



Indigenous ethnomedicinal knowledge and herbal remedies among Saharan women healers in Southwestern Algeria

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Research

Abstract

Background: Traditional healing remains central to primary healthcare in Saharan communities across North Africa. In Algeria, ethnomedicinal knowledge is largely held by women healers. This study aimed to document herbal remedies used by Saharan women healers and to examine age- and practice-related variation in reported ethnomedicinal knowledge.

Methods: We documented the practices of 39 women traditional healers from Bechar and Beni Abbes provinces. Ethnobotanical data were quantified using the Relative Frequency of Citation (RFC), Fidelity Level (FL), and Informant Consensus Factor (ICF). Age-related variation was assessed by correlating informant age with use-report counts (UR), and experience-related differences were examined by comparing UR across practitioner groups.

Results: A total of 776 UR were recorded, documenting 95 medicinal plant taxa belonging to 40 botanical families. *Artemisia herba-alba* was the most frequently cited species (RFC = 0.846). Informant consensus was highest for respiratory (ICF = 0.89) and digestive disorders (ICF = 0.76), and 11 taxa showed complete fidelity (FL = 100%). Approximately 25% of informants reported consulting biomedical services primarily for diagnostic purposes and subsequently relying on traditional remedies for management. Total UR showed a weak positive association with age, and professional Douaya reported higher UR values than non-regular traditional healing practitioners.

Conclusions: Women healers reported a diverse ethnomedicinal repertoire. Lower UR among non-regular practitioners may reflect differences in reported ethnomedicinal knowledge and practice intensity, underscoring the need to document and safeguard women's traditional healing knowledge.

Keywords: Ethnobotany, Traditional healers, Women, Algerian Sahara, Medicinal plants, knowledge transmission

Background

Herbal medicine is deeply embedded in the cultural and therapeutic heritage of North African societies (Benkaddour *et al.* 2025). Over several decades, traditional medicine practiced by indigenous women in Algeria and Morocco was frequently delegitimized as superstition, while simultaneously being appropriated through the documentation of local remedies to support extraction and commercialization of medicinal products (Amster 2022). Algeria offers a particularly relevant setting for ethnomedicinal research because of its broad ecological gradient, from Mediterranean and steppe landscapes to hyper-arid environments. In Saharan regions, traditional medicine remains pivotal to primary healthcare (Miara *et al.* 2019b, Tedjani *et al.* 2023) and this heritage is notably embodied by women healers locally referred to as “*Douaya*”, a term designating female practitioners recognized for their experience with plant-based therapies. The expertise is largely acquired and maintained through oral transmission and apprenticeship-like socialization across generations (Senouci *et al.* 2019, Bendif *et al.* 2021). However, despite their cultural and medical significance, the knowledge held by Saharan women healers is increasingly under pressure. Sociocultural change and urbanization among younger generations may weaken the traditional mechanisms of transmission (Lasisi & Ekpenyong 2011). Ethnobotanical surveys in Algerian Saharan and steppe regions consistently report high reliance on medicinal plants (Sekkoum *et al.* 2011, Benarba 2016, Miara *et al.* 2018, Miara *et al.* 2019a, Belhouala & Benarba 2021). Yet, most available studies are based on mixed-gender samples and community-wide knowledge, and no study has examined women healers as distinct knowledge-holders within Saharan socio-medical systems. In this context, the present study investigates Saharan women healers in the southwestern provinces of Bechar and Beni Abbes. The objectives were (i) to document the diversity of medicinal plants, preparation techniques, and plant-based remedies used by the women healers; (ii) to quantify the internal structure and consistency of their ethnobotanical knowledge using established ethnobotanical indices; and (iii) to explore whether reported ethnomedicinal knowledge varies with age and healing-practice status as a preliminary indication of possible intergenerational differences.

Materials and Methods

Study area

Bechar and Beni Abbes provinces are located in the southwestern Algerian Sahara. They formed a single administrative unit until 2019 and together cover approximately 161,400 km², about 900 km south of Algiers (27°18'40"-32°25'27" N; 0°21'48"-5°30'23" W). The area is bordered by Naâma to the north, El Bayadh to the east, Adrar to the south, and Morocco to the west. Beni Abbes (111,350 km²) is crossed by the Saoura Valley, characterized by oasis systems and palm groves. The region has a hyper-arid Saharan climate with very low annual precipitation and high thermal amplitudes (Fig. 1).

