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RESEARCH ARTICLE

Medicinal plants and local knowledge in the eastern Tell of Algeria: an ethnobotanical survey in Heddada, Khedara and Ouled Moumen (Souk Ahras Province), with a comparison across the Maghreb and North Africa

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Abstract The eastern Tellian Atlas, on the Algerian–Tunisian border, is floristically rich but ethnobotanically underexplored. We documented the medicinal flora and local knowledge of three rural communes of Souk Ahras Province (Heddada, Khedara and Ouled Moumen) through semi-structured interviews with 200 members of agro-pastoral households. Participants cited 137 taxa in 49 families, yielding 1838 use-reports. Asteraceae (21 taxa) and Lamiaceae (20) are the best-represented families; leaves are the most frequently used plant part; infusion (33.4%) and decoction (30.6%) are the leading preparations. At least 25 taxa are crop wild relatives in the sense of Maxted et al. (2006), among them the oleaster form of *Olea europaea*, *Allium ampeloprasum*, *Cynara cardunculus* and *Daucus carota*; a further large group represents the wild gene pools of cultivated medicinal and aromatic plants. The checklist was compared with 16 comprehensive Algerian and 14 other North African surveys using Jaccard and Sørensen coefficients on taxonomically harmonised species lists. The inventory ranks 4th of 17 Algerian and 6th of 31 North African datasets, a position not explained by interview effort; floristic similarity is organised by bioclimate rather than by nationality, Mediterranean/Tell comparators being 7.9 times more similar to Souk Ahras than Saharan/Sahelian ones (median Jaccard index 0.243 vs. 0.031, $p < 0.001$). The wild-harvested core of the pharmacopoeia, rich in crop wild relatives, is therefore a cross-border Maghreb heritage whose in situ conservation must be planned regionally, and the frequencies of citation and harvested organs recorded here supply the use-weighted evidence that North African crop wild relative prioritisation has lacked.

Keywords Ethnobotany · Medicinal plants · Algeria · Maghreb · Crop wild relatives · Comparative ethnobotany

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Introduction

In the rural Maghreb, plants remain a first line of treatment for everyday complaints, and the knowledge that governs their harvest, preparation and administration is transmitted orally within households and grazing communities rather than through written or institutional channels. In Algeria, that knowledge is under pressure from rural depopulation, the expansion of biomedical services, the commercialisation of herbal products through urban herbalist stalls and the loss of the pastoral practices through which children once learned the flora at first hand. Documenting local pharmacopoeias while their holders are still active is therefore both an ethnographic and a conservation task, since the plants concerned are largely wild-harvested and their populations are exposed to grazing, land-use change and, for the most valued taxa, to commercial collection.

Algeria sits at a biogeographic crossroads: the Mediterranean Tell to the north, the steppe and high plateaus in the centre, and the Sahara to the south. This gradient structures both the species pool available to local communities and the traditions of plant use that develop around it. Ethnobotanical surveys from Algeria have documented substantial variation in medicinal flora richness, from as few as 31 taxa in the deep Sahara (Ramdane et al. 2015) to 167 in multiregional studies (Belhouala and Benarba 2021), and have consistently identified Lamiaceae as the dominant medicinal family in the north, with a shift towards Fabaceae and Asteraceae in more arid zones. The ethnobotanical importance of Souk Ahras has also been highlighted by Draiaia et al. (2024), who documented a diverse repertoire of medicinal plants used by the local population. The eastern Tell, and Souk Ahras Province in particular, is nevertheless among the least documented parts of the country, despite carrying some of the most extensive cork oak and zeen oak forests in eastern Algeria and a dense agro-pastoral population that still depends on them.

The cultural background against which such a pharmacopoeia must be read is layered. The medicinal traditions of the Maghreb combine an Amazigh (Berber) substrate of wild-plant knowledge with the learned Graeco-Arab (*Unani*) humoral medicine that spread with Islam from the seventh century, with the Prophetic medicine (*Al-Tibb al-Nabawi*) that codified the use of a small set of pan-Islamic remedies, and with the Andalusian and Ottoman legacies that shaped urban herbalist markets (Bellakhdar 1997; Saad and Said 2011). These strata are shared, in different proportions, from Morocco to Libya, whereas the Nilotic, Saharan and Sahelian societies further south and east draw on partly distinct botanical pools and medical cosmologies (Boulos 1983).

A local inventory alone, however, cannot say whether what it records is idiosyncratic to a place or a local expression of a broader cultural-ecological tradition (Moerman 1996; Leonti 2011; Gaoue et al. 2017). For the Maghreb, where a shared Mediterranean and semi-arid flora crosses national borders (Quézel and Santa 1962–1963; Médail and Quézel 1997; Dobignard and Chatelain 2010–2013), that question is best answered by benchmarking a new inventory against previously published comprehensive surveys, first within the country of study and then across the region. Most Algerian inventories remain single-site descriptions whose interpretation is limited by the absence of such a framework: without a reproducible similarity metric applied to taxonomically harmonised checklists, local specificity cannot be distinguished from regional representativeness.

A further motivation is specific to plant genetic resources. Medicinal floras of the Mediterranean Basin are rich in crop wild relatives (CWR) and in wild-harvested taxa that are the progenitors, or the still-exploited wild gene pools, of Old World crops and of cultivated medicinal and aromatic plants (Zohary et al. 2012; Maxted et al. 2006; Vincent et al. 2013). North Africa has recently received dedicated CWR checklists and prioritisation exercises (Lala et al. 2018; El Mokni et al. 2022; Labrighli et al. 2025), but the ethnobotanical use record, which documents where and how such taxa are still harvested, has rarely been linked to them. The two bodies of evidence are complementary: CWR inventories establish which wild taxa matter for breeding and food security, whereas ethnobotanical use records establish which of them are actually being harvested, from which organs, how intensively and by whom (Heywood et al. 2007; Iriondo et al. 2008).

This study therefore has three aims: first, to document the medicinal flora of Heddada, Khedara and Ouled Moumen and the local knowledge attached to it, with vernacular names, plant parts, preparations and therapeutic indications; second, to identify within that inventory the crop wild relatives and the

wild gene pools of cultivated medicinal and aromatic plants that are still actively harvested; and third, to place the resulting checklist in its regional context through a two-level comparison with 30 comprehensive surveys from Algeria and the rest of North Africa. The comparison addresses four questions: whether the inventory lies within the observed range of North African surveys rather than above it (richness); whether its richness is an artefact of the number of people interviewed (effort); whether floristic similarity declines with geographic distance (geography); and whether bioclimatic affiliation separates floras more sharply than national borders do (ecology).

Materials and methods

Study area

The study covers the communes of Heddada, Khedara and Ouled Moumen in the north-eastern part of Souk Ahras Province, along the Tunisian border, 25–35 km east of the provincial capital (Fig. 1c; centroid of the three communes 36.28°N, 8.28°E). The area lies at the eastern end of the Tellian Atlas, where the upper Medjerda valley opens towards Tunisia, between about 500 m in the valley bottoms and over 1000 m on the surrounding ridges (Djebel Ouled Moumen). The climate is Mediterranean of the sub-humid type, with cool, wet winters and hot, dry summers and an annual rainfall of roughly 600–900 mm, decreasing southwards towards the semi-arid high plains, according to the official monograph of the province compiled by its Directorate of Planning and Budget Monitoring (*Direction de la Programmation et du Suivi Budgétaires*, DPSB 2019). The province is among the most heavily wooded of eastern Algeria: cork oak (*Quercus suber* L.) covers about 12,000 ha and zeen oak (*Quercus canariensis* Willd.) about 4600 ha, with holm oak (*Quercus ilex* L.), Aleppo pine (*Pinus halepensis* Mill.), cypress and ash; forest edges and clearings carry a rich matorral of *Pistacia lentiscus* L., *Myrtus communis* L., *Erica arborea* L., *Cistus* spp., *Lavandula stoechas* L. and *Calicotome* spp. (Quézel and Santa 1962–1963; DPSB 2019). The local economy is agro-pastoral, based on cereals, pulses, fruit trees and extensive livestock rearing (over 80,000 cattle and 300,000 sheep and goats in the province). Khedara and Ouled Moumen are classified as mountain communes and Heddada as an agricultural commune; their populations were estimated at 10,135, 5697 and 8945 inhabitants in 2019, of whom about 55%, 94% and 42% respectively live in scattered rural settlements rather than in the commune centre (DPSB 2019). The inhabitants are Arabic-speaking, self-identifying as Arabs, and Sunni Muslims; the language of everyday communication, and of all interviews, is Algerian dialectal Arabic (Glottolog code alge1239).

The three communes were treated as one contiguous study area, not as separate units to be compared with one another. They were chosen on four criteria: (1) contiguity, since they are adjacent communes forming a continuous strip along the Tunisian border in the north-eastern corner of the province (Fig. 1c); (2) a common bioclimate and vegetation, all three lying in the sub-humid Tell within the same cork oak, holm oak and matorral landscape; (3) complementary land use, since Khedara and Ouled Moumen are officially classified as mountain communes and Heddada as an agricultural commune, so that together they include both the forested uplands and the cultivated land from which medicinal plants are gathered; and (4) a common cultural and linguistic background of Arabic-speaking agro-pastoral households. Sampling was stratified by commune, with 66 or 67 participants in each (Table 1), so that the whole study area was covered; the use-reports were then pooled, because the aim was to document the pharmacopoeia of the study area as a whole.

Field methods and participants

Fieldwork was carried out in spring and summer 2026 (March–August 2026). Two hundred adult participants (aged 18 or over) belonging to agro-pastoral households—farmers, shepherds, housewives and elderly people recognised locally as knowledgeable about plants—were interviewed face to face, in Algerian dialectal Arabic, through semi-structured interviews conducted in their homes, fields and grazing areas. Participants were selected by purposive and snowball sampling, starting from people indicated locally as knowledgeable and continuing until no new taxa were being cited. Of the 200 participants, 96 were women (48.0%) and 104 were men (52.0%). Participants spanned all adult age bands, with the

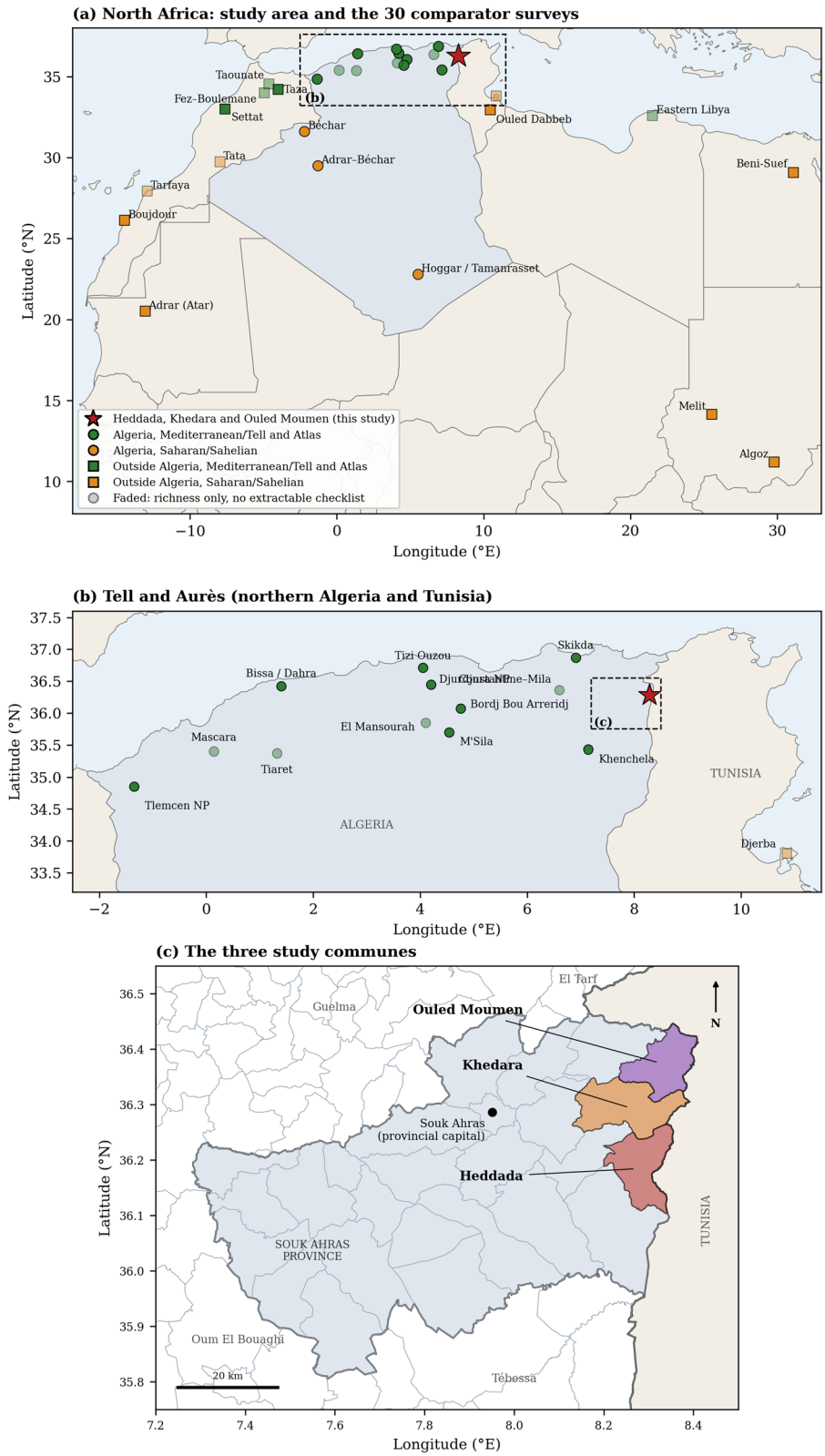

Fig. 1 Location of the study area and of the 30 comparator surveys. **a** North Africa; **b** the Tell and Aurès of northern Algeria and Tunisia; **c** the three study communes of Heddada, Khedara and Ouled Moumen within Souk Ahras Province, along the Tunisian border. The red star marks the centroid of the three communes (36.28°N, 8.28°E). Circles are Algerian comparators, squares comparators from outside Algeria; green marks the Mediterranean/Tell and Atlas bioclimatic group, orange the Saharan/Sahelian group. Faded symbols mark surveys used for richness comparisons only, because no complete species checklist could be extracted from the publication. The multiregional national survey of Belhouala and Benarba (2021) has no single centroid and is not mapped. Country boundaries are from Natural Earth (2026) and province and commune boundaries from geoBoundaries (Runfola et al. 2020)

Table 1 Participant characteristics by commune

Characteristic	Heddada ($n=66$)	Khedara ($n=67$)	Ouled Moumen ($n=67$)	Total ($n=200$)
Sex (%)				
Women	48.5	43.3	52.2	48.0
Men	51.5	56.7	47.8	52.0
Age group (%)				
18–29	15.4	9.2	20.6	15.0
30–44	24.6	16.9	22.2	21.2
45–59	26.2	33.8	30.2	30.1
≥60	33.8	40.0	27.0	33.7
Education (%)				
No formal education	31.8	34.3	25.4	30.5
Primary	28.8	40.3	22.4	30.5
Secondary	16.7	7.5	26.9	17.0
University	18.2	14.9	25.4	19.5
Not recorded	4.5	3.0	0.0	2.5

Age-group percentages are computed on the 193 participants whose age was recorded

largest groups aged 45–59 years (30.1%) and 60 years or older (33.7%).

