolor</i> Juss.	Asthma; Eye inflammation	7	0.09	0.013
43	<i>Grewia tenax</i> (Forssk.) Fiori	Digestive tonic; Loss of appetite	3	0.039	0.005
44	<i>Hibiscus sabdarifa</i> L.	Tiredness; Aphrodisiac	1	0.01	0.001
45	<i>Sida spinosa</i> L.	Loss of appetite; cough	1	0.01	0.001
46	<i>Azadirachta indica</i> A. Juss	Malaria; Tiredness; Skin irritation	1	0.01	0.005
47	<i>Khaya senegalensis</i> A.Juss	Anaemia; Malaria; Intestinal worms; Jaundice	1	0.01	0.005
48	<i>Moringa oleifera</i> Lam.	Skin irritation; anaemia; hypertension; sterility; diabetes; sexual dysfunction	1	0.01	0.01
49	<i>Boerhavia diffusa</i> L.	Inflammation; Sexual dysfunction; Influenza	1	0.01	0.01
50	<i>Rogeria adenophylla</i> Gay ex Delile	Inflammation	1	0.01	0.01
51	<i>Stipagrostis pungens</i> (Desf.) De Winter	Aphrodisiac; Diuretic	1	0.01	0.01
52	<i>Ziziphus lotus</i> (L.) Lam.	Diabetes; Intestinal worms; Gastrointestinal infection	75	0.98	0.49
53	<i>Ziziphus mauritiana</i> Lam	Diabetes; Intestinal worms; Gastrointestinal infection	75	0.98	0.49
54	<i>Mitragyna inermis</i> (Willd.) Kuntze	Rheumatism; Headaches; Pneumonia	1	0.01	0.01
55	<i>Tribulus terrestris</i> L.	Tingling in fingers, feet and toes, Muscle pain, Bronchitis	1	0.01	0.01
56	<i>Helianthemum lippii</i> (L.) Dum.Cours.	Inflammation	1	0.01	0.01

FC = Frequency of citation; RFC= Relative frequency of citation; FIV= family importance value

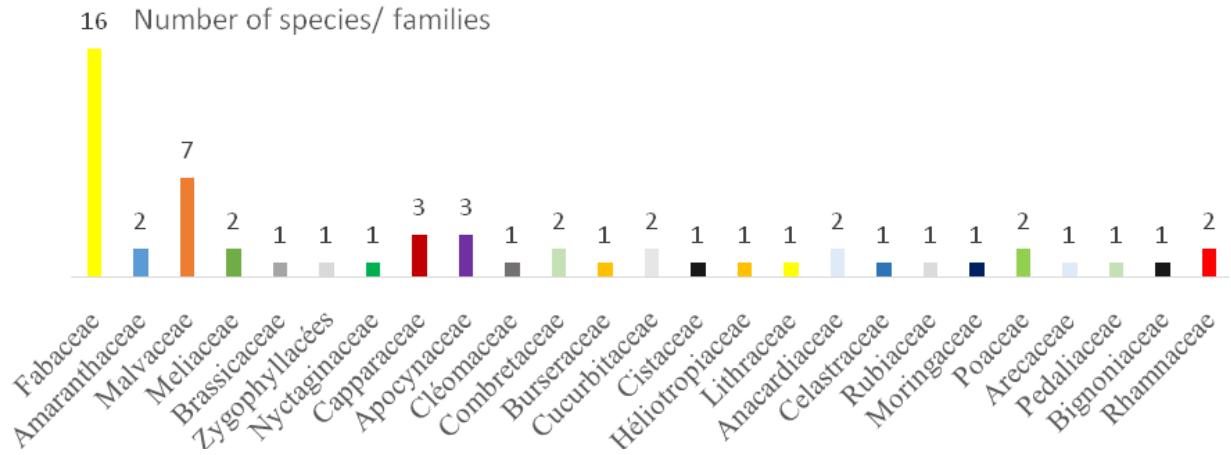


Figure 7. Number of species inventoried by family

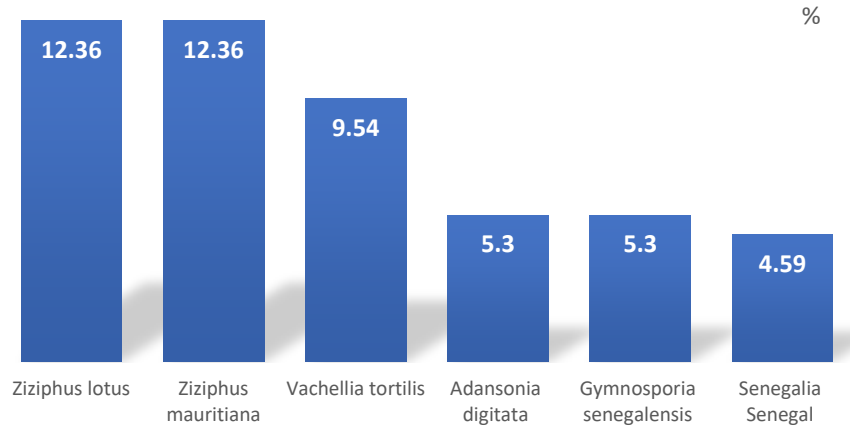


Figure 8. The plants most used by healers in the five regions (Tiris Zemmour, Inchiri, Adrar, Brakna, and Tarza). The relative frequency of citation (RFC)