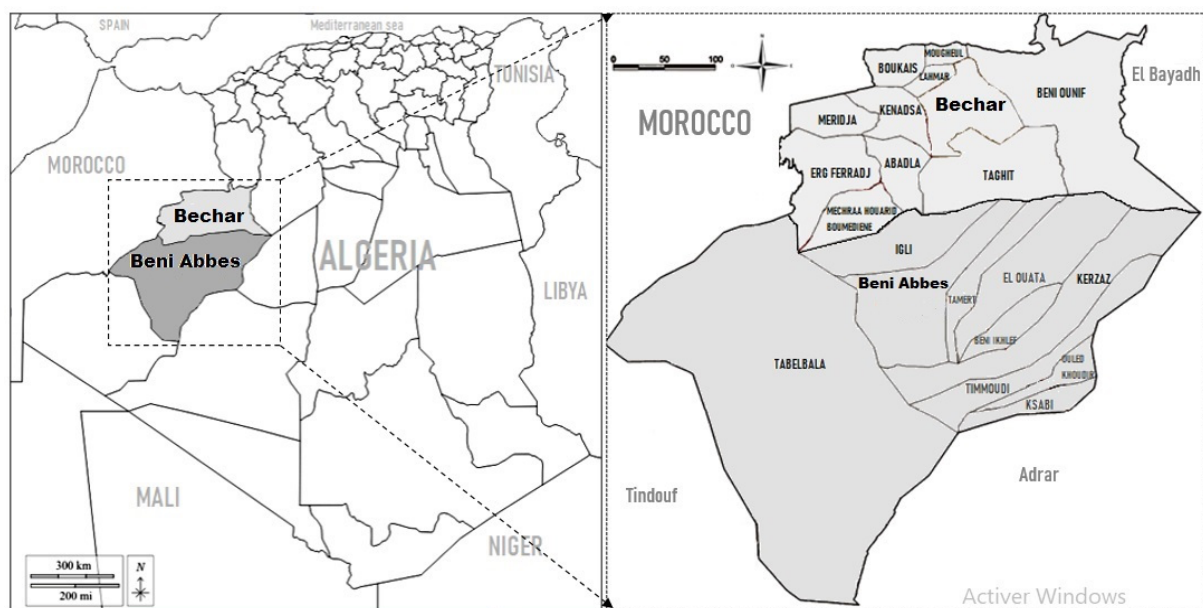


Figure 1. Study area comprising the Bechar and Beni Abbes provinces in the southwest of Algeria

Survey ethics and data collection

The ethnobotanical survey was conducted between 2023 and 2025 in the Bechar and Beni Abbes provinces of southwestern Algeria. Female holders of ethnomedicinal knowledge were recruited using a purposive snowball sampling strategy. Initial informants were identified with the assistance of local community members familiar with traditional healing practices, based on local recognition and practical healing experience. They were then asked to recommend other knowledgeable women from different districts, and additional locally known women healers were also approached to reduce dependence on a single referral network.

Before each interview, the study objectives were explained, oral informed consent was obtained, and participation was voluntary. Responses were anonymized by assigning each informant a code in the database. The study followed the ethical principles of the International Society of Ethnobiology Code of Ethics. A total of 39 women were interviewed. Semi-structured interviews were conducted at participants' homes or workplaces using a pre-tested questionnaire covering socio-demographic data, reliance on modern healthcare, medicinal plants used, preparation methods, routes of administration, and perceived therapeutic indications.

Informants were categorized according to the professional status and regularity of their healing practice. "Professional Douaya" were defined as women who self-identified as Douaya and practiced traditional healing as a recognized professional activity, regardless of age. They were regularly consulted by community members for herbal remedies, therapeutic guidance, and treatment. The second group consisted of non-regular traditional healing practitioners who had practical ethnomedicinal knowledge and occasionally used or recommended herbal remedies but did not practice healing as a profession. Data saturation was assessed empirically during fieldwork, as the final interviews mainly produced recurrent information without substantially new plants, uses, preparation methods, or administration routes.

Botanical identification

Reported plant species were collected in situ during guided field walks, obtained as conserved material provided by informants, or purchased from local herbal markets (in case of not available or imported species), with assistance from two expert informants. Taxonomic identification was performed and verified by Dr. A. Abdelhakem (National Nature Agency, Algeria) using standard taxonomic keys. Scientific names and author citations were checked and updated using Plants of the World Online. Voucher specimens were deposited in the Medicinal Plant Encyclopedia Herbarium (MPE) at the Bioactive Molecules and Chiral Separation Laboratory (BMCS), University Tahri Mohamed of Bechar, Algeria.

Quantitative analysis

Use Report (UR)

A use report (UR) was defined as one informant reporting one medicinal plant species for one therapeutic indication. When the same informant reported the same species for more than one therapeutic indication, each indication was counted as a separate UR.

Relative Frequency of Citation (RFC)

RFC was used to estimate the relative importance of each species within the community and was calculated as:

$$RFC = FC/N \quad (0 < RFC < 1)$$

Where, FC is the number of informants who cited the species and N is the total number of informants.

Informant Consensus Factor (ICF)

ICF was used to quantify agreement among informants regarding plants used for each ailment and was calculated as:

$$ICF = (Nur - Nt) / (Nur - 1)$$

Where, Nur is the number of use reports in a category and Nt the number of taxa used. Reported therapeutic indications were first recorded using informants' own terms and then grouped into broad ICD-11 categories using the WHO ICD-11 browser (World Health Organization 2026). This grouping was adapted pragmatically for ethnobotanical analysis and does not imply clinical diagnosis.

Fidelity Level (FL)

FL was calculated to estimate the proportion of informants who agreed on a specific use of a species:

$$FL (\%) = N_p/N \times 100$$

Where, N_p is the number of informants citing the species for the same ailment and N is the number of informants citing that species for any ailment.

Data analysis

Statistical analyses were performed using IBM SPSS Statistics (v20.0). Use report counts (UR) did not meet normality assumptions; therefore, non-parametric tests were applied. The association between informant age and total UR was assessed using Spearman's rank correlation, while differences in total UR between the two practitioner groups were evaluated using the Mann-Whitney U test. Effect sizes were reported using Spearman's rho and rank-biserial correlation, and the Hodges-Lehmann estimator was used to estimate the median difference between groups with a 95% confidence interval. As two planned inferential tests were performed on total UR, p-values were adjusted using the Holm-Bonferroni procedure. Statistical significance was set at $p < 0.05$.

Results**Informants' Profile**

We interviewed 39 female informants (Table 1), most of whom were from Bechar (87.18%), with the remaining 12.82% from Beni Abbes. Informants covered a broad age range, with the largest proportion in the 26-39-year group (33.33%), followed by <25 years (30.77%), 40-59 years (23.08%), and ≥ 60 years (12.82%). Education levels were heterogeneous: more than half of the informants reported a university level (51.28%), 33.33% had secondary education, 10.26% primary education, and 5.13% were illiterate.