For each plant cited, the vernacular (dialectal Arabic) name, the part used, the mode of preparation and administration, the dose where reported and the ailment treated were recorded. A use-report is defined here as a single participant citing a single taxon for a single ailment (Heinrich et al. 2009; Weckerle et al. 2018); the 200 interviews yielded 1838 use-reports. The study was conducted in accordance with the Code of Ethics of the International Society of Ethnobiology (2006, with 2008 additions). The aims and scope of the study were explained before each interview, prior informed consent was obtained verbally, participation was voluntary and anonymous, no personal identifiers were recorded, and participants could withdraw at any time. No formal ethics-committee approval was required under Algerian regulations for this non-invasive ethnobotanical study; prior authorisation was obtained from the local authorities of Heddada, Khedara and Ouled Moumen.

Plant identification and nomenclature

Plants were shown or collected together with the participants and identified with the *Nouvelle flore de l'Algérie et des régions désertiques méridionales* (Quézel and Santa 1962–1963). Accepted names follow Plants of the World Online (POWO 2026) and World Flora Online (WFO 2026), cross-checked against the *Index synonymique de la flore d'Afrique du Nord* (Dobignard and Chatelain 2010–2013); family circumscriptions follow APG IV (Angiosperm Phylogeny Group 2016). Voucher specimens of all cited taxa were collected during the field walks, pressed, dried, mounted on archival sheets and assigned reference numbers. Because the University of Souk Ahras does not maintain a formally registered herbarium, the specimens were deposited in the Laboratory of Natural and Life Sciences of the University of Souk Ahras, where they are available for consultation. Field photographs were retained as complementary documentation. Voucher numbers are listed in Table 4.

Analysis of the local dataset

The local dataset was summarised by number of taxa, families and use-reports; by the frequency of citation of each taxon; and by the relative frequency of plant parts and of modes of preparation across all recorded remedies. Botanical families were ranked both by number of taxa and by number of use-reports, since the two criteria do not necessarily identify the same dominant family.

In addition, three quantitative indices commonly reported in ethnobotanical studies were calculated.

The *use value* (UV) of each taxon was calculated as:

$$UV = \Sigma U/N$$

where ΣU is the total number of use-reports recorded for the taxon and N is the total number of study participants (Phillips and Gentry 1993).

The *relative frequency of citation* (RFC) was calculated as:

$$RFC = FC/N$$

where FC is the number of study participants who cited the taxon and N is the total number of study participants; RFC therefore ranges between 0 and 1 (Tardío and Pardo-de-Santayana 2008). Finally, the *informant consensus factor* (ICF) was calculated for each ailment category as:

$$ICF = (N_{ur} - N_t)/(N_{ur} - 1)$$

where N_{ur} is the number of use-reports in a given ailment category and N_t is the number of taxa used in that category; ICF values approach 1 when a few taxa are used by many participants (high consensus) and approach 0 when taxa are cited idiosyncratically (Trotter and Logan 1986; Heinrich et al. 1998). Use value and relative frequency of citation for each taxon are reported in Table 4, and informant consensus factors by ailment category are presented in Table 5.

Regional comparison

Only field studies documenting the whole medicinal flora of a locality were retained as comparators. Studies restricted to a single disease, a single plant family or a market survey were excluded, as were pharmacological or phytochemical studies without a complete species inventory; review articles and aggregated checklists were not used as individual comparators. The large Moroccan systematic review of Fakchich and Elachouri (2021), which pools 63 studies and 905 taxa, is used only as regional background, because pooling many surveys inflates richness far beyond any one locality.

Comparisons were structured at two nested levels (Fig. 1). Level 1 comprises 16 comprehensive Algerian surveys deliberately spread across the ecological gradient, from the Mediterranean Tell (Skikda, Constantine–Mila, Bordj Bou Arreridj, Khenchela, Mascara, Tlemcen, Dahra, Kabylia) through the high steppe (Tiaret, M'Sila) to the south-west and the deep Sahara (Béchar, Adrar, Hoggar), plus one multiregional national study. Level 2 comprises 14 comprehensive surveys from Morocco (7), Tunisia (2), Libya (1), Egypt (1), Mauritania (1) and Sudan (2). Together the 30 comparators and the present study constitute the 31 datasets used throughout (Tables 2, 3). Each comparator was characterised by medicinal species richness, family richness, dominant families, dominant plant part, dominant preparation method and floristic overlap with the present inventory.

Pairwise floristic similarity between the study inventory and each comparator was quantified with the *Jaccard index* (J), calculated as:

$$J = C/(A + B - C)$$

where $A = 137$ is the number of taxa in the study inventory, B is the number of taxa in the comparator inventory and C is the number of taxa shared by the two; J ranges from 0 (no taxon in common) to 1 (identical checklists) (Jaccard 1912; Koleff et al. 2003). As a sensitivity check, similarity was also calculated with the *Sørensen–Dice coefficient* (S):

$$S = 2C/(A + B)$$

where A, B and C are defined as above; S also ranges from 0 to 1, but it gives double weight to shared taxa and is therefore less sensitive than J to differences in inventory size (Koleff et al. 2003). Conclusions are reported only where both indices agree. For the matrix test described below, the *Simpson overlap* (O) was also used:

$$O = C/\min(A, B)$$

where $\min(A, B)$ is the size of the smaller of the two inventories; O equals 1 when the smaller checklist is entirely contained in the larger one, and is therefore independent of differences in inventory size (Koleff et al. 2003).

Coefficients require a species-level checklist on both sides, so the matrix is restricted to the 20 comparators with a fully extractable checklist; no value was estimated or imputed, and comparators lacking a recoverable checklist are listed explicitly. Before intersecting checklists, all names were harmonised against POWO and WFO. Accepted names applied throughout include the following, with the synonyms used in some comparator publications in parentheses: *Salvia rosmarinus* Spenn. (syn. *Rosmarinus officinalis*

Table 2 Comprehensive Algerian surveys used as Level 1 comparators, ranked by medicinal species richness (the present study in bold)

Study	Region/zone	Taxa	Participants	Dominant family	Main part	Main preparation
Belhouala and Benarba (2021)	Multiregional (national)	167	40	Lamiaceae	Leaves	Decoction
Bensizerara et al. (2025)	Khenchela (NE)	158	300	Asteraceae	Leaves	Infusion + decoction
Benarba et al. (2015)	Mascara (NW)	141	43	Lamiaceae	Leaves	Decoction
This study	**Souk Ahras (NE)**	**137**	**200**	**Lamiaceae**	**Leaves**	**Infusion**
Zatout et al. (2021)	Tlemcen NP (NW)	109	254	Lamiaceae	Roots/rhizomes	Decoction
Ouelbani et al. (2016)	Constantine–Mila (NE)	102	79	Lamiaceae	Leaves	Infusion
Toul et al. (2026)	Béchar (SW)	99	175	NR	Leaves	Decoction
Meddour and Meddour-Sahar (2015)	Kabylia	98	46	Lamiaceae	NR	NR
Miara et al. (2018)	Algerian steppe (Tiaret, nomadic)	97	73	Lamiaceae	Leaves	Decoction
Bouasla and Bouasla (2017)	Skikda (NE)	90	89	Lamiaceae	Leaves	Decoction
Benarba (2016)	Adrar–Béchar (Sahara)	83	22	Lamiaceae	Leaves	Decoction
Miara et al. (2019)	Bordj Bou Arreridj (NE)	83	51	Lamiaceae	Leaves	Infusion
Meddour et al. (2020)	Djurdjura NP (Kabylia)	80	31	Lamiaceae	Aerial parts	Infusion
Bendif et al. (2018)	El Mansourah (Bordj Bou Arreridj)	78	200	Lamiaceae	Leaves	Infusion
Senouci et al. (2019)	Bissa/Dahra (NW)	70	262	Lamiaceae	Leaves	Decoction
Boudjelal et al. (2013)	M'Sila (steppe)	58	83	Lamiaceae	Aerial parts	Infusion + decoction
Ramdane et al. (2015)	Hoggar (deep Sahara)	31	100	Lamiaceae	Aerial parts/leaves	Decoction

Participant counts are as published; where a study reports several sampling rounds the total is used. Dominant family, part and preparation are the single modal category reported by each author. For the present study the dominant family is Lamiaceae by number of use-reports (384, compared with 248 for Asteraceae); by number of taxa the leading family is Asteraceae (21 taxa against 20)

NR not reported in the source publication

L.), *Visnaga daucoides* Gaertn. (syn. *Ammi visnaga* (L.) Lam.), *Mentha suaveolens* Ehrh. (syn. *M. rotundifolia* (L.) Huds.), *Petroselinum crispum* (Mill.) Fuss (syn. *P. sativum* Hoffm.), *Macrochloa tenacissima* (L.) Kunth (syn. *Stipa tenacissima* L.) and *Cynara cardunculus* L. (syn. *C. scolymus* L.). Genus-only records and differing congeners (for example *Thymus vulgaris* L. versus *T. algeriensis* Boiss. & Reut.) were scored as non-matches, a deliberately conservative rule that biases similarity downwards. Because harmonisation merges synonyms within each comparator list, the harmonised inventory size used in the coefficients is one or two taxa lower than the published size for 12 of the 20 comparators; both values are given in Table 7.

Richness was summarised by mean, median, SD and type-7 quartiles, and the study's position reported both as an empirical percentile (proportion of comparators with fewer taxa) and as a normal-theory percentile, with a 95% bootstrap confidence interval for the comparator median from 20,000 resamples (seed 20,260,830). Because these descriptors characterise distributions but do not test differences between them, richness was also compared with non-parametric tests, which assume neither normality nor equal variances and are suited to small and unequal groups: a Kruskal–Wallis H test across the four combinations of geographic level (Algeria, outside Algeria) and bioclimatic zone (Mediterranean/Tell and Atlas, Saharan/Sahelian), exact Mann–Whitney U tests between levels and between zones, and one-sample Wilcoxon signed-rank tests of comparator richness against the 137 taxa of the study inventory (Hollander et al. 2014). Every summary statistic is labelled with its reference set—Algeria-only ($n = 16$), outside-Algeria ($n = 14$) or pooled ($n = 30$)—and the

Table 3 Comprehensive surveys from wider North Africa outside Algeria used as Level 2 comparators, ranked by medicinal species richness

Study	Country/region	Taxa	Participants	Dominant family	Main part	Main preparation
El-Mokasabi et al. (2018)	Eastern Libya	179	61	Asteraceae	NR	NR
Abouri et al. (2012)	Tata, Morocco	163	900	Lamiaceae	Leaves	Decoction + infusion
Idm'hand et al. (2020)	Tarfaya, Morocco	130	600	Lamiaceae	Leaves	Decoction
Achour et al. (2022)	Fez-Boulemane, Morocco	108	30	Lamiaceae	Aerial parts	Decoction
El-Hilaly et al. (2003)	Taounate, Morocco	102	NR	Fabaceae	NR	NR
Issa et al. (2018)	Algoz, Sudan	94	30	Fabaceae	Roots/stems	Infusion + maceration
Karous et al. (2021)	Ouled Dabbeb, Tunisia	70	30	Lamiaceae/Asteraceae	Leaves	Decoction
Yebouk et al. (2020)	Adrar, Mauritania	68	120	Fabaceae	NR	NR
Elharas and Ouhssine (2025)	Boujdour, Morocco	64	630	Asteraceae	Leaves	Decoction
Muhakr et al. (2024)	Melit, Sudan	59	135	Fabaceae	Fruits/stem bark	Decoction
Kachmar et al. (2021)	Taza, Morocco	55	200	Lamiaceae	Leaves	Decoction + infusion
Lahyaoui et al. (2025)	Settat, Morocco	51	242	Lamiaceae	Leaves	Infusion + decoction
AbouZid and Mohamed (2011)	Beni-Suef, Egypt	48	57	Apiaceae	NR	NR
Ben Salah et al. (2019)	Djerba, Tunisia	45	75	Asteraceae	Leaves	Decoction

Countries represented: Morocco (7), Tunisia (2), Sudan (2), Libya (1), Egypt (1), Mauritania (1). Yebouk et al. (2020) explicitly reports both 68 medicinal species and 120 participants; these figures do not require combining the 2020 and 2023 publications (Yebouk et al. 2023). Ben Salah et al. (2019) reports 45 medicinal species within a wider inventory of 86 identified useful plants belonging to 80 genera and 43 families. The value of 45 medicinal species is therefore retained; the genus and family totals refer to the wider inventory