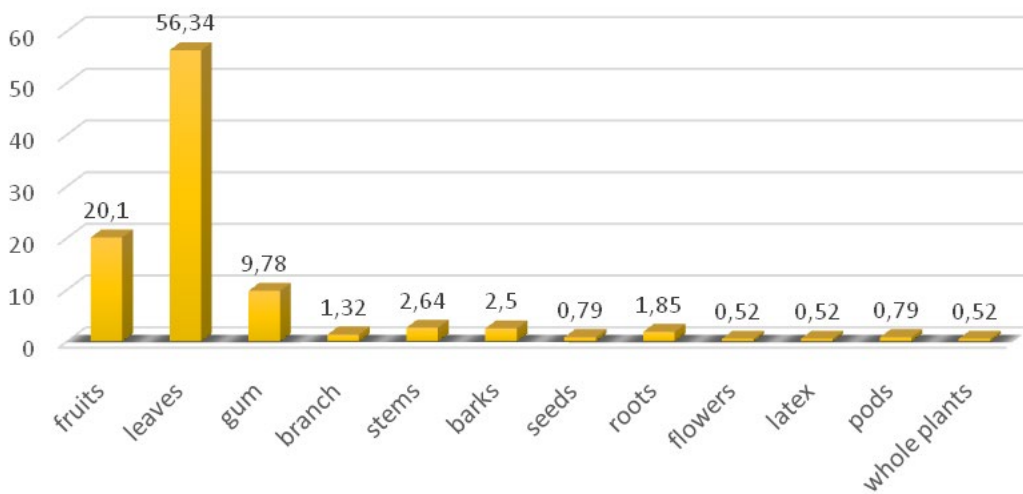


Figure 9. Use of plant parts as crude drugs expressed in percentage (leaves, fruit, gum, stems, bark, seeds, roots, flowers, latex, pods and whole plants) in the five regions (Tiris Zemmour, Inchiri, Adrar, Brakna, and Tarza)

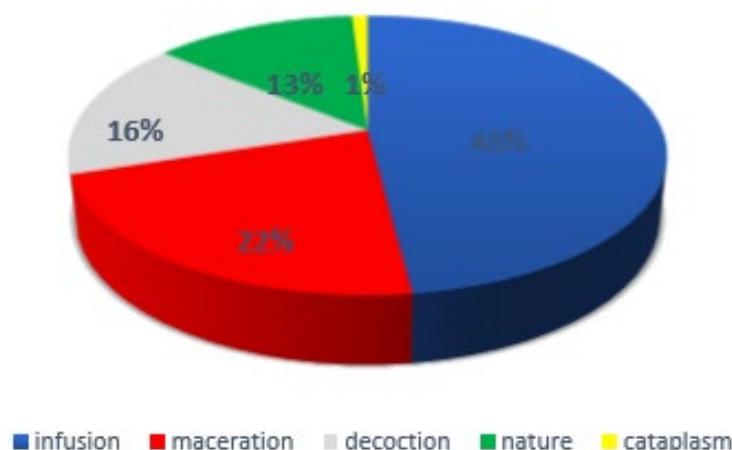


Figure 10. Percentage use of plants by preparation method (infusion, maceration, decoction, nature and cataplasms) by five regions (Tiris Zemmour, Inchiri, Adrar, Brakna, and Trarza)

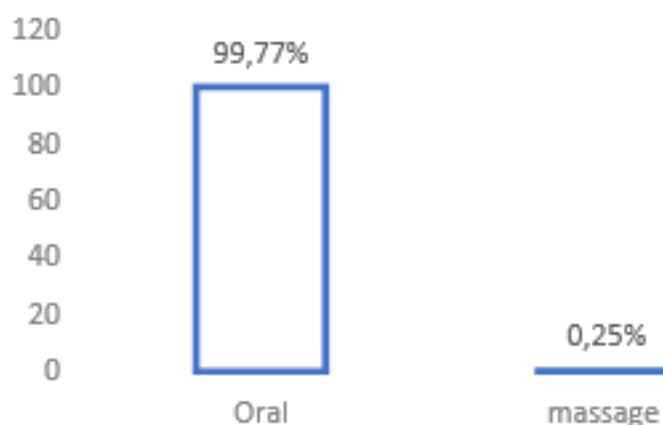


Figure 11. Percentage of plant use according to the method of administration (oral, massage) in the regions studied (Tiris Zemmour, Inchiri, Adrar, Brakna, and Trarza)

ETHICS APPROVAL

Each participant gave their oral agreement before the survey.

CONSENT FOR PUBLICATION

Not applicable

AVAILABILITY OF DATA AND MATERIALS

The manuscript contains all the data.

COMPETING INTERESTS

The authors declare that there are no financial or non-financial conflicts of interest.

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AUTHORS' CONTRIBUTIONS

Woury Aly Souleymane Sall: performed the survey and analyzed the results; Brahim Ould Elemine: performed the survey, Reviewing, discussing results, and editing; El Weilla Mohamed Mahmoud: performed the survey and analyzed the results, Mohamed Mahmoud Abidine: performed the survey and analyzed the results; Ahmedou Soulé: analyzed the results and editing; Ahmedou Vadel: Reviewing, discussing of results, and editing. All authors read and approved the final manuscript.

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