Table 1. Informants' demographic attributes

Variable	Categories	Percentages
Gender	Female	100%
Age	<25	30.77%
	26-39	33.33%
	40-59	23.08%
	≥ 60	12.82%
Education level	Illiterate	5.13%
	Primary	10.26%
	Secondary	33.33%
	University	51.28%
Province	Bechar	87.18%
	Beni Abbes	12.82%
Experience	Professional <i>Douaya</i>	43.59%
	Non-regular traditional healing practitioners	56.41%

A weak positive association was observed between informant age and total use reports per informant (Fig. 2), suggesting that older informants tended to report slightly more medicinal uses (Spearman's $\rho = 0.343$, unadjusted $p = 0.033$, Holm-adjusted $p = 0.033$, $n = 39$). Professional *Douaya* reported higher total UR values than non-regular traditional healing practitioners, with median values of 22 and 16 use reports, respectively. This difference remained significant after Holm-Bonferroni correction (Mann-Whitney $U = 92.00$, $Z = -2.697$, unadjusted $p = 0.007$, Holm-adjusted $p = 0.014$). The Hodges-Lehmann estimate indicated a median difference of 6 use reports between groups (95% CI: 2-11), with a moderate-to-large rank-biserial effect size ($r_{rb} = 0.51$) (Fig. 3).

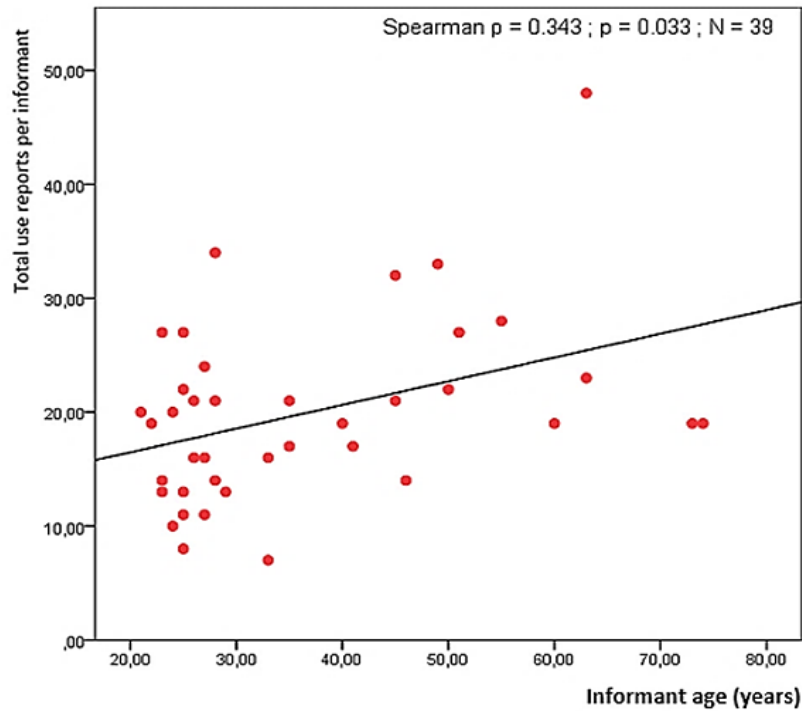


Figure 2. Correlation between informant age and total use reports per informant. A weak positive association was observed between age and total use reports per informant (Spearman's $\rho = 0.343$, Holm-adjusted $p = 0.033$, $n = 39$).

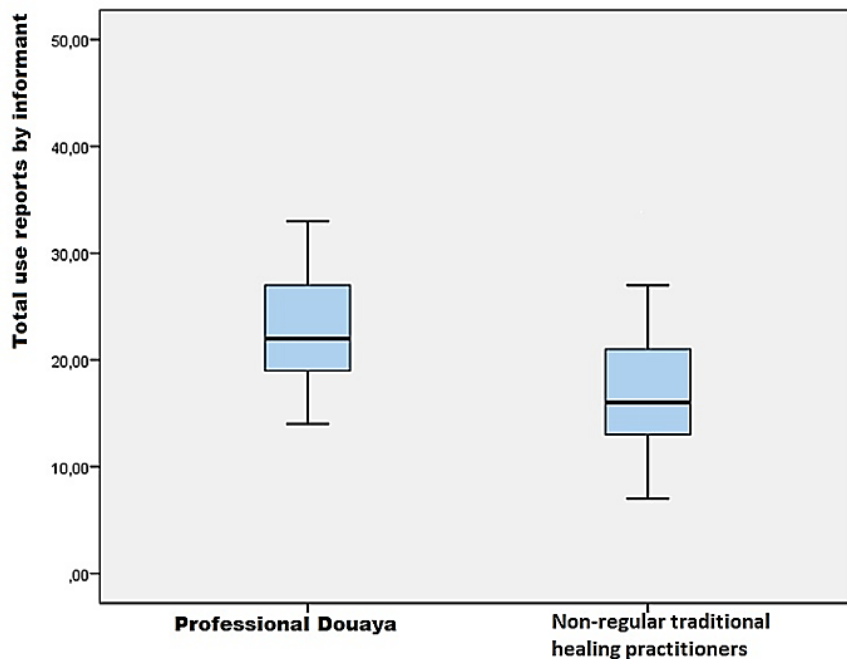


Figure 3. Comparison of total use reports per informant between professional Douaya and non-regular traditional healing practitioners. Professional Douaya ($n = 17$) reported higher total UR values than non-regular practitioners ($n = 22$) (Mann-Whitney $U = 92.00$, Holm-adjusted $p = 0.014$). The total sample size was $n = 39$.

Botanical diversity

The survey yielded 776 use reports and documented 95 medicinal plant taxa (Table 2) belonging to 40 botanical families. Apiaceae was the most represented family, with 11 taxa. Asteraceae, Fabaceae, and Lamiaceae were the next most represented families, each comprising eight taxa. RFC values ranged from 0.026 to 0.846, indicating marked differences in how widely each taxon was recognized across informants. The most important RFC values were observed for *Artemisia herba-alba* (0.846), *Trigonella foenum-graecum* (0.795), and *Syzygium aromaticum* (0.769).