NR not reported

three sets are never pooled implicitly. Sampling effort was assessed by regressing taxa on the number of participants across the 29 comparator datasets reporting it, with the present study excluded from the fit. The association was measured with two coefficients: Pearson's product-moment correlation, which corresponds to the linear regression model and measures linear association, and Spearman's rank correlation, which assumes neither normality nor linearity and is robust to outliers. Both were needed because participant numbers are strongly right-skewed (22–900; Shapiro–Wilk $W = 0.688$, $p < 0.001$), so that a Pearson coefficient can be driven by a few very large surveys. The same pair of coefficients was used for the distance-decay analyses, and a conclusion was drawn only when the two agreed. Great-circle distances between the centroid of the three study communes (36.28°N, 8.28°E) and each comparator centroid were computed with the haversine formula ($R = 6371.0088$ km); distance-decay was fitted as $J \sim$ distance and $J \sim \log(\text{distance})$, compared by AIC, and a first-order partial correlation controlling for comparator inventory size was computed. Comparators were classified as Mediterranean/Tell and Atlas ($n = 10$) or Saharan/Sahelian ($n = 9$) from published site descriptions and latitude, before any similarity value was inspected, and the contrast tested with an exact Mann–Whitney U test with the rank-biserial correlation as effect size. Differences in J among the four combinations of geographic level and bioclimatic zone were tested with a Kruskal–Wallis H test followed by Dunn's post hoc comparisons with Holm correction (Dunn 1964). To relate floristic composition to the ecological gradient with a constrained ordination, a redundancy analysis (RDA) was performed on a site-by-taxon matrix recording the presence or absence of each taxon of the study inventory in each of the 19 georeferenced comparators (108 taxa recorded in at

Table 4 The 137 medicinal taxa recorded in Heddada, Khedara and Ouled Moumen (Souk Ahras Province, north-eastern Algeria), with their vernacular names, voucher numbers, parts used, modes of preparation and administration and therapeutic indications

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Amaranthaceae	*Atriplex halimus* L.	*Gtaf*	SAH-dridi-1791	Leaves	Decoction; poultice; infusion	Postpartum hygienic wash (5); weakness and low blood (4); iron-deficiency anaemia (3); blood building (1)	11	13	0.055	0.065
Amaranthaceae	*Salsola kali* L.	*Tasmoumt*	SAH-dridi-181	Aerial parts	Raw	Minor dermatological wounds (3)	3	3	0.015	0.015
Amaranthaceae	*Spinacia oleracea* L.	*Sbenekh*	SAH-dridi-1433	Leaves	Decoction; poultice; infusion	Blood building (4); iron-deficiency anaemia (3); weakness and low blood (3)	10	10	0.050	0.050
Amaryllidaceae	*Allium ampeloprasum* L.	*Korrath*	SAH-dridi-913	Bulbs; leaves; flowers; seeds; whole plant	Raw; decoction; powder; infusion	Phlegm and catarrh (4); chest congestion (2); high blood pressure (2); acid reflux (1); blood pressure control (1); bronchial congestion (1); cloudy urine (1); dysuria (1); mild hypertension (1); palpitations (1); poor circulation (1)	14	16	0.070	0.080
Amaryllidaceae	*Allium triquetrum* L.	*Thoum el-ghaba*	SAH-dridi-1184	Whole plant	Maceration; decoction; infusion	Cold-induced rheumatic/musculoskeletal pain (17)	17	17	0.085	0.085

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Anacardiaceae	*Pistacia lentiscus* L.	*Dharw*	SAH-dridi-1200	Resin; flowers; leaves; aerial parts; bark; fruits	Raw; poultice; decoction; powder; maceration; infusion; steam inhalation	Bronchitis (10); osteoarthritis (10); rheumatism (10); generalised body aches (6); gastrointestinal complaints (5); skin infection (5); general malaise (4); itching (4); knee pain (4); skin rash (4); flu-like symptoms (3); nasal congestion (3); dry cracked skin (2); fatigue and body pain (2); indigestion (2); muscle aches (2); abdominal pain (1); acid reflux (1); acne (1); bloating after meals (1); boils (1); loss of appetite (1); nausea (1); persistent cough (1); slow digestion (1)	56	85	0.280	0.425
Apiaceae	*Ammoides pusilla* (Brot.) Breistr.	*Noukha*	SAH-dridi-1997	Leaves	Decoction	Gum inflammation (1)	1	1	0.005	0.005
Apiaceae	*Anethum graveolens* L.	*Chebth*	SAH-dridi-1352	Seeds	Infusion; powder; decoction; maceration	Paediatric colic (9); abdominal bloating (8)	17	17	0.085	0.085
Apiaceae	*Apium graveolens* L.	*Krafes*	SAH-dridi-1623	Flowers	Infusion	Heart tonic (1)	1	1	0.005	0.005

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Apiaceae	*Bunium bulbocastanum* L.	*Talghouda*	SAH-dridi-1688	Roots; flowers; seeds; aerial parts; whole plant	Decoction; hot oil extract; infusion; maceration	Restorative tonic (11); lymph node inflammation (7); stomach cramps (2); bloating after meals (1); chronic constipation (1); menstrual irregularities (1); nausea (1); reduced sexual vigour (1); slow digestion (1)	25	26	0.125	0.130
Apiaceae	*Daucus carota* L.	*Sennariya*	SAH-dridi-192	Roots	Raw; decoction; powder	Intestinal parasites (3); visual impairment (3)	6	6	0.030	0.030
Apiaceae	*Eryngium campestre* L.	*Chouk el-hmar*	SAH-dridi-1547	Roots	Poultice; powder	Insect stings (3); scorpion stings (2)	5	5	0.025	0.025
Apiaceae	*Ferula communis* L.	*Kelkh*	SAH-dridi-2089	Flowers	Decoction	Menstrual irregularities (1)	1	1	0.005	0.005
Apiaceae	*Foeniculum vulgare* Mill.	*Besbas*	SAH-dridi-360	Seeds	Infusion; decoction; maceration; powder	Paediatric colic (9); galactagogue (5)	14	14	0.070	0.070
Apiaceae	*Heracleum sphondylium* L.	*Bou nafaa*	SAH-dridi-1173	Roots	Decoction; hot oil extract	Neurological fatigue (10)	10	10	0.050	0.050
Apiaceae	*Petroselinum crispum* (Mill.) Fuss	*Maadnous*	SAH-dridi-116	Seeds	Powder mixed with honey	Recurrent cystitis (1)	1	1	0.005	0.005
Apiaceae	*Thapsia garganica* L.	*Deryas*	SAH-dridi-517	Roots; seeds	Poultice; infusion	Bone fractures (3); influenza (2); chest cold (1); common cold (1)	7	7	0.035	0.035
Apiaceae	*Visnaga daucoides* Gaertn.	*Khella*	SAH-dridi-1726	Seeds	Infusion; maceration; decoction	Urinary spasms (8); urinary gravel (4); stone expulsion (2); renal stones (1)	12	15	0.060	0.075
Apocynaceae	*Nerium oleander* L.	*Defla*	SAH-dridi-1406	Leaves	Poultice	Veterinary dermatological care (1)	1	1	0.005	0.005
Aristolochiaceae	*Aristolochia fontanesii* Boiss. & Reut.	*Bereztem*	SAH-dridi-165	Aerial parts; bark	Maceration; powder	Traditional anticancer use (2)	2	2	0.010	0.010

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Asparagaceae	*Asparagus albus* L.	*Sekkoum*	SAH-dridi-978	Flowers	Infusion	Stone expulsion (1)	1	1	0.005	0.005
Asphodelaceae	*Asphodelus ramosus* L.	*Berwag*	SAH-dridi-1249	Aerial parts; flowers; leaves; seeds	Infusion; decoction; maceration; powder	Dysuria (2); reduced sexual vigour (2); urinary retention (2); fertility concerns (1); lower back and kidney ache (1)	7	8	0.035	0.040
Asteraceae	*Anacyclus pyrethrum* (L.) Lag.	*Aqerqarha*	SAH-dridi-810	Roots; whole plant; flowers; aerial parts; leaves; seeds	Raw; decoction; chewed raw; infusion; maceration; poultice; powder; steam inhalation	Dental pain (9); oral sores (6); kidney pain (2); bone fragility (1); fertility concerns (1); nasal congestion (1); osteoarthritis (1); productive cough (1); sore throat with cough (1)	22	23	0.110	0.115
Asteraceae	*Artemisia absinthium* L.	*Chajrat Mariam*	SAH-dridi-436	Aerial parts; seeds; flowers; leaves; whole plant	Decoction; powder; infusion; maceration; raw	Intestinal parasites (10); high fever (6); reduced sexual vigour (6); fever with chills (4); feverishness (2); heartburn (2); loss of appetite (2); menstrual irregularities (2); bloating after meals (1); fertility concerns (1); nausea (1); stomach cramps (1)	33	38	0.165	0.190

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Asteraceae	*Artemisia herba-alba* Asso	*Chih*	SAH-dridi-707	Aerial parts; flowers; leaves; whole plant	Infusion; decoction; powder; steam inhalation; maceration	Severe gastrointestinal pain (14); diabetes management (4); type 2 diabetes (4); high blood sugar (3); loss of appetite (3); abdominal pain (1); acid reflux (1); bloating after meals (1); blood sugar control (1); common cold (1); heartburn (1); nasal congestion (1); nausea (1); slow digestion (1); stomach cramps (1)	36	38	0.180	0.190
Asteraceae	*Bellis perennis* L.	*Oqhouane*	SAH-dridi-333	Flowers	Poultice	Abrasions (3)	3	3	0.015	0.015
Asteraceae	*Calendula arvensis* L.	*Jemra berria*	SAH-dridi-230	Leaves	Maceration	Wounds (1)	1	1	0.005	0.005
Asteraceae	*Calendula officinalis* L.	*Djemra*	SAH-dridi-501	Flowers	Maceration; infusion	Dermatological inflammation (5)	5	5	0.025	0.025
Asteraceae	*Carduus pycnocephalus* L.	*Chouk el-hmir*	SAH-dridi-127	Roots	Raw	Dental pain (1)	1	1	0.005	0.005
Asteraceae	*Carthamus tinctorius* L.	*Qortom*	SAH-dridi-398	Flowers	Decoction; infusion	Jaundice (7); jaundice (local perception) (3)	10	10	0.050	0.050
Asteraceae	*Centaurea benedicta* (L.) L.	*Chouket el-mbarka*	SAH-dridi-2026	Aerial parts	Infusion; decoction; maceration	Poor appetite (6); gastric ulcers (2)	8	8	0.040	0.040
Asteraceae	*Chamaeleon gummifer* (L.) Cass.	*Addad*	SAH-dridi-1520	Roots	Poultice; decoction; powder	Dermatological lesions (3); warts (3)	4	6	0.020	0.030

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Asteraceae	*Chamaemelum nobile* (L.) All.	*Babounj*	SAH-dridi-940	Flowers; whole plant; seeds	Infusion; poultice; steam inhalation	Mild gastrointestinal discomfort (11); paediatric sleep aid (5); common cold (1); dry cracked skin (1); frequent headaches (1); general malaise (1); nervous system disorders (1)	21	21	0.105	0.105
Asteraceae	*Cirsium vulgare* (Savi) Ten.	*Chouk*	SAH-dridi-1211	Roots	Decoction	Hepatic complaints (3)	3	3	0.015	0.015
Asteraceae	*Cynara cardunculus* L.	*Karnoun; Khorchef*	SAH-dridi-1379	Leaves; aerial parts; whole plant; flowers; seeds	Decoction; infusion; maceration; powder; raw	Hepatic detoxification (5); arthritis (3); heartburn (3); generalised body aches (2); indigestion (2); loss of appetite (2); poor circulation (2); stomach cramps (2); blood purification (1); chest tightness (1); cloudy urine (1); heart tonic (1); kidney pain (1); lower back and kidney ache (1); nausea (1)	26	28	0.130	0.140
Asteraceae	*Dittrichia viscosa* (L.) Greuter	*Magramane*	SAH-dridi-463	Roots	Poultice	Warts (2)	2	2	0.010	0.010

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Asteraceae	*Echinops bovei* Boiss.	*Taskra*	SAH-dridi-734	Flowers; leaves; whole plant	Decoction; poultice; maceration; powder	Abdominal pain (1); fatigue and body pain (1); fertility concerns (1); generalised body aches (1); nausea (1); reduced sexual vigour (1)	6	6	0.030	0.030
Asteraceae	*Matricaria chamomilla* L.	*Babounj*	SAH-dridi-1238	Flowers	Infusion	Mild eye complaints (2); paediatric colic (1)	3	3	0.015	0.015
Asteraceae	*Scolymus hispanicus* L.	*Gornina*	SAH-dridi-1536	Roots; leaves; flowers; seeds; aerial parts; whole plant	Decoction; infusion; hot oil extract; maceration; powder	Sluggish liver (5); nausea (2); abdominal pain (1); bloating after meals (1); chronic constipation (1); dysuria (1); loss of appetite (1); stomach cramps (1); urinary retention (1)	13	14	0.065	0.070
Asteraceae	*Scolymus maculatus* L.	*Gornina*	SAH-dridi-1807	Roots	Decoction; hot oil extract	Jaundice (7); hepatic detoxification (3)	10	10	0.050	0.050
Asteraceae	*Senecio vulgaris* L.	*Mordjida*	SAH-dridi-2078	Aerial parts	Poultice	Dysmenorrhoea (2)	2	2	0.010	0.010

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Asteraceae	*Silybum marianum* (L.) Gaertn.	*Chouk el-hmir*	SAH-dridi-349	Seeds; flowers; aerial parts; whole plant; leaves	Decoction; infusion; powder; maceration; raw	Hepatic pain (6); bloating after meals (3); heartburn (2); abdominal pain (1); dysuria (1); frequent urination (1); heart tonic (1); lower back and kidney ache (1); nausea (1); palpitations (1); poor circulation (1); urinary retention (1)	19	20	0.095	0.100
Asteraceae	*Taraxacum officinale* F.H.Wigg.	*Tarkhachkon*	SAH-dridi-1975	Leaves	Decoction; infusion	Hepatic complaints (4); water retention (2)	6	6	0.030	0.030
Boraginaceae	*Alkanna tinctoria* (L.) Tausch	*Hennet el-ghoul*	SAH-dridi-642	Roots	Maceration; poultice; powder	Burn healing (8); chronic eczema (5); eczema patches (3); skin eczema (3)	18	19	0.090	0.095
Boraginaceae	*Anchusa azurea* Mill.	*Hamehem*	SAH-dridi-1081	Aerial parts	Infusion; decoction; maceration	Persistent dry cough (10); tickly cough (9); phlegm and catarrh (4); bronchial congestion (3); night-time cough (3); chest congestion (2)	29	31	0.145	0.155

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Boraginaceae	*Borago officinalis* L.	*Lsan eth-thor; Ham-hama*	SAH-dridi-875	Aerial parts; seeds; leaves	Infusion; decoction	Respiratory ailments (9); gastrointestinal complaints (5); abdominal pain (1); nausea (1); productive cough (1); slow digestion (1); sore throat with cough (1); throat irritation (1)	19	20	0.095	0.100
Brassicaceae	*Brassica nigra* (L.) W.D.J.Koch	*Khardal*	SAH-dridi-1146	Seeds	Poultice; decoction	Phlegm and catarrh (2); rheumatic joint pain (2)	4	4	0.020	0.020
Brassicaceae	*Brassica oleracea* L.	*Kromb*	SAH-dridi-1417	Leaves	Raw; decoction	Joint inflammation (5)	5	5	0.025	0.025
Brassicaceae	*Capsella bursa-pastoris* (L.) Medik.	*Kiss er-raai*	SAH-dridi-1856	Aerial parts	Infusion; maceration; decoction	Excessive menstrual bleeding (10)	10	10	0.050	0.050
Brassicaceae	*Sinapis alba* L.	*Khardal sghir*	SAH-dridi-620	Seeds	Poultice; maceration	Phlegm and catarrh (2); bronchial congestion (1); chest congestion (1)	4	4	0.020	0.020
Cactaceae	*Opuntia ficus-indica* (L.) Mill.	*El-hendi*	SAH-dridi-219	Flowers; fruits; leaves; bark	Decoction; infusion; poultice; maceration; raw	Hair care (2); acne (1); boils (1); feverishness (1); heartburn (1); migraine (1); slow digestion (1)	8	8	0.040	0.040

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Capparaceae	*Capparis spinosa* L.	*El-kebbar*	SAH-dridi-1585	Fruits; roots; aerial parts; flowers; leaves	Decoction; infusion; poultice; powder; maceration; steam inhalation	Sciatica (2); back pain (1); boils (1); cold-induced rheumatic/musculoskeletal pain (1); common cold (1); fever with chills (1); frequent headaches (1); general malaise (1); itching (1); kidney pain (1); muscle stiffness (1); persistent cough (1); rheumatic pain (1); skin infection (1); throat irritation (1)	16	16	0.080	0.080
Caprifoliaceae	*Lonicera etrusca* Santi	*Soltane el-ghaba*	SAH-dridi-1883	Flowers; aerial parts; fruits	Infusion; maceration; decoction	Psoriasis (4); dermatitis (2); general malaise (1); itching (1); muscle aches (1); muscle pain (1); skin infection (1)	11	11	0.055	0.055
Caryophyllaceae	*Herniaria glabra* L.	*Herrast lehjar*	SAH-dridi-1444	Aerial parts; whole plant; flowers; leaves; seeds	Decoction; infusion; raw; maceration; poultice; powder	Cloudy urine (6); dysuria (4); reduced sexual vigour (4); bone fragility (3); urinary retention (3); menstrual irregularities (2); fertility concerns (1); frequent urination (1); lower back and kidney ache (1); osteoarthritis (1)	24	26	0.120	0.130

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Caryophyllaceae	*Herniaria hirsuta* L.	*Herrast lehjar*	SAH-dridi-1715	Leaves; seeds	Infusion; powder mixed with honey	Recurrent cystitis (1); urinary gravel (1)	2	2	0.010	0.010
Caryophyllaceae	*Paronychia arabica* (L.) DC.	*Kassaret lehjar*	SAH-dridi-1574	Aerial parts	Infusion; maceration; decoction	Lithiasis (stones) (8); urinary complaint (5); urinary complaint (unspecified) (3)	14	16	0.070	0.080
Caryophyllaceae	*Spergularia rubra* (L.) J.Presl & C.Presl	*Fetat lehjar*	SAH-dridi-1162	Aerial parts	Infusion; decoction	Urinary stones (18); bladder inflammation (1); diuretic (1); gout (1); renal colic (1); urinary sand (1)	23	23	0.115	0.115
Cistaceae	*Cistus monspeliensis* L.	*Chetba*	SAH-dridi-1482	Leaves	Maceration	Wounds (1)	1	1	0.005	0.005
Cistaceae	*Cistus salviifolius* L.	*Touzala*	SAH-dridi-1753	Leaves	Poultice	Skin infection (1)	1	1	0.005	0.005
Cupressaceae	*Cupressus sempervirens* L.	*Sarou*	SAH-dridi-837	Leaves; fruits	Decoction; infusion	Haemorrhoids (11); varicose veins (6); back pain (1); common cold (1); nasal congestion (1); palpitations (1); poor circulation (1)	22	22	0.110	0.110
Cupressaceae	*Juniperus oxycedrus* L.	*Taga*	SAH-dridi-257	Resin; fruits	Raw; infusion; fumigation	Veterinary dermatological care (5); digestive weakness (2); bladder inflammation (1); severe eczema (1)	9	9	0.045	0.045

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Cupressaceae	*Juniperus phoenicea* L.	*Araar*	SAH-dridi-528	Leaves; aerial parts; bark; flowers; fruits	Poultice; infusion; decoction; raw	Cold-induced rheumatic/musculoskeletal pain (21); acid reflux (2); indigestion (2); abdominal pain (1); cloudy urine (1); kidney pain (1); lower back and kidney ache (1); nausea (1); rheumatic pain (1); skin infection (1); skin rash (1); slow digestion (1); stomach cramps (1)	33	35	0.165	0.175
Ephedraceae	*Ephedra fragilis* Desf.	*Alenda*	SAH-dridi-1005	Aerial parts; bark; fruits	Decoction; infusion; maceration; powder	Traditional anticancer use (6); urinary tract infections (4); dysuria (1); endocrine diseases (1)	9	12	0.045	0.060
Ericaceae	*Arbutus unedo* L.	*Lendj*	SAH-dridi-1894	Leaves; fruits	Decoction; infusion	Renal flush (4); high blood pressure (2); blood pressure control (1); cloudy urine (1); mild hypertension (1); urinary retention (1)	10	10	0.050	0.050
Ericaceae	*Erica arborea* L.	*Khlenj*	SAH-dridi-1276	Flowers	Infusion; powder	Dysuria (5); stone expulsion (3); renal stones (2); flu-like symptoms (1)	11	11	0.055	0.055
Fabaceae	*Bituminaria bituminosa* (L.) C.H.Stirt.	*Btana*	SAH-dridi-604	Resin	Fumigation	Burns (1)	1	1	0.005	0.005
Fabaceae	*Calicotome spinosa* (L.) Link	*Gandoul*	SAH-dridi-772	Flowers	Infusion; decoction	Urinary flush (8); mild diuresis (7)	14	15	0.070	0.075

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Fabaceae	*Calicotome villosa* (Poir.) Link	*Gandoul*	SAH-dridi-1043	Flowers; fruits; leaves; bark	Infusion; decoction; maceration; poultice	Mild diuresis (9); boils (1); chest tightness (1); heart tonic (1); itching (1); skin infection (1)	14	14	0.070	0.070
Fabaceae	*Ceratonia siliqua* L.	*Kharroub*	SAH-dridi-669	Fruits; bark; leaves; resin	Powder; infusion; decoction; maceration; poultice	Paediatric diarrhoea (14); stomach discomfort (8); mild indigestion (5); upset stomach (5); acne (1); boils (1); indigestion (1); loss of appetite (1); palpitations (1); poor circulation (1)	34	38	0.170	0.190
Fabaceae	*Medicago sativa* L.	*Fessa*	SAH-dridi-1509	Aerial parts	Infusion; maceration; decoction	General fatigue (10)	10	10	0.050	0.050
Fabaceae	*Trifolium pratense* L.	*Nefl*	SAH-dridi-1330	Flowers	Infusion; decoction	Gynaecological complaints (5); women's reproductive issues (4); female ailments (3)	12	12	0.060	0.060

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Fabaceae	*Trigonella foenum-graecum* L.	*Helba*	SAH-dridi-1601	Seeds; leaves; whole plant; flowers; aerial parts	Powder; powder mixed with honey; decoction; maceration; infusion; steam inhalation; raw	Weight loss (17); dysuria (13); reduced sexual vigour (9); recurrent cystitis (7); bladder inflammation (6); menstrual irregularities (3); heartburn (2); poor circulation (2); chest tightness (1); chronic constipation (1); cloudy urine (1); feverishness (1); high fever (1); loss of appetite (1); lower back and kidney ache (1); palpitations (1); slow digestion (1); stomach cramps (1)	60	69	0.300	0.345
Fagaceae	*Quercus ilex* L.	*Bellout*	SAH-dridi-2013	Bark; leaves; seeds	Decoction; infusion; poultice; powder	Boils (1); mild indigestion (1); skin rash (1); stomach cramps (1); stomach discomfort (1)	5	5	0.025	0.025
Fagaceae	*Quercus rotundifolia* Lam.	*Bellout*	SAH-dridi-284	Bark; leaves	Decoction; poultice	Itching (1); stomach discomfort (1)	2	2	0.010	0.010
Fagaceae	*Quercus suber* L.	*Fernane*	SAH-dridi-555	Leaves; roots	Decoction; raw	Mouth ulcers (1); oral sores (1)	2	2	0.010	0.010
Lamiaceae	*Ajuga iva* (L.) Schreb.	*Chendgoura*	SAH-dridi-371	Aerial parts	Decoction; infusion; maceration	Gastrointestinal cramps (6); high blood pressure (3); mild hypertension (3); blood pressure control (1)	13	13	0.065	0.065
Lamiaceae	*Clinopodium nepeta* (L.) Kuntze	*Nabta*	SAH-dridi-1959	Seeds	Fumigation	Ritual fumigation (1)	1	1	0.005	0.005

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Lamiaceae	*Lamium amplexicaule* L.	*Nettigha*	SAH-dridi-799	Aerial parts	Infusion	Gynaecological discharges (2); female ailments (1)	3	3	0.015	0.015
Lamiaceae	*Lavandula angustifolia* Mill.	*Khozama*	SAH-dridi-1341	Aerial parts	Fumigation; steam inhalation	Migraine (8); gynaecological cold-related condition (3)	11	11	0.055	0.055
Lamiaceae	*Lavandula stoechas* L.	*Halhal*	SAH-dridi-1612	Fruits; seeds	Decoction; infusion	Anxiety (1); migraine (1)	2	2	0.010	0.010
Lamiaceae	*Marrubium vulgare* L.	*Meriouet*	SAH-dridi-967	Aerial parts; seeds; flowers; leaves; whole plant	Decoction; infusion; steam inhalation; poultice; powder; maceration	Endocrine diseases (23); respiratory complaint (15); reduced sexual vigour (4); chest cold (2); fever with chills (2); flu-like symptoms (2); menstrual irregularities (2); osteoarthritis (2); sore throat with cough (2); weak bones (2); chest tightness (1); common cold (1); feverishness (1); heart tonic (1); nasal congestion (1); palpitations (1); persistent cough (1); poor circulation (1); throat irritation (1)	58	65	0.290	0.325

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Lamiaceae	*Melissa officinalis* L.	*Tronjan*	SAH-dridi-1780	Leaves; seeds; flowers; whole plant; aerial parts	Infusion; decoction; poultice; powder	Generalised body aches (4); anxiety (3); reduced sexual vigour (3); palpitations (2); abdominal pain (1); chronic constipation (1); fatigue and body pain (1); indigestion (1); loss of appetite (1)	16	17	0.080	0.085
Lamiaceae	*Mentha pulegium* L.	*Fliou*	SAH-dridi-2051	Leaves; seeds; flowers; whole plant; aerial parts	Infusion; poultice; decoction; powder; maceration; steam inhalation; chewed raw; raw	Rheumatism (7); osteoporosis (4); back pain (3); weak bones (3); chest cold (2); fatigue and body pain (2); heart tonic (2); muscle aches (2); osteoarthritis (2); respiratory complaint (2); sore throat with cough (2); tension headache (2); abdominal pain (1); acid reflux (1); bone fragility (1); flu-like symptoms (1); general malaise (1); generalised aches (1); nasal congestion (1); nausea (1); palpitations (1); persistent cough (1); productive cough (1)	37	44	0.185	0.220

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Lamiaceae	*Mentha spicata* L.	*Naanaa*	SAH-dridi-322	Leaves; flowers; whole plant; aerial parts; seeds	Infusion; decoction; powder	Nervous system disorders (5); stone expulsion (5); dysmenorrhoea (4); urinary gravel (2); chest tightness (1); dysuria (1); flu-like symptoms (1); menstrual irregularities (1); poor circulation (1); reduced sexual vigour (1)	21	22	0.105	0.110
Lamiaceae	*Mentha suaveolens* Ehrh.	*Timija*	SAH-dridi-593	Leaves	Infusion	Dysmenorrhoea (1)	1	1	0.005	0.005
Lamiaceae	*Ocimum basilicum* L.	*Hbaq*	SAH-dridi-1677	Fruits	Infusion	Anxiety (1)	1	1	0.005	0.005
Lamiaceae	*Origanum majorana* L.	*Merdedouche*	SAH-dridi-761	Leaves	Infusion; poultice; decoction	Gastric spasms (9); anxiety (3)	12	12	0.060	0.060
Lamiaceae	*Origanum vulgare* L.	*Zaatar*	SAH-dridi-1032	Aerial parts	Infusion; decoction; maceration	Asthma (19); cough (16)	32	35	0.160	0.175