Table 2. List of medicinal plants cited by the informants.

Family	Scientific name	Vernacular name	Part used	Preparation/administration	Traditional use(s)	RFC
Amaranthaceae	<i>Haloxylon scoparium</i> Pomel	Remth	AP, R	Decoction, infusion, powder, cataplasm	Wounds, infections, burns, diabetes, gastrointestinal diseases, snake bites, cancer, lymph node-related complaints	0.385
Amaranthaceae	<i>Beta vulgaris</i> L.	Chmandar	Bu	Raw	Anemia	0.051
Amaranthaceae	<i>Atriplex halimus</i> L.	Guetaff	L	Decoction, infusion, Suppository	Lymph node-related complaints, ovarian cysts, stomach diseases, allergy, skin infection	0.154
Amaryllidaceae	<i>Allium cepa</i> L.	B'ssal	Bu	Fumigation, raw, juice	Headache, infection, kidney illness, women infertility	0.205
Amaryllidaceae	<i>Allium sativum</i> L.	Thoom	Bu	Decoction in olive oil, crushed raw	Hypertension, infection, inflammation, cancer, anemia, headache	0.282
Anacardiaceae	<i>Pistacia atlantica</i> Desf.	Betom	Fr	Raw	Panic disorder, goiter	0.077
Anacardiaceae	<i>Pistacia lentiscus</i> L.	Dharw	Oil	Topical application	Burns, asthma	0.282
Apiaceae	<i>Ammodaucus leucotrichus</i> Coss.	Nessoufa	Fl	Mastication, infusion	Hypertension, panic disorder, stomach pain	0.462
Apiaceae	<i>Bunium bulbocastanum</i> L.	Talghouda	Tb	Raw, powder	Goiter	0.077
Apiaceae	<i>Daucus carota</i> L.	Zeroudya	S	Infusion	Liver disorder, infertility, anemia, kidney illness	0.077
Apiaceae	<i>Foeniculum vulgare</i> Mill.	Besbas	S	Infusion	Gastrointestinal diseases	0.256
Apiaceae	<i>Magydaris pastinacea</i> (Lam.) Paol.	Frifra	AP	Infusion	Panic disorder	0.051
Apiaceae	<i>Petroselinum crispum</i> (Mill.) Fuss	Maadnous	AP	Fresh	kidney illness	0.051
Apiaceae	<i>Pimpinella anisum</i> L.	Habbet hlawa	S	Infusion	Gastrointestinal diseases, panic disorder, anemia	0.282
Apiaceae	<i>Coriandrum sativum</i> L.	Kosbor	S	Infusion	Diabetes	0.051
Apiaceae	<i>Apium graveolens</i> L.	Krafess	AP	Raw, decoction	Hypertension, urinary tract diseases, stomach pain	0.103
Apiaceae	<i>Cuminum cyminum</i> L.	Kemmoun	S	Raw, infusion, Suppository	Stomach pain, panic disorder, abdominal distention	0.179
Apiaceae	<i>Ammi visnaga</i> (L.) Lam.	Noukha	S	Infusion	Cold, allergy	0.487
Apocynaceae	<i>Nerium oleander</i> L.	Defla	L	Decoction, mouthwash	Headache, kidney illness, gum pain, allergy	0.205
Araliaceae	<i>Panax ginseng</i> C.A. Meyer	Ginseng	R	Infusion	Cancer	0.026
Aristolochiaceae	<i>Aristolochia longa</i> L.	Berrostom	R	Powder	Cancer	0.026
Asteraceae	<i>Carlina gummifera</i> (L.) Less.	Oud adada	R	Decoction, powder	Headache, burns	0.154
Asteraceae	<i>Chamaemelum nobile</i> (L.) All.	Baboondj	Fl	Infusion, decoction, fumigation	Stomach pain, burns, anxiety, headache, allergy, genital infection	0.333
Asteraceae	<i>Santolina rosmarinifolia</i> L.	Jaâda	AP	Fresh in food, infusion	Stomach pain	0.026
Asteraceae	<i>Artemisia herba-alba</i> Asso.	Chih	AP	Infusion, decoction, cataplasm, suppository	Infections, stomach pain, burns, diabetes, cold, allergy	0.846