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Lamiaceae	*Origanum vulgare* subsp. *glandulosum* (Desf.) Ietsw.	*Zaatar el-mlouk*	SAH-dridi-490	Aerial parts; leaves; flowers; seeds; whole plant	Decoction; infusion; powder; maceration; steam inhalation; raw	Chest cold (3); productive cough (3); respiratory infections (3); slow digestion (3); stomach cramps (3); throat irritation (3); flu-like symptoms (2); loss of appetite (2); nausea (2); sore throat with cough (2); acid reflux (1); chronic constipation (1); dysuria (1); fever with chills (1); heartburn (1); high fever (1); indigestion (1); nasal congestion (1); poor circulation (1)	30	35	0.150	0.175
Lamiaceae	*Phlomis herba-venti* L.	*Khayata*	SAH-dridi-658	Leaves	Raw	Skin care (1)	1	1	0.005	0.005
Lamiaceae	*Salvia argentea* L.	*Khayatat el-jerrah*	SAH-dridi-452	Leaves	Poultice	Postpartum hygienic wash (1)	1	1	0.005	0.005

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Lamiaceae	*Salvia officinalis* L.	*Salmia; Souak en-nbi*	SAH-dridi-723	Aerial parts; leaves; whole plant; seeds; flowers	Decoction; infusion; powder; maceration; poultice; raw	Frequent urination (3); bloating after meals (2); reduced sexual vigour (2); cloudy urine (1); fatigue and body pain (1); fertility concerns (1); general malaise (1); heartburn (1); kidney pain (1); memory loss (1); menstrual irregularities (1); mouth wash (1); slow digestion (1)	16	17	0.080	0.085
Lamiaceae	*Salvia rosmarinus* Spenn.	*Iklil el-jabal*	SAH-dridi-994	Leaves; bark; flowers; aerial parts; fruits	Infusion; compress; decoction; steam inhalation; powder; raw	Alopecia (10); musculoskeletal pain (10); nasal congestion (3); menstrual irregularities (2); reduced sexual vigour (2); throat irritation (2); acid reflux (1); common cold (1); heartburn (1); nausea (1); persistent cough (1); productive cough (1); slow digestion (1)	34	36	0.170	0.180
Lamiaceae	*Teucrium polium* L.	*Djaada*	SAH-dridi-246	Aerial parts	Decoction; maceration	Abdominal pain (7); colic (2); gastric ulcers (1)	8	10	0.040	0.050

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Lamiaceae	*Thymus vulgaris* L.	*Zaatar*	SAH-dridi-788	Aerial parts	Infusion; infusion sweetened; decoction; infusion sweetened with sugar	Stomach ache (10); tonsillitis (10); epigastric pain (9); throat pain (7); gastritis pain (6); hoarseness (6); antiseptic wounds (1); asthma (1); bronchitis (1); flatulence (1); general fatigue (1); intestinal parasites (1); tickly cough (1); toothache (1); whooping cough (1)	51	57	0.255	0.285
Lauraceae	*Laurus nobilis* L.	*Rand*	SAH-dridi-1070	Leaves; seeds	Decoction	Fever with chills (1); oral inflammation (1)	2	2	0.010	0.010
Lythraceae	*Lythrum salicaria* L.	*Rihant el-ma*	SAH-dridi-154	Aerial parts	Decoction; infusion	Severe diarrhoea (4)	4	4	0.020	0.020
Malvaceae	*Malva neglecta* Wallr.	*Khobbeiz*	SAH-dridi-425	Leaves	Decoction; infusion; poultice	Throat irritation (8); phlegm and catarrh (3); chest congestion (2); bronchial congestion (1)	14	14	0.070	0.070
Malvaceae	*Malva sylvestris* L.	*Khobiza*	SAH-dridi-696	Aerial parts; leaves; seeds; flowers; whole plant	Decoction; infusion; maceration; poultice; powder	Throat inflammation (4); digestive complaints (3); urinary retention (2); frequent urination (1); heartburn (1); indigestion (1); loss of appetite (1); osteoarthritis (1); slow digestion (1); weak bones (1)	15	16	0.075	0.080
Moraceae	*Morus nigra* L.	*Tout kahla*	SAH-dridi-864	Flowers	Infusion	Paediatric restlessness (1)	1	1	0.005	0.005

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Myrtaceae	*Eucalyptus globulus* Labill.	*Kalitous*	SAH-dridi-1818	Leaves	Fumigation	Phlegm and catarrh (1); winter colds (1)	2	2	0.010	0.010
Myrtaceae	*Myrtus communis* L.	*Rihane*	SAH-dridi-1135	Leaves; flowers; bark; fruits; aerial parts	Decoction; infusion; maceration; powder	Oral inflammation (9); gum inflammation (7); hair growth (6); strengthening hair (6); dandruff and hair care (4); hair-loss prevention (4); mouth ulcers (4); acid reflux (3); bloating after meals (2); kidney pain (2); stomach cramps (2); chest tightness (1); chronic constipation (1); cloudy urine (1); dysuria (1); fertility concerns (1); frequent urination (1); indigestion (1); lower back and kidney ache (1); nausea (1); slow digestion (1); urinary retention (1)	54	60	0.270	0.300
Nitrariaceae	*Peganum harmala* L.	*Harmel*	SAH-dridi-1845	Seeds	Fumigation; decoction; powder	Ritual fumigation (15); joint pain (10); neurological disorders (7); dizziness (1); evil eye (1); intestinal worms (1); scabies (1)	33	36	0.165	0.180

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Oleaceae	*Olea europaea* L.	*Zitoun*	SAH-dridi-1948	Leaves	Infusion; decoction; maceration; poultice	High blood sugar (14); mild hypertension (9); high blood pressure (8); blood sugar control (7); type 2 diabetes (6); blood pressure control (5); diabetes management (4); bronchial congestion (1); chronic eczema (1); diarrhoea (krisha) (1); ear infections (1); feverishness (1); gastric ulcers (1); hair-loss prevention (1); haemorrhoids (1); hypercholesterolaemia (1); jaundice (1); rheumatism (1); urinary tract infections (1); wounds (1)	55	66	0.275	0.330
Oleaceae	*Phillyrea angustifolia* L.	*Ktem*	SAH-dridi-387	Bark	Infusion	Chest tightness (1)	1	1	0.005	0.005
Orchidaceae	*Anacamptis morio* (L.) R.M.Bateman, Pridgeon & M.W.Chase	*Khessyet eth-thaaleb*	SAH-dridi-539	Roots	Powder; chewed raw	Restorative winter remedy (11); restorative remedy (5); restorative winter remedy (local perception) (1)	17	17	0.085	0.085
Papaveraceae	*Fumaria officinalis* L.	*Baqlet el-mlouk*	SAH-dridi-631	Aerial parts	Decoction; maceration	Blood purification (4); dermatological pruritus (1)	4	5	0.020	0.025

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Papaveraceae	*Papaver rhoeas* L.	*Khachkhach*	SAH-dridi-1303	Flowers	Infusion; decoction	Paediatric restlessness (6); tickly cough (2); nighttime cough (1)	9	9	0.045	0.045
Pinaceae	*Pinus halepensis* Mill.	*Sanawbar*	SAH-dridi-929	Resin; leaves; seeds	Fumigation; steam inhalation; infusion	Burns (2); skin inflammation (2); sore throat with cough (2); frequent urination (1); respiratory ailments (1)	8	8	0.040	0.040
Plantaginaceae	*Globularia alypum* L.	*Taselgha*	SAH-dridi-902	Leaves; aerial parts; flowers	Decoction; infusion	Bone fractures (6); back pain (1); cloudy urine (1); frequent urination (1)	9	9	0.045	0.045
Plantaginaceae	*Plantago major* L.	*Massaça*	SAH-dridi-1471	Leaves	Powder	Boils (1)	1	1	0.005	0.005
Poaceae	*Ampelodesmos mauritanicus* (Poir.) T.Durand & Schinz	*El-diss*	SAH-dridi-268	Roots	Decoction; hot oil extract	Urinary tract infections (4)	4	4	0.020	0.020
Poaceae	*Avena sativa* L.	*Khertall*	SAH-dridi-2062	Seeds	Decoction; maceration	Dermatological pruritus (4); neurological fatigue (3)	6	7	0.030	0.035
Poaceae	*Cynodon dactylon* (L.) Pers.	*Njem*	SAH-dridi-1650	Aerial parts	Maceration	Recurrent cystitis (1)	1	1	0.005	0.005
Poaceae	*Zea mays* L.	*Chouchet ed-dra*	SAH-dridi-685	Seeds	Infusion	Urinary spasms (1)	1	1	0.005	0.005
Resedaceae	*Reseda alba* L.	*Khozama beida*	SAH-dridi-826	Aerial parts	Infusion; decoction	Mild gastrointestinal pain (6)	6	6	0.030	0.030
Rhamnaceae	*Ziziphus lotus* (L.) Lam.	*Sedra*	SAH-dridi-956	Leaves; fruits	Decoction; infusion; raw	Ritual washing (17); hepatic disease (13); anxiety and sleep disorders (1); diarrhoea (1); digestive complaints (1)	33	33	0.165	0.165

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Rosaceae	*Agrimonia eupatoria* L.	*Ghafeth*	SAH-dridi-100	Aerial parts	Infusion; decoction; maceration	Diarrhoea (5); gastrointestinal pain (5)	10	10	0.050	0.050
Rosaceae	*Crataegus azarolus* L.	*Zaarour*	SAH-dridi-295	Fruits; bark; leaves; resin; seeds	Infusion; decoction; powder; steam inhalation	Palpitations (11); anxiety (7); chronic constipation (1); common cold (1); flu-like symptoms (1); heartburn (1); slow digestion (1)	23	23	0.115	0.115
Rosaceae	*Crataegus monogyna* Jacq.	*Zaarour*	SAH-dridi-566	Aerial parts	Decoction	High blood pressure (1)	1	1	0.005	0.005
Rosaceae	*Cydonia oblonga* Mill.	*Sfarjel*	SAH-dridi-1108	Leaves	Decoction	Ritual washing (local perception) (1)	1	1	0.005	0.005
Rosaceae	*Rosa canina* L.	*Nesri*	SAH-dridi-1097	Fruits; aerial parts; flowers; leaves	Decoction; maceration; poultice	General fatigue (2); winter tea (2); back pain (1); bone fragility (1); general malaise (1); osteoarthritis (1); weak bones (1)	9	9	0.045	0.045

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Rosaceae	*Rubus ulmifolius* Schott	*Aalliq*	SAH-dridi-1368	Leaves; fruits; flowers; aerial parts; bark	Decoction; poultice; infusion; steam inhalation; powder; raw	Gingival bleeding (3); common cold (2); endocrine diseases (2); osteoarthritis (2); skin infection (2); acne (1); back pain (1); boils (1); bone fragility (1); flu-like symptoms (1); hoarseness (1); knee pain (1); persistent cough (1); sore throat with cough (1); throat irritation (1); throat pain (1); tonsillitis (1)	21	23	0.105	0.115

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Rutaceae	*Ruta chalepensis* L.	*Fidjel*	SAH-dridi-1639	Aerial parts; flowers; leaves; seeds; whole plant	Infusion; decoction; maceration; steam inhalation; powder; raw	Chest cold (5); frequent headaches (3); tension headache (3); flu-like symptoms (2); lower back and kidney ache (2); migraine (2); nasal congestion (2); slow digestion (2); throat irritation (2); acid reflux (1); bladder inflammation (1); bloating after meals (1); dysuria (1); frequent urination (1); heartburn (1); indigestion (1); kidney pain (1); persistent cough (1); productive cough (1); recurrent cystitis (1)	16	34	0.080	0.170
Rutaceae	*Ruta montana* (L.) L.	*Fidjel el-berri*	SAH-dridi-1910	Aerial parts	Fumigation	Ritual uses (1)	1	1	0.005	0.005
Salicaceae	*Populus alba* L.	*Haur; Sefsaf*	SAH-dridi-1742	Bark; leaves; seeds	Decoction; maceration	Haemorrhoids (1); osteoarthritis (1); skin rash (1)	3	3	0.015	0.015
Scrophulariaceae	*Verbascum sinuatum* L.	*Bou Slimane*	SAH-dridi-414	Leaves	Decoction	Ritual washing (local perception) (1)	1	1	0.005	0.005
Smilacaceae	*Smilax aspera* L.	*Tabgha*	SAH-dridi-891	Leaves	Decoction	Fever with chills (1)	1	1	0.005	0.005
Solanaceae	*Hyoscyamus albus* L.	*Bendj*	SAH-dridi-1986	Seeds	Fumigation	Neurological disorders (1)	1	1	0.005	0.005
Tamaricaceae	*Tamarix africana* Poir.	*Tarfa*	SAH-dridi-1704	Leaves	Decoction; poultice; infusion	Dermatological hardening (4); skin eczema (3); chronic eczema (2)	9	9	0.045	0.045

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Theaceae	*Camellia sinensis* (L.) Kuntze	*Tay*	SAH-dridi-1314	Leaves	Decoction	Headache wash (1)	1	1	0.005	0.005
Thymelaeaceae	*Daphne gnidium* L.	*Lazzaz*	SAH-dridi-1921	Leaves; flowers; fruits	Maceration; decoction; poultice	Wounds (2); burns (1); hepatitis c (1); skin infection (1); slow digestion (1)	5	6	0.025	0.030
Urticaceae	*Urtica dioica* L.	*Horiga*	SAH-dridi-1872	Leaves	Infusion; compress	Joint pain (3); weakness and low blood (2); blood building (1); iron-deficiency anaemia (1)	7	7	0.035	0.035
Urticaceae	*Urtica urens* L.	*Horrayeg*	SAH-dridi-143	Leaves; aerial parts; whole plant; flowers; seeds	Raw; decoction; infusion; maceration; poultice; powder	Traditional anticancer use (7); hair care (6); osteoarthritis (5); back pain (4); nervous system disorders (3); dysuria (2); general malaise (2); skin eczema (2); skin infection (2); urinary retention (2); anxiety (1); boils (1); chronic eczema (1); eczema patches (1); heart tonic (1); infant skin care (1); lower back and kidney ache (1); muscle aches (1); poor circulation (1)	43	44	0.215	0.220
Verbenaceae	*Aloysia citrodora* Palau	*Louiza*	SAH-dridi-1455	Leaves	Decoction; infusion	Ritual washing (1); water retention (1)	2	2	0.010	0.010
Viburnaceae	*Sambucus nigra* L.	*Beylasan*	SAH-dridi-1265	Roots	Raw	Dental pain (1)	1	1	0.005	0.005

Table 4 (continued)

Family	Taxon	Vernacular name (Algerian dialectal Arabic)	Voucher	Part(s) used	Preparation and administration	Ailments treated	FC	UR	RFC	UV
Zygophyllaceae	*Tribulus terrestris* L.	*Gtab*	SAH-dridi-1059	Seeds	Powder mixed with honey	Dysuria (1)	1	1	0.005	0.005

Accepted names follow POWO (2026) and WFO (2026) and family circumscriptions APG IV (Angiosperm Phylogeny Group 2016); taxa are listed alphabetically within families; Viburnaceae is used for *Sambucus*, following POWO and WFO

The number in parentheses after each ailment is the number of use-reports for that ailment. Authorities are given for all taxa in this table because it is the reference checklist of the study and 41 of the 137 taxa are not mentioned elsewhere in the text

FC frequency of citation (number of participants citing the taxon), *UR* number of use-reports, *RFC* relative frequency of citation (FC/N, with $N = 200$ participants), *UV* use value (UR/N)

least one comparator), after Hellinger transformation (Legendre and Gallagher 2001). The explanatory variables were bioclimatic zone (binary), the logarithm of distance from the study area and comparator inventory size; their significance was assessed with 9999 permutations, and the variation was partitioned into the fractions explained by bioclimatic zone alone, by distance alone and by both jointly, using adjusted R^2 (Borcard et al. 1992; Peres-Neto et al. 2006). RDA was preferred to canonical correspondence analysis (CCA) because the matrix contains many zeros, which the chi-square distance underlying CCA overweights for species-poor sites (Legendre and Gallagher 2001). Because a single row of study-versus-comparator values cannot by itself support a matrix test, the Mantel statistic was additionally computed on a genuine site-by-site matrix built from the six comparators whose species tables could be digitised from the published PDFs, giving seven sites and 21 pairs, under two digitisation scenarios (a strict one retaining only names read from the aligned species tables, and a union one adding names corroborated elsewhere in the same article). All computations were done in NumPy and SciPy (Virtanen et al. 2020), and the full script is available from the corresponding author on request.

Results

The medicinal flora of the three communes

The 200 participants cited 137 medicinal taxa belonging to 49 botanical families and 1838 use-reports, an average of 9.2 use-reports and 8.4 taxa per participant. The complete inventory, with vernacular names, parts used, preparations and therapeutic indications, is given in Table 4.

Two families account for almost a third of the inventory: Asteraceae with 21 taxa and Lamiaceae with 20, followed by Apiaceae (12); Fabaceae (7); Rosaceae (6); Brassicaceae, Caryophyllaceae and Poaceae (4 each); and Amaranthaceae, Boraginaceae, Cupressaceae and Fagaceae (3 each); 27 families are represented by a single taxon (Fig. 2). By number of use-reports, Lamiaceae leads with 384 (20.9%), followed by Asteraceae with 248 (13.5%), Fabaceae with 159 (8.7%) and Apiaceae with 104 (5.7%). The description of this study as Lamiaceae-dominant

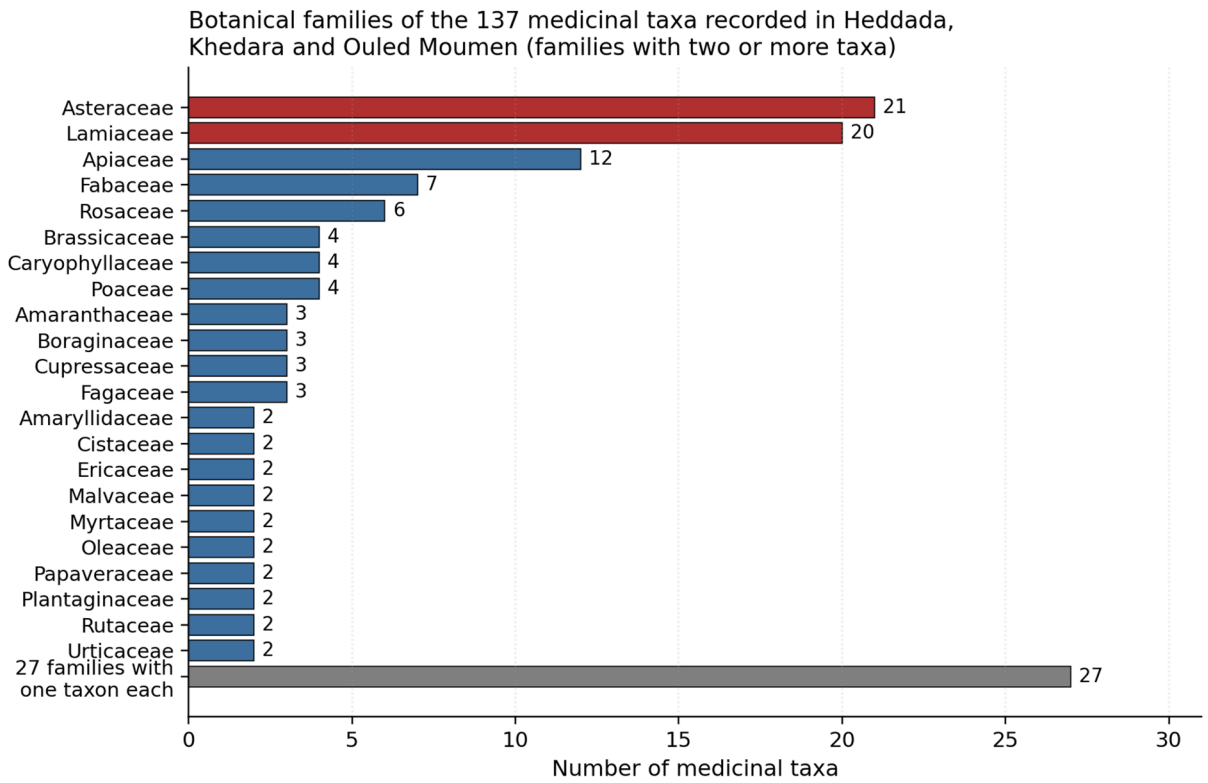

Fig. 2 Botanical families of the 137 medicinal taxa recorded in Heddada, Khedara and Ouled Moumen, ranked by number of taxa; the 27 families represented by a single taxon are pooled in the last bar. Asteraceae and Lamiaceae, in red, are separated by a single taxon

uses the use-report criterion, not taxon richness. The prominence of aromatic Lamiaceae—*Ajuga iva* (L.) Schreb., *Marrubium vulgare* L., *Mentha pulegium* L., *Teucrium polium* L., *Thymus vulgaris*, *Salvia rosmarinus*, three taxa of *Origanum* and three of *Mentha*—together with a strong Apiaceae component (*Ammoides pusilla* (Brot.) Breistr., *Foeniculum vulgare* Mill., *Ferula communis* L., *Thapsia garganica* L., *Visnaga daucoides*) is characteristic of sub-humid Mediterranean pharmacopoeias and reflects the matorral and forest-edge habitats that surround the three communes.

The inventory combines three ecological groups. The largest consists of wild-harvested species of the local forest, matorral and grazing land (*Quercus suber*, *Q. ilex*, *Q. rotundifolia* Lam., *Pinus halepensis*, *Juniperus oxycedrus* L., *J. phoenicea* L., *Pistacia lentiscus*, *Myrtus communis*, *Arbutus unedo* L., *Erica arborea*, *Cistus monspeliensis* L., *C. salviifolius* L., *Daphne gnidium* L., *Globularia alypum* L., *Ampelodesmos mauritanicus* (Poir.) T.Durand & Schinz, *Asphodelus ramosus* L., *Thapsia garganica*, *Chamaeleon gummifer* (L.) Cass.). A second group comprises ruderal and segetal species of fields, field margins and village surroundings (*Malva sylvestris* L., *M. neglecta* Wallr., *Urtica dioica* L., *U. urens* L., *Papaver rhoeas* L., *Fumaria officinalis* L., *Capsella bursa-pastoris* (L.) Medik., *Taraxacum officinale* F.H.Wigg., *Silybum marianum* (L.) Gaertn., *Carduus pycnocephalus* L., *Cirsium vulgare* (Savi) Ten., *Senecio vulgaris* L.). A third, smaller group consists of cultivated or purchased plants that enter the domestic pharmacopoeia through gardens and through the herbalist stalls of Souk Ahras and Tunisian border markets (*Camellia sinensis* (L.) Kuntze, *Zea mays* L., *Spinacia oleracea* L., *Carthamus tinctorius* L., *Anethum graveolens* L., *Ocimum basilicum* L., *Origanum majorana* L., *Aloysia citrodora* Palau, *Trigonella foenum-graecum* L., *Cupressus sempervirens* L., *Eucalyptus globulus* Labill. and *Opuntia*

ficus-indica (L.) Mill., the last two naturalised). The presence of *Anacamptis morio* (L.) R.M.Bateman, Pridgeon & M.W.Chase, an orchid whose tubers supply the *Sahlab* of the regional markets, and of highly toxic taxa used under careful control (*Nerium oleander* L., *Hyoscyamus albus* L., *Chamaeleon gummifer*, *Peganum harmala* L., *Aristolochia fontanesii* Boiss. & Reut.) indicates a repertoire still governed by specialised local knowledge rather than by generic herbal commerce.

Plant parts and modes of preparation

Leaves are the most frequently used plant part (26.6% of use-reports), followed by aerial parts (25.9%), seeds (12.9%), flowers (12.1%), roots (7.3%), fruits (5.6%), whole plants (4.4%), resin (2.6%), bark (2.0%) and bulbs (0.6%). Aqueous extraction dominates the preparation of remedies: infusion accounts for 33.4% of all preparations and decoction for 30.6%, so that the two together cover almost two thirds of the recorded practice, with maceration, powder, poultice and direct ingestion or topical application accounting for the remainder (maceration and poultice, 7.1% each; powder, 7.0%; raw use, 6.3%; fumigation, 3.0%; steam inhalation, 2.2%; powder mixed with honey, 1.1%; hot-oil extraction, 0.8%; compress, 0.6%; explicitly sweetened infusion variants, 0.4%; and chewing raw material, 0.3%). The predominance of infusion over decoction is consistent with a repertoire built mainly on leaves and flowering tops, decoction being generally reserved for roots, bark and seeds. The distribution of use-reports across therapeutic categories and the corresponding ICF values are given in Table 5. Digestive, hepatic and oral/dental indications account for 438 reports (23.8%), respiratory indications for 270 (14.7%) and urinary indications for 196 (10.7%). The grouping is informed by ICPC-2 (WONCA International Classification Committee 1998); ritual, ethnoveterinary and sex-unspecified reproductive reports are retained separately rather than assigned an unsupported clinical diagnosis.

Table 5 Distribution of reported indications and informant consensus by analytical category

Group	Analytical category	NUR	NT	Participants	UR %	ICF
D	Digestive, hepatic and oral/dental	438	54	165	23.8	0.879
R	Respiratory	270	34	141	14.7	0.877
U	Urinary	196	35	123	10.7	0.826
L	Musculoskeletal	172	24	108	9.4	0.865
S	Skin/hair	169	37	99	9.2	0.786
A	General/unspecified	142	33	101	7.7	0.773
K	Cardiovascular	97	20	76	5.3	0.802
T	Endocrine/metabolic/nutritional	88	7	67	4.8	0.931
W/X	Female reproductive/postpartum	61	18	52	3.3	0.717
N	Neurological	54	14	47	2.9	0.755
REP	Reproductive/sexual, unspecified	42	13	35	2.3	0.707
RIT	Ritual	38	7	35	2.1	0.838
P	Psychological/sleep	30	11	27	1.6	0.655
B	Blood/lymphatic	29	4	26	1.6	0.893
VET	Ethnoveterinary	6	2	6	0.3	0.800
F	Eye	5	2	5	0.3	0.750
H	Ear	1	1	1	0.1	NA

Analytical category codes are informed by ICPC-2: D, digestive, hepatic and oral/dental; R, respiratory; U, urinary; L, musculoskeletal; S, skin/hair; A, general/unspecified; K, cardiovascular; T, endocrine/metabolic/nutritional; W/X, female reproductive/postpartum; N, neurological; REP, reproductive/sexual, unspecified; RIT, ritual; P, psychological/sleep; B, blood/lymphatic; VET, ethnoveterinary; F, eye; H, ear. NUR, number of use-reports; NT, number of taxa; ICF, informant consensus factor, calculated as (NUR − NT)/(NUR − 1) and not applicable (NA) when NUR = 1. The grouping is informed by ICPC-2 and is not clinical diagnostic coding; participants can occur in more than one category

Crop wild relatives and wild gene pools

At least 25 of the 137 taxa are crop wild relatives in the sense of Maxted et al. (2006), that is, wild taxa belonging to the same genus, and often the same gene pool, as a cultivated crop (Table 6). They include the oleaster form of *Olea europaea* L., *Allium ampeloprasum* L. (wild leek, progenitor of leek and kurrat), *Daucus carota* L., *Apium graveolens* L., *Foeniculum vulgare*, *Brassica nigra* (L.) W.D.J.Koch and *B. oleracea* L., *Sinapis alba* L., *Cynara cardunculus* (wild cardoon, progenitor of artichoke and cultivated cardoon), *Scolymus hispanicus* L., *Medicago sativa* L., *Trifolium pratense* L., *Trigonella foenum-graecum*, *Avena sativa* L., *Ceratonia siliqua* L., *Crataegus azarolus* L., *Cydonia oblonga* Mill., *Rubus ulmifolius* Schott, *Rosa canina* L., *Capparis spinosa* L., *Pistacia lentiscus* (used as rootstock for pistachio), *Asparagus albus* L., *Malva* spp. and *Ziziphus lotus* (L.) Lam. A second, larger group comprises the wild gene pools of cultivated medicinal and aromatic plants whose domestication is recent or still incomplete, and for which Mediterranean wild populations are the primary genetic resource (Table 6): *Thymus*, *Origanum*, *Mentha*, *Salvia*, *Lavandula*, *Melissa*, *Clinopodium*, *Anacyclus pyrethrum* (L.) Lag., *Chamaemelum nobile* (L.) All., *Matricaria chamomilla* L., *Silybum marianum*, *Calendula*, *Artemisia* and *Ammoides pusilla* (Zohary et al. 2012). Both groups are harvested from wild or semi-wild populations within the communal territories, so that the use-reports collected here are also a record of current harvesting pressure on those populations.