Asteraceae	<i>Cotula cinerea</i> Delile	Kartoufa	AP	Infusion	Infections, diarrhoea, cold, allergy, anemia, headache	0.154
Asteraceae	<i>Saussurea costus</i> (Falc.) Lipsch.	Kist Hindi	R	Decoction	Headache	0.051
Asteraceae	<i>Anvillea radiata</i> Coss. & Durieu	Nougd	AP	Infusion	Allergy	0.256
Asteraceae	<i>Matricaria pubescens</i> Desf. Sch.Bip.	Wazwaza	L	Mastication, infusion	Cold, menstrual pain	0.077
Brassicaceae	<i>Lepidium sativum</i> L.	Habb erched	S	Infusion	Infertility, urinary tract diseases, diarrhoea, anemia, hypertension	0.154
Brassicaceae	<i>Anastatica hierochuntica</i> L.	Keff Maryam	AP	Infusion, powder	Women infertility, uterus tumor, anxiety, diabetes, headache, anemia, urinary tract diseases	0.256
Burseraceae	<i>Commiphora myrrha</i> (Nees) Engl.	Oum nass	Gm	Decoction, powder	Infection, wound, bone fracture	0.077
Cactaceae	<i>Opuntia ficus-indica</i> (L.) Mill.	Sabbar	L	Raw	Dermatitis and eczema, burns	0.077
Capparaceae	<i>Capparis spinosa</i> L.	Kebbar	L	Decoction	Kidney diseases	0.026
Caryophyllaceae	<i>Spergularia rubra</i> (L.) J.Presl & C.Presl	Fettatet lahjar	AP	Infusion	Kidney diseases and lithiasis	0.128
Cucurbitaceae	<i>Cucurbita maxima</i> Duchesne	Kabouya	S	Infusion, decoction	Prostate diseases, men infertility, anxiety	0.077
Cucurbitaceae	<i>Citrullus colocynthis</i> (L.) Schrad.	Hdej	S	Infusion	Diabetes, headache, rheumatism	0.103
Cucurbitaceae	<i>Ecballium elaterium</i> (L.) A.Rich.	Fegous Lahmir	Fr	Decoction: nasal drops	Liver diseases	0.077
Cucurbitaceae	<i>Lagenaria siceraria</i> (Molina) Standl.	Garaa selaoui	Ftb	Burned	Headache	0.026
Cupressaceae	<i>Juniperus phoenicea</i> L.	Arâar	AP	Infusion, decoction, fumigation	Cough, respiratory diseases, stomach pain, infection, headache, diarrhoea	0.513
Cyperaceae	<i>Cyperus rotundus</i> L.	Tara	Rh	Infusion	Stomach pain	0.051
Cyperaceae	<i>Cyperus esculentus</i> L.	Habb laâziz	S	Infusion	Hypertension, anemia	0.026
Ephedraceae	<i>Ephedra alata</i> Decne.	Alanda	St	Infusion	Cancer	0.359
Euphorbiaceae	<i>Euphorbia guyoniana</i> Boiss. & Reut.	Moulbina	L	Infusion	Stomach pain, diarrhoea, panic disorder	0.205
Euphorbiaceae	<i>Euphorbia officinarum</i> subsp. <i>echinus</i> (Hook.f. & Coss.)	Daghmous	Fl	Powder	Cancer	0.026
Euphorbiaceae	<i>Mercurialis annua</i> L.	Mourkebi	AP	Decoction	Cancer	0.051
Fabaceae	<i>Lupinus albus</i> L.	Torms Morr	S	Infusion	Diabetes	0.077
Fabaceae	<i>Trigonella foenum-graecum</i> L.	Halba	S	Raw, Infusion	Panic disorder, diabetes, anemia, gastrointestinal problems, allergy, bone fracture	0.795
Fabaceae	<i>Ceratonia siliqua</i> L.	Kharoub	Fr, L	Molasses, decoction	Anemia, stomach pain, allergy, anxiety	0.282
Fabaceae	<i>Senna italica</i> Mill.	Sana makki	AP	Decoction	Constipation, inflammation	0.051
Fabaceae	<i>Lens culinaris</i> Medik.	Adess	S	Cooked, powder	Anemia, hypertension	0.282
Fabaceae	<i>Glycyrrhiza glabra</i> L.	Aarq souss	R	Infusion	Allergy, panic disorder	0.077
Fabaceae	<i>Acacia senegal</i> (L.) Willd.	Aalk Talh	Gm	Decoction, powder	Hypotension, kidney illness, allergy	0.077

Fabaceae	<i>Vigna unguiculata</i> (L.) Walp.	Tedlaghet	S	Infusion, cooked	Anemia	0.103
Lamiaceae	<i>Rosmarinus officinalis</i> L.	Lazir	AP	Infusion, decoction	Panic disorder, respiratory diseases, cancer Allergy	0.154
Lamiaceae	<i>Origanum majorana</i> L.	Bardakoosh	L	Infusion	Hypertension	0.051
Lamiaceae	<i>Mentha suaveolens</i> Ehrh.	Timerssat	L	Decoction	Burns, skin infection, diabetes	0.051
Lamiaceae	<i>Ocimum basilicum</i> L.	Hbaq	AP	Decoction	Allergy, ovarian cysts	0.154
Lamiaceae	<i>Lavandula stoechas</i> L.	Khezama	Fl	Infusion, fumigation suppository	Uterine conditions, skin infection	0.256
Lamiaceae	<i>Teucrium polium</i> L.	Khayata	AP	Decoction	Wounds, burns	0.051
Lamiaceae	<i>Origanum vulgare</i> L.	Zaâtar	AP	Decoction, infusion, fumigation	Cold and flu, allergy, anemia	0.590
Lamiaceae	<i>Mentha spicata</i> L.	Naânaâ	L	Infusion, mouthwash, mastication	Anxiety, headache, diabetes, cold, abdominal distention, burns, hypertension	0.513
Lauraceae	<i>Laurus nobilis</i> L.	Rand	L	Infusion	Hypertension	0.026
Lauraceae	<i>Cinnamomum verum</i> J. Presl	Qarfa	Stb	Infusion	Diabetes, hypertension, headache, cold	0.256
Lythraceae	<i>Lawsonia inermis</i> L.	Hanna	L	Powder	Burns, infections, kidney diseases	0.077
Lythraceae	<i>Punica granatum</i> L.	Rommen	Ftb	Infusion	Gastrointestinal diseases, infections, diabetes	0.410
Malvaceae	<i>Malva sylvestris</i> L.	Khobeiza	L	Decoction	Kidney diseases	0.026
Malvaceae	<i>Hibiscus sabdariffa</i> L.	Karkadya	Fl	Infusion	Hypertension, anemia, cancer, diabetes	0.179
Malvaceae	<i>Gossypium hirsutum</i> L.	Kton	L, S	Infusion	Kidney diseases, swollen lymph nodes	0.051
Moringaceae	<i>Moringa oleifera</i> Lam.	Moringa	L	Infusion, decoction, powder	Diabetes, anemia, cancer, headache, hypertension, allergy	0.333
Myrtaceae	<i>Syzygium aromaticum</i> (L.) Merr. & L.M. Perry	Kronfel	Fib	Powder, decoction, infusion	Cold, headache, cancer, allergy	0.769
Myrtaceae	<i>Eucalyptus globulus</i> Labill.	Kalitous	L	Infusion, fumigation	Cold	0.231
Oleaceae	<i>Olea europaea</i> L. subsp. <i>europaea</i>	Zitoune	L, Oil	Mastication, decoction, infusion	Hypertension, diabetes, burns, headache, kidney diseases	0.333
Pinaceae	<i>Pinus halepensis</i> Mill.	Tayda	Stb	Powder	Burns	0.256
Poaceae	<i>Hordeum vulgare</i> L.	Chaâir	S	Raw, decoction	Kidney diseases, gastrointestinal problems	0.051
Poaceae	<i>Sorghum bicolor</i> (L.) Moench	Bechna	S	Infusion	Kidney diseases	0.128
Poaceae	<i>Zea mays</i> L.	Dhra	Stg	Infusion	Kidney diseases	0.051
Portulacaceae	<i>Portulaca oleracea</i> L.	Rejla	AP	Cooked	Cancer	0.051
Ranunculaceae	<i>Nigella sativa</i> L.	Habba souda	S	Raw, powder	Allergy, headache, kidney diseases, stomach pain, diabetes, panic disorder, cancer	0.410
Rhamnaceae	<i>Rhamnus alaternus</i> L.	Mliless	L	Infusion	Liver diseases, anemia	0.051
Rhamnaceae	<i>Ziziphus lotus</i> (L.) Lam.	Nbeg	Fr	Raw	Diarrhoea, kidney diseases, panic disorder, stomach pain	0.128
Rosaceae	<i>Prunus persica</i> (L.) Batsch	Khoukh	L, S	Infusion	Cysts, cancer	0.051
Rosaceae	<i>Prunus amygdalus var. amara</i> L.	Looz	Oil	Topical application	Allergy	0.026