The local flora in its regional context

Across the 16 comprehensive Algerian comparators, richness ranges from 31 taxa (Hoggar) to 167 (multiregional national survey), with mean 96.5, median 93.5 and type-7 quartiles $Q1 = 79.5$ and $Q3 = 103.8$ (Table 2). With 137 taxa the present inventory ranks 4th of the 17 Algerian datasets ($z = +1.16$, empirical percentile 81.2, normal-theory percentile 87.6), 42% above the Algerian mean and above Q3, but well inside the observed range. Among the 14 surveys from outside Algeria, richness ranges from 45 to 179 taxa (mean 88.3, median 69.0; Table 3), and the study ranks 3rd of 15 at that level and 6th of the 31 pooled datasets (empirical percentile 83.3; 95% bootstrap CI of the pooled median 70–100 taxa) (Figs. 3, 4). The non-Algerian median is lower than the Algerian one because that set includes more Saharan and Sahelian localities, although the difference is not significant (see below); each statistic is therefore reported together with the set it refers to. The non-parametric tests confirm the position of the study inventory. Comparator richness is significantly lower than the 137 taxa of the study inventory in all three reference sets (one-sample Wilcoxon signed-rank tests: Algeria, 13 of 16 comparators below, $p = 0.002$; outside Algeria, 12 of 14, $p = 0.002$; pooled, 25 of 30, $p < 0.001$). Richness does not differ significantly among the four combinations of geographic level and bioclimatic zone (Kruskal–Wallis $H = 2.44$, $df = 3$, $p = 0.487$), between Algerian and non-Algerian surveys (Mann–Whitney $U = 136$, $p = 0.334$) or between Mediterranean/Tell and Saharan/Sahelian surveys (median 97 versus 69 taxa; $U = 137$, $p = 0.128$). Richness therefore places the study inventory in the upper part of the regional distribution, but it does not discriminate between the ecological or national groups of comparators; floristic composition, analysed below, does.

That position is not an artefact of interview effort. Across the 29 comparator datasets reporting participant numbers, the association between taxa and participants is weak and non-significant (Pearson $r = +0.241$, $p = 0.208$; Spearman $r = -0.062$, $p = 0.750$), and the fitted line $\text{taxa} = 84.54 + 0.04565 \times \text{participants}$ explains 5.8% of the variance. The two coefficients differ in sign because the weak positive Pearson value depends on the three largest surveys (600–900 participants): without them $r = -0.057$ ($p = 0.780$), which is why the rank-based coefficient is reported alongside it. At 200 participants the model predicts 93.7 taxa, so the observed 137 represent an excess of +43.3 taxa over the effort-based expectation (Fig. 5).

The three utilitarian dimensions converge across the region. Among the 29 datasets (the present study included) that name a single dominant family, Lamiaceae leads in 20, far ahead of Asteraceae (4), Fabaceae (4, all of them outside Algeria) and Apiaceae (1) (Fig. 6). Leaves are the modal plant part in 19 datasets, ahead of aerial parts (4), roots and other underground organs (2) and fruits or bark (1); decoction is the modal preparation in 15 datasets, with a joint infusion/decoction practice in 5

Table 6 Crop wild relatives and wild gene pools of cultivated medicinal and aromatic plants among the 137 taxa recorded in the study area

Taxon	Related crop or cultivated species	Status
(a) Crop wild relatives		
Allium ampeloprasum	Leek, kurrat, great-headed garlic	Wild progenitor
Apium graveolens	Celery, celeriac	Wild progenitor
Asparagus albus	Asparagus	Congeneric wild relative
Avena sativa	Oat	Feral and weedy populations
Brassica nigra	Black mustard	Wild and weedy populations of the crop
Brassica oleracea	Cabbage, kale, cauliflower	Wild relative, primary gene pool
Capparis spinosa	Caper	Wild populations of the crop
Ceratonia siliqua	Carob	Wild populations of the crop
Crataegus azarolus	Azarole	Wild populations of the fruit crop
Cydonia oblonga	Quince	Wild and feral populations
Cynara cardunculus	Globe artichoke, cultivated cardoon	Wild progenitor
Daucus carota	Carrot	Wild progenitor
Foeniculum vulgare	Fennel	Wild populations of the crop
Malva neglecta, *M. sylvestris*	Leaf vegetables (mallow)	Wild-harvested relatives
Medicago sativa	Lucerne	Wild and feral populations of the forage crop
Olea europaea (oleaster form)	Olive	Wild progenitor and primary gene pool
Pistacia lentiscus	Pistachio; mastic	Secondary gene pool and rootstock
Rosa canina	Rose (hips, rootstock)	Congeneric wild relative and rootstock source
Rubus ulmifolius	Blackberry	Congeneric wild relative
Scolymus hispanicus	Golden thistle (minor vegetable)	Wild-harvested crop relative
Sinapis alba	White mustard	Wild populations of the crop
Trifolium pratense	Red clover	Wild populations of the forage crop
Trigonella foenum-graecum	Fenugreek	Wild and landrace populations
Ziziphus lotus	Jujube (*Ziziphus jujuba*)	Congeneric wild relative
(b) Wild gene pools of cultivated medicinal and aromatic plants		
Ammoides pusilla	Ammoides (*Noukha*)	Wild-harvested Maghreb aromatic, no cultivated form
Anacyclus pyrethrum	Pellitory (pyrethrum root)	Wild-harvested medicinal, IUCN-threatened in the Maghreb
Artemisia absinthium, *A. herba-alba*	Wormwood, white wormwood	Wild-harvested medicinal and aromatic species
Calendula arvensis, *C. officinalis*	Marigold	Wild relative and wild gene pool
Chamaemelum nobile	Roman chamomile	Wild gene pool of the crop
Clinopodium nepeta	Calamint	Wild-harvested aromatic, incipient domestication
Lavandula angustifolia, *L. stoechas*	Lavender	Wild gene pool of the essential-oil crops
Matricaria chamomilla	German chamomile	Wild and weedy populations of the crop
Melissa officinalis	Lemon balm	Wild populations of the crop
Mentha pulegium, *M. spicata*, *M. suaveolens*	Mints	Wild gene pool of cultivated mints
Origanum majorana, *O. vulgare*, *O. vulgare* subsp. *glandulosum*	Oregano, marjoram	Wild gene pool; subsp. *glandulosum* endemic to the Maghreb
Salvia argentea, *S. officinalis*, *S. rosmarinus*	Sage, rosemary	Wild gene pool of the cultivated crops
Silybum marianum	Milk thistle	Wild populations supplying the pharmaceutical crop
Thymus vulgaris	Thyme	Wild gene pool of the cultivated crop

Group (a) follows the genus-level definition of a crop wild relative of Maxted et al. (2006); group (b) comprises wild populations that constitute the primary genetic resource of medicinal and aromatic plants whose domestication is recent or still incomplete (Zohary et al. 2012)

and infusion alone in 5 (Fig. 7). The present inventory is modal for plant part but not for preparation, its own leading mode being infusion; what is genuinely shared across the region is aqueous extraction, the dominant mode in all 26 datasets that report one. This comparator tally should not be confused with

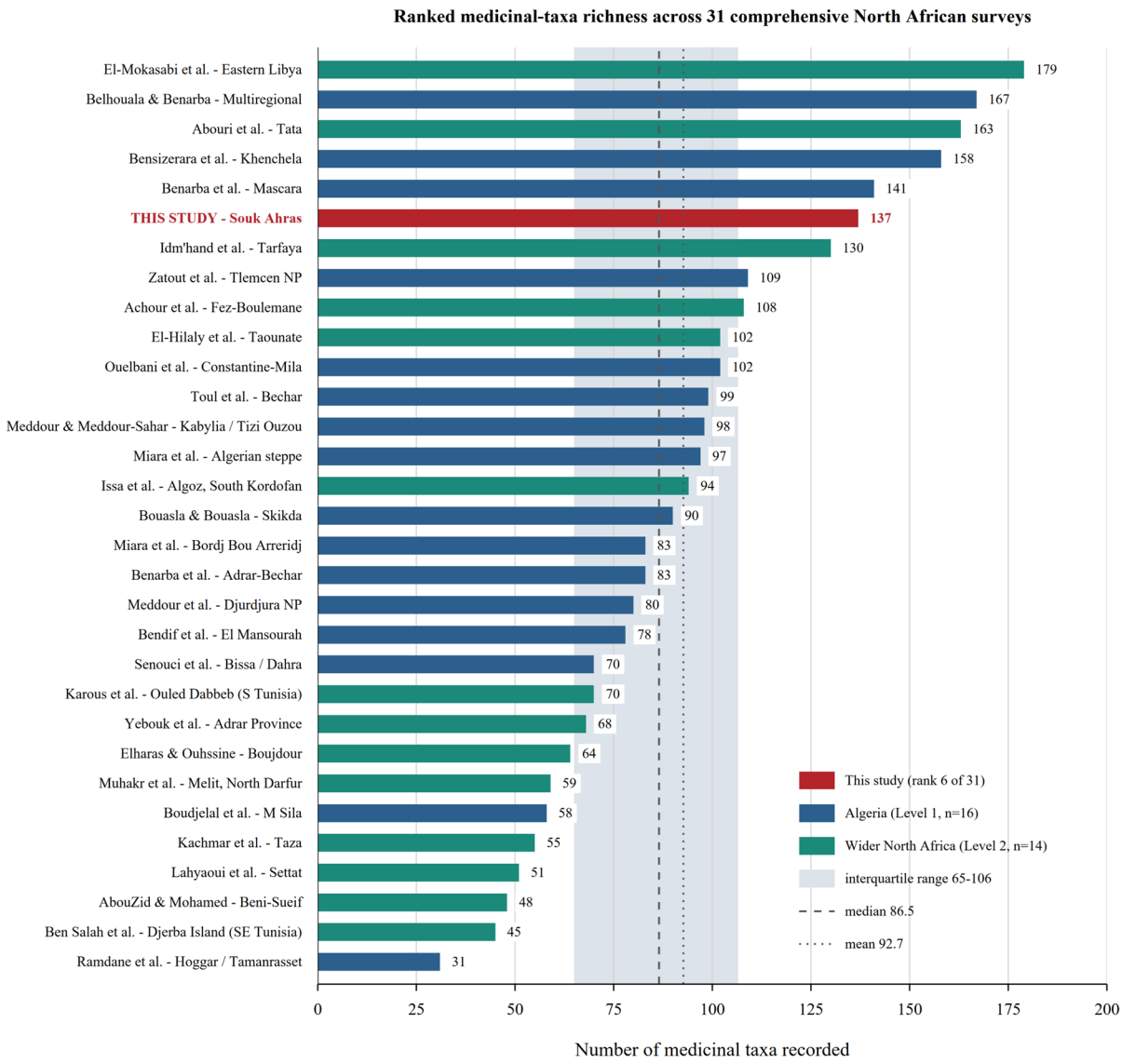

Fig. 3 Medicinal species richness of all 31 North African datasets, ranked. Bars are coloured by reference set (Algeria, wider North Africa outside Algeria, present study). The shaded band is the interquartile range of the 30 comparators and the dashed and dotted lines mark their median and mean. The study sits above the third quartile yet far below the regional maximum

the pooled Moroccan background, where a systematic review of 63 field studies ranks families Asteraceae > Fabaceae > Lamiaceae > Apiaceae (Fakchich and Elachouri 2021), an order that reflects the species pool of many pooled surveys rather than the modal dominance of individual localities.