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Rubiaceae	<i>Rubia tinctorum</i> L.	Foua	St	Infusion	Anemia, hypertension, panic disorder	0.308
Rutaceae	<i>Citrus limon</i> (L.) Osbeck	Lym	Fr, L	Juice, decoction	Cold, headache, kidney diseases	0.436
Rutaceae	<i>Ruta chalepensis</i> L.	Fijel	AP	Infusion	Colon diseases	0.026
Thymelaeaceae	<i>Aquilaria malaccensis</i> Lam.	Oud ghris	Stb	Infusion	Cysts, diabetes	0.051
Thymelaeaceae	<i>Thymelaea hirsuta</i> (L.) Endl.	Methnen	L	Infusion	Urinary tract diseases	0.051
Urticaceae	<i>Urtica dioica</i> L.	Karras	AP	Infusion	Anemia	0.026
Verbenaceae	<i>Aloysia citrodora</i> Palau	Louiza	L	Infusion	Cold	0.026
Viscaceae	<i>Viscum album</i> L.	Heddala	L	Decoction	Cancer	0.026
Zingiberaceae	<i>Curcuma longa</i> L.	Korkom	R	Powder	Cancer, diabetes, gastrointestinal diseases, anxiety, anemia, allergy	0.128
Zingiberaceae	<i>Zingiber officinale</i> Roscoe	Zanjabil	R	Powder, infusion, decoction	Cold, allergy, cancer, anxiety	0.282
Zygophyllaceae	<i>Peganum harmala</i> L.	Harmal	L	Powder	Burns, stomach pain	0.077
Zygophyllaceae	<i>Zygophyllum album</i> L.	Agaya	AP	Decoction	Stomach pain	0.026

Plant preparation

The informants used various methods for preparing medicinal plants, with infusion (38%) as the most prevalent method. Decoction accounts for 18% of preparation methods. Fumigation used at 16% indicates the important use of treatments involving direct inhalation of smoke. Methods such as sprinkling powdered plant material (10%), cataplasm (5%), mastication (4%), suppositories (3%), and mouthwashes (2%) are less commonly used. Other methods of preparation, such as molasses extraction and burning plants, each account for 2%.

Fidelity level and informant consensus factor

Several taxa showed very high FL values for specific ICD-11 ailment categories (Table 3), indicating strong specificity of use among informants citing those taxa. Notably, 11 taxa reached FL = 100% in at least one category, meaning that all informants who mentioned the taxon reported it for the same ailment category. Overall agreement among informants varied across ailment categories (Table 3). The highest consensus was observed for Diseases of the respiratory system (ICF = 0.89), followed by Diseases of the digestive system (0.76). Moderate consensus was found for Mental, behavioral or neurodevelopmental disorders (0.68) and Injury/poisoning-related conditions (0.67), whereas lower values were observed for Diseases of the immune system (0.56) and Diseases of the genitourinary system (0.50).

Table 3. Informant consensus factor per ailment categories and fidelity levels for the most cited medicinal species

Ailment category	ICF	Most cited species	FL (%)
Neoplasms	0.63	<i>Ephedra alata</i> Decne.	100
		<i>Allium sativum</i> L.	36.36
Diseases of the circulatory system	0.65	<i>Ammodaucus leucotrichus</i> Coss.	94.44
		<i>Allium sativum</i> L.	54.55
Diseases of the genitourinary system	0.50	<i>Spergularia rubra</i> L.	100
		<i>Sorghum bicolor</i> L.	100
Diseases of the digestive system	0.76	<i>Punica granatum</i> L.	81.25
		<i>Artemisia herba-alba</i> Asso.	75.76
Endocrine, nutritional or metabolic diseases	0.63	<i>Nigella sativa</i> L.	31.25
		<i>Moringa oleifera</i> Lam.	30.77
Diseases of the respiratory system	0.89	<i>Ammi visnaga</i> Lam.	100
		<i>Origanum vulgare</i> L.	95.65
Diseases of the skin	0.65	<i>Lavandula stoechas</i> L.	100
		<i>Haloxylon scoparium</i> Pomel	66.67
Diseases of the blood or blood-forming organs	0.63	<i>Vigna unguiculata</i> (L.) Walp.	100
		<i>Lens culinaris</i> Medik.	100
Injury, poisoning or certain other consequences of external causes	0.67	<i>Pinus halepensis</i> Mill.	100
		<i>Pistacia lentiscus</i> L.	100
Mental, behavioral or neurodevelopmental disorders	0.68	<i>Trigonella foenum-graecum</i> L.	70.97
		<i>Chamaemelum nobile</i> (L.) All.	46.15
Diseases of the immune system	0.56	<i>Anvillea radiata</i> Coss.	100
		<i>Nigella sativa</i> L.	37.50
Diseases of the nervous system	0.63	<i>Carlina gummifera</i> (L.) Less.	100
		<i>Nerium oleander</i> L.	62.50

Ailments were classified according to the International Classification of Diseases (ICD-11)

Neoplasms: Cancer, uterus tumor, cysts

Diseases of the circulatory system: hypertension, hypotension, and disorders of lymphatic vessels or lymph nodes

Diseases of the genitourinary system: Genital infection, ovarian cysts, infertility, uterus diseases, menstrual pain, prostate infection, kidney diseases, urinary tract diseases.

Diseases of the digestive system: Liver diseases, gastrointestinal, stomach diseases, gum ulcers and pain, diarrhoea, constipation, colon diseases, abdominal distention

Endocrine, nutritional or metabolic diseases: Goiter and diabetes

Diseases of the respiratory system: Asthma, Cold, Cough.

Diseases of the skin: skin infections, dermatitis and eczema

Diseases of the blood or blood-forming organs: Anemia

Injury, poisoning or certain other consequences of external causes: Burns, wounds and bone fracture

Mental, behavioral or neurodevelopmental disorders: anxiety or fear-related disorders: panic disorder and anxiety

Diseases of the immune system: allergic or hypersensitivity conditions

Diseases of the nervous system: Headache.

New reports on Saharan herbal remedies

Informants described several herbal formulations, and some prepared herbal remedies during the survey (Fig. 4). Natural ointments are typically prepared by mixing powdered plant material (e.g., *Artemisia herba-alba*, *Haloxylon scoparium*) with goat fat and are used topically for skin-related complaints. *Oukdaa* is based on honey or molasses (from dates or carob), combined with plant powders and nuts; it is taken orally and is locally perceived as supportive in conditions such as fatigue/weakness and weight gain. Suppositories are prepared by mixing plant with small amounts of water and are administered rectally or vaginally for locally defined gynecological and gastrointestinal complaints. Finally, *Djebira* is a topical formulation prepared from *Trigonella foenum-graecum* and *Commiphora myrrha* mixed with egg and/or honey and is locally used in the context of bone injuries.

Reliance on modern medicine

Informants reported different ways of interacting with biomedical healthcare. Two elderly informants reported never consulting doctors and relying exclusively on traditional practices. Ten informants reported consulting doctors mainly for diagnostic purposes or laboratory tests. Some healers explained that they obtained prescriptions but then replaced the prescribed drugs with medicinal plants, for example substituting metronidazole with *Artemisia herba-alba* for gastrointestinal conditions. Others reported going to the hospital only for radiological exams in cases of fractures, then using the results to apply a *Djebira* remedy for healing. In contrast, most informants sometimes sought biomedical care for both diagnosis and treatment, while also using traditional medicine.



Figure 4. Traditional healers (Informants) preparing herbal-based remedies

Discussion

This study examines women healers as specialized knowledge-holders within the Saharan ethnomedicinal system of southwestern Algeria. Reported ethnomedicinal data varied according to age and healing-practice status: total UR was weakly positively associated with age, and professional Douaya reported higher UR than non-regular traditional healing practitioners. This may reflect cumulative exposure to medicinal plant use, repeated healing practice, and longer opportunities for oral learning. This pattern is relevant to intergenerational transmission, as Douaya knowledge is largely maintained through oral transmission, observation, and apprenticeship-like socialization within local healing networks (Senouci *et al.* 2019). However, UR values may also be influenced by interview duration, communication skills, specialization, social role, and willingness to share knowledge. Lower UR among younger or non-regular practitioners may therefore suggest a possible reduction in reported ethnomedicinal knowledge, while broader sociocultural changes, urbanization, reduced traditional learning opportunities, and increasing reliance on biomedical healthcare should also be considered (Lasisi & Ekpenyong 2011; Arjona-García *et al.* 2021).

This study also highlights women's role in preserving and transmitting traditional knowledge, not only as household users of medicinal plants but also as specialized actors within local healing networks. This is particularly relevant in North African contexts, where women's pharmacological knowledge has historically been central to domestic and community healthcare, while often being marginalized or reframed by formal medical and colonial systems (Amster 2022). Ethnobotanical research

in Morocco has also shown that gender roles may shape the distribution of plant knowledge, with women holding important knowledge at the intersection of food, household care, and medicinal plant use (Teixidor-Toneu *et al.* 2021).