Complete checklists were recovered for 20 comparators, 12 inside Algeria and 8 outside it. Jaccard coefficients span 0.010–0.270 and Sørensen coefficients 0.020–0.425 (Table 7). The seven most similar assemblages are all Mediterranean Algerian or Tell/Atlas floras ($J = 0.204$–0.270), whereas the seven least similar are all Saharan or Sahelian ($J = 0.010$–0.079) (Fig. 8). Absolute values in this range are normal in comparative ethnobotany rather than evidence of isolation: because J penalises every unshared taxon on either side, two surveys sharing a regional core of 40–50 species still return

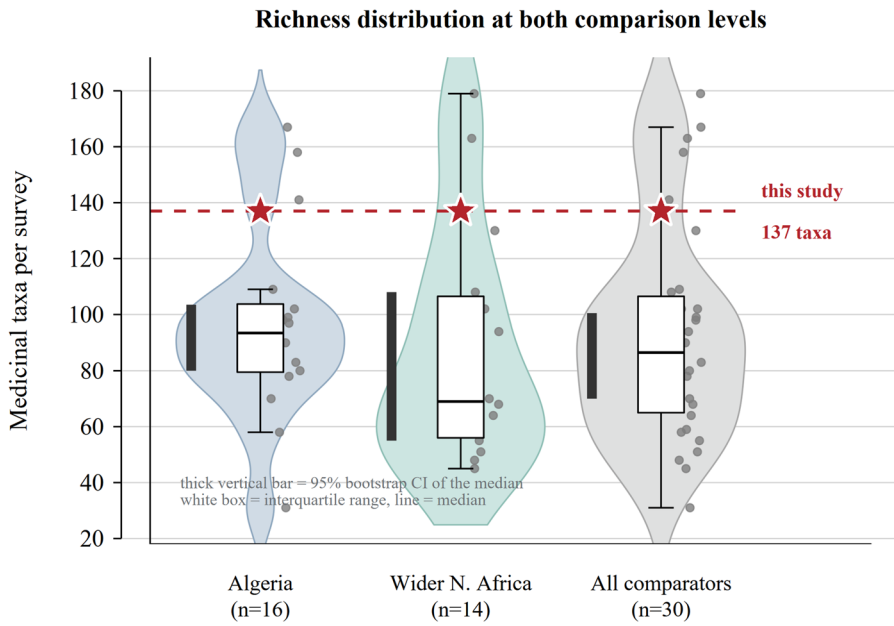

Fig. 4 Distribution of medicinal species richness in the three reference sets. Violins show the kernel density of comparator richness, boxes the interquartile range and median, grey dots the individual surveys, and the thick vertical bars the 95% bootstrap confidence interval of each median. The dashed red line marks the 137 taxa of the present study, which falls above every comparator median but inside every comparator range

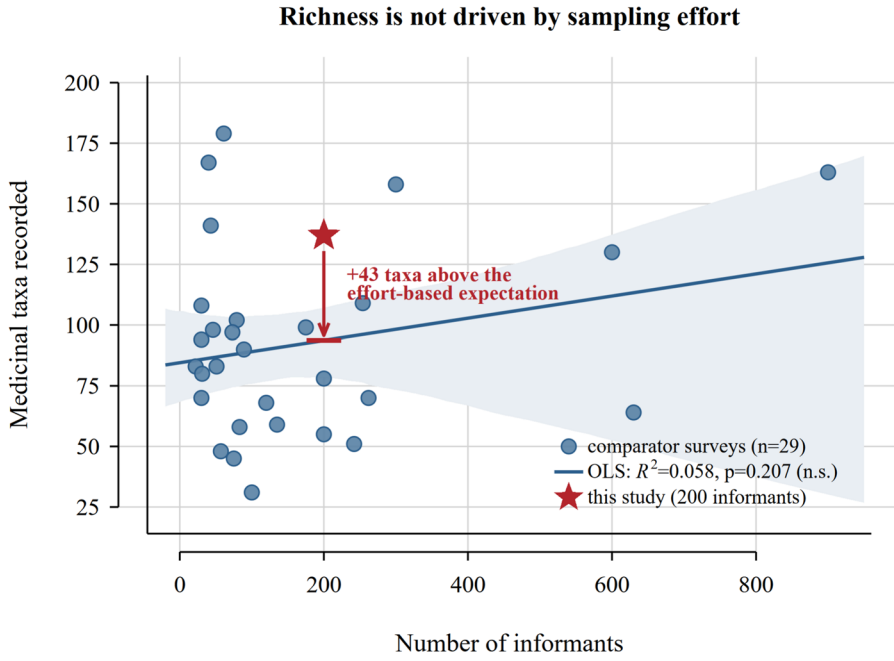

Fig. 5 Medicinal species richness versus number of participants across the 29 comparator datasets reporting participant numbers; the present study is not part of the fit. The regression line with its 95% bootstrap confidence band is essentially flat; the star marks the present study, whose richness lies well above the effort-based expectation at 200 participants

$J \approx 0.25$ whenever each also contains 60–90 locally recorded taxa. The rank order, which is identical under both indices, carries the signal.

The shared fraction is concentrated in a recurrent Maghreb core. *Trigonella foenum-graecum*, *Peganum harmala*, *Mentha pulegium*, *Ajuga iva*, *Marrubium vulgare*, *Myrtus communis*, *Olea europaea*, *Pistacia lentiscus* and *Thymus* spp. recur across most Mediterranean comparators, together with *Artemisia herba-alba* Asso, *Teucrium polium*, *Globularia alypum*, *Lavandula stoechas*, *Salvia rosmarinus*, *Foeniculum vulgare*, *Ceratonia siliqua*, *Nerium oleander*, *Eucalyptus globulus*, *Opuntia ficus-indica* and *Ziziphus lotus* (Table 8). Only a handful of taxa cross

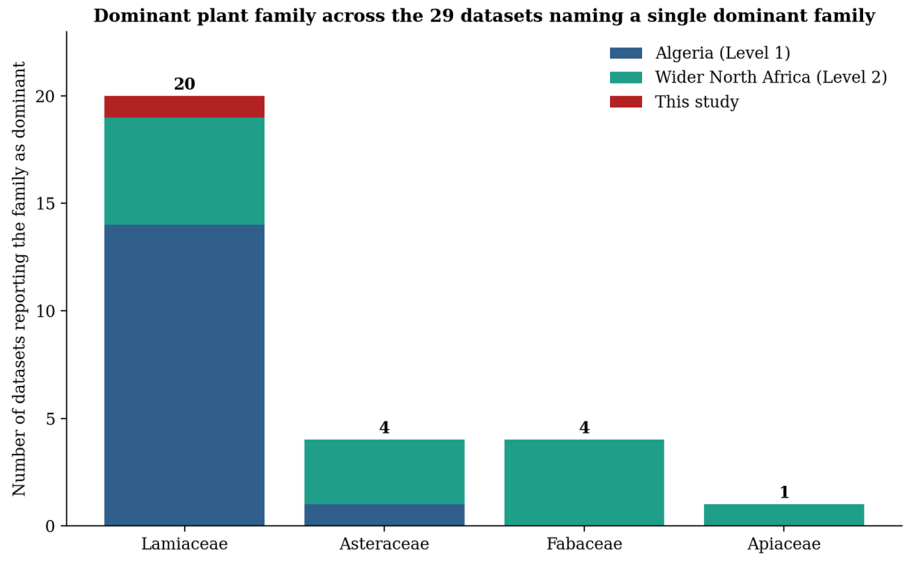

Fig. 6 Dominant plant family across the 29 datasets that name a single dominant family, stacked by geographic level. Blue = Algerian comparators, teal = comparators from wider North Africa outside Algeria, red = the present study. Lamiaceae dominance is concentrated in Algeria and the Moroccan Mediterranean fringe, whereas all four Fabaceae-dominated localities lie outside Algeria, three of them in Saharan or Sahelian territory

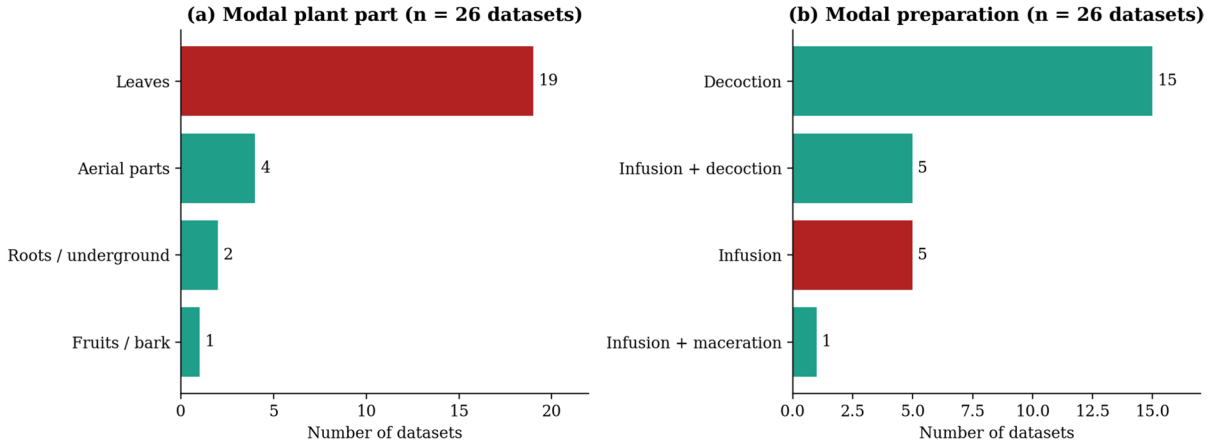

Fig. 7 Modal plant part (**a**) and modal preparation method (**b**) across the comparator set. Red bars mark the category to which the present study belongs. Counts exclude the five comparators that did not report the corresponding category

into the Saharan and Sahelian comparators, and these are almost exclusively traded or cultivated species—*Trigonella foenum-graecum*, *Ocimum basilicum*, *Mentha spicata* L., *Foeniculum vulgare*, *Zea mays* and *Tribulus terrestris* L. account for most of the 2–5 taxa shared with Darfur, Kordofan, Mauritania and southern Morocco. The highest overlap with any single comparator reaches 52 shared taxa (Tlemcen National Park) and 44–46 with the Kabylian, steppe and Dahra floras, so that roughly a third of the Souk Ahras inventory belongs to a widely shared regional repertoire while the remainder reflects local floristic composition, the conservative treatment of congeners adopted here and the breadth of the present inventory.

Similarity declines steeply with distance from the study area: over the 19 georeferenced comparators $r = -0.810$, $R^2 = 0.656$, $p = 2.60 \times 10^{-5}$, with agreement from the rank-based test (Spearman $r = -0.758$, $p = 1.70 \times 10^{-4}$), from the Sørensen index ($r = -0.821$) and from a partial correlation controlling for comparator inventory size ($r = -0.781$, $p = 1.30 \times 10^{-4}$); the linear form is preferred over the log-linear one by $\Delta\text{AIC} = 6.3$ (Fig. 9). The pooled relationship must not, however, be read as a monotonic decay operating

Table 7 Floristic similarity between the study flora ($A = 137$ taxa) and the 20 comparators with fully extractable checklists, ranked by Jaccard similarity

Comparator	Level	Bioclimatic zone	B (published)	B (harmonised)	C (shared)	J	S	Distance (km)
Senouci et al. (2019)	Algeria	Med/Tell	70	70	44	0.270	0.425	654
Zatout et al. (2021)	Algeria	Med/Tell	109	108	52	0.269	0.424	882
Miara et al. (2019)	Algeria	Med/Tell	83	83	45	0.257	0.409	317
Meddour et al. (2020)	Algeria	Med/Tell	80	79	44	0.256	0.407	366
Meddour and Meddour-Sahar (2015)	Algeria	Med/Tell	98	97	46	0.245	0.393	382
Bouasla and Bouasla (2017)	Algeria	Med/Tell	90	89	44	0.242	0.389	140
Boudjelal et al. (2013)	Algeria	Med/Tell	58	58	33	0.204	0.338	343
Kachmar et al. (2021)	Outside	Med/Tell	55	54	32	0.201	0.335	1140
Belhouala and Benarba (2021)	Algeria	Multiregional	167	167	49	0.192	0.322	n/a
Benarba (2016)	Algeria	Saharan	83	82	35	0.190	0.320	1147
Bensizerara et al. (2025)	Algeria	Med/Tell	158	157	46	0.185	0.313	140
Lahyaoui et al. (2025)	Outside	Med/Tell	51	50	27	0.169	0.289	1498
Toul et al. (2026)	Algeria	Saharan	99	98	25	0.119	0.213	1098
Karous et al. (2021)	Outside	Saharan	70	69	15	0.079	0.146	422
AbouZid and Mohamed (2011)	Outside	Saharan	48	48	12	0.069	0.130	2275
Ramdane et al. (2015)	Algeria	Saharan	31	31	5	0.031	0.060	1524
Muhakr et al. (2024)	Outside	Saharan	59	59	5	0.026	0.051	3006
Yebouk et al. (2020)	Outside	Saharan	68	66	5	0.025	0.049	2503
Issa et al. (2018)	Outside	Saharan	94	94	5	0.022	0.043	3430
Elharas and Ouhssine (2025)	Outside	Saharan	64	63	2	0.010	0.020	2433

B published = inventory size as printed in the source publication and in Tables 2 and 3; B harmonised = inventory size after synonym merging under POWO and WFO, which is the value used in $J = C/(A + B - C)$ and $S = 2C/(A + B)$. The two differ by one taxon in 11 comparators and by two in Yebouk et al. (2020), so that every coefficient in this table can be reproduced by hand from the harmonised column. Distances are great-circle distances from the centroid of the three study communes (36.28°N, 8.28°E); the multiregional national survey has no single centroid and is excluded from all distance analyses

J Jaccard index, S Sørensen–Dice coefficient, C number of taxa shared with the study inventory, *Med/Tell* Mediterranean/Tell and Atlas zone

everywhere. Split by bioclimatic zone, the decay disappears inside the Mediterranean/Tell group ($n = 10$, Spearman $r = -0.042$, $p = 0.907$) and is retained only within the Saharan/Sahelian group ($n = 9$, Spearman $r = -0.800$, $p = 0.010$). Individual comparators make the same point: Skikda at 140 km ($J = 0.242$) and Khenchela at 140 km ($J = 0.185$) are less similar to the study flora than Tlemcen at 882 km ($J = 0.269$) and Bissa/Dahra at 654 km ($J = 0.270$).

Bioclimate accounts for the pattern better than either distance or nationality. Comparators classified a priori as Mediterranean/Tell and Atlas are far more similar to the study flora than Saharan/Sahelian ones (median $J = 0.243$ versus 0.031, a 7.9-fold difference; $U = 88$, exact two-sided $p < 0.001$; rank-biserial correlation 0.956), zone alone explains more variance than distance ($R^2 = 0.766$ against 0.656), and the partial correlation of similarity with distance controlling for zone falls to $r = -0.574$ ($p = 0.013$). National affiliation is a poor predictor: the Moroccan Tell floras of Taza and Settat ($J = 0.201$ and 0.169) are more similar to Souk Ahras than the Algerian Saharan floras of Béchar and the Hoggar ($J = 0.119$ and 0.031), despite