Overall, the traditional healing practices reported by the informants rely on well-known medicinal plants, several of which are currently used as sources of bioactive molecules (Hanoun *et al.* 2023, Chenna *et al.* 2025). *Apiaceae* was the most represented family, with 11 taxa, while *Asteraceae*, *Fabaceae*, and *Lamiaceae* were equally represented, with eight taxa each. The 95 medicinal taxa recorded in the present study indicate a substantial ethnomedicinal repertoire among Douaya. This richness is lower than the 126 species reported from Adrar in the Algerian Sahara (Hassaïne & Benmalek 2023), but higher than the 83 species documented among traditional healers from Bechar and Adrar (Benarba 2016) and the 68 species reported from Adrar Province in northern Mauritania (Yebouk *et al.* 2020). However, Yebouk *et al.* (2020) documented a broader dataset in terms of use reports, with 2317 UR recorded from 120 informants. Regarding species salience, the high RFC values observed here for *Artemisia herba-alba*, *Trigonella foenum-graecum*, and *Syzygium aromaticum* suggest that a limited group of species is widely shared among women healers. This partly overlaps with Hassaïne & Benmalek (2023), who reported *Artemisia herba-alba*, *Origanum vulgare*, *Foeniculum vulgare*, *Mentha spicata*, and *Trigonella foenum-graecum* among the species cited more than 30 times in Adrar. The high ICF values observed here for respiratory disorders (0.89) and digestive disorders (0.76) are also partly consistent with Saharan surveys showing notable agreement for commonly treated ailment categories. In El Kantara, Mechaala *et al.* (2022) reported high ICF values for gastrointestinal system disorders (0.94) and respiratory problems (0.90), while Benarba (2016) reported relatively high FIC values for respiratory tract diseases (0.627) and gastrointestinal diseases (0.603) among traditional healers from Bechar and Adrar, although kidney diseases (0.727) and cancer (0.687) showed the highest consensus in that study.

The most common preparation methods were infusion and decoction, as reported in several Algerian ethnobotanical studies (Ouelbani *et al.* 2016; Miara *et al.* 2019b). In addition, locally specific remedies such as fat-based ointments, Oukdaa, plant-based suppositories, and Djebira reflect the practical specificity of Douaya ethnopharmacological knowledge. Fat-based ointments prepared with goat fat and powdered plants may favor prolonged contact with skin lesions, particularly when they include species such as *Haloxylon scoparium*, which has reported antimicrobial activity (Ahmed-Gaid *et al.* 2025a). Oukdaa illustrates the overlap between nutritional and therapeutic practices through honey, molasses, plant powders, and nuts, while plant-based suppositories reflect targeted routes of administration for gynecological or gastrointestinal complaints. Djebira, prepared with *Trigonella foenum-graecum* and *Commiphora myrrha*, was reported for bone injuries, a use that may be related to reports suggesting a callus-promoting effect of fenugreek in fracture repair (Aldhilan *et al.* 2023).

The reported reliance on biomedical services suggests that traditional healing practices do not operate in isolation from modern healthcare. The diagnosis-then-herbal pattern reported by approximately one quarter of informants may reflect a form of medical pluralism, in which biomedical services are used mainly for diagnosis, laboratory tests, radiological exams, or clinical confirmation, while medicinal plants remain part of treatment or follow-up practices (Amzat & Razum 2014). This pattern appears to represent an informal coexistence between biomedical and traditional systems rather than formal institutional integration (Leonti & Casu 2013). Examples such as the use of Djebira after radiological confirmation of fractures, or the reported use of *Artemisia herba-alba* instead of metronidazole for gastrointestinal conditions, illustrate how some Douaya may incorporate biomedical information into traditional therapeutic decision-making. The latter use may be related to the perceived antimicrobial or antiparasitic value of *A. herba-alba*, for which *in vitro* activity against *Entamoeba histolytica* trophozoites has been reported in comparison with metronidazole (Kadir *et al.* 2016). However, this pattern also raises public health concerns, particularly regarding delayed appropriate care, treatment failure, dosage uncertainty, toxicity, and possible herb-drug interactions.

The reported medicinal uses should also be interpreted in light of safety and conservation considerations. Some cited species, including *Nerium oleander*, *Aristolochia longa*, *Citrullus colocynthis*, and *Peganum harmala*, contain potentially toxic compounds or require careful dosage (Debelle *et al.* 2008; Moloudizargari *et al.* 2013; Li *et al.* 2022; Zhai *et al.* 2022). In addition, harvesting wild medicinal plants may threaten local populations, especially in Saharan arid environments where regeneration is slow and roots, bark, bulbs, woody parts, or whole plants are collected (Lubbe & Verpoorte 2011; Hemmami *et al.* 2023). Therefore, the documented uses should be interpreted with attention to safety, sustainable harvesting, and possible cultivation of frequently used species.

Limitations

Although this study provides detailed ethnobotanical data from 39 women healers, its scope remains limited. The sample was restricted to specialized female knowledge holders from two provinces and was not intended to be statistically

representative of the wider Saharan population. In addition, the use of snowball sampling may have introduced network-based bias, as participants could have recommended women from similar family, social, or healing networks. Therefore, the findings should be interpreted as reflecting the reported knowledge of a targeted group of locally recognized women healers and should not be directly generalized to all women or all traditional practitioners in southwestern Algeria.

Conclusion

This study documents a diverse repertoire of Saharan ethnomedicinal knowledge reported by women healers in Bechar and Beni Abbes provinces. The frequent citation of several medicinal plants and the high consensus observed for specific ailment categories reflect a coherent traditional knowledge system. Differences in UR according to age and healing-practice status suggest possible variation in reported ethnomedicinal knowledge among practitioners; however, these findings do not demonstrate a confirmed disruption in intergenerational transmission. Given the cross-sectional design, they should be interpreted cautiously and considered alongside possible effects of specialization, regularity of practice, access to healthcare, education level, and willingness to share knowledge. Continued documentation and safeguarding of women's ethnomedicinal knowledge remain important, and future research should further investigate transmission processes as well as the pharmacological validation and safety of the reported remedies.

Declarations

List of abbreviations: UR - Use Report; RFC - Relative Frequency of Citation; ICF - Informant Consensus Factor; FL - Fidelity level

Ethics approval and consent to participate: The study was conducted in accordance with relevant laws and institutional guidelines and the ethical principles of the International Society of Ethnobiology (ISE) Code of Ethics. Prior to each interview, informed consent was obtained from all participants, and data were recorded and reported anonymously.

Consent for publication: All authors have read and approved the manuscript and agreed to its submission for publication.

Availability of data and materials: Voucher specimen codes of the recorded plant species are provided in the supplementary file.

Competing interests: Authors have no conflict of interest.

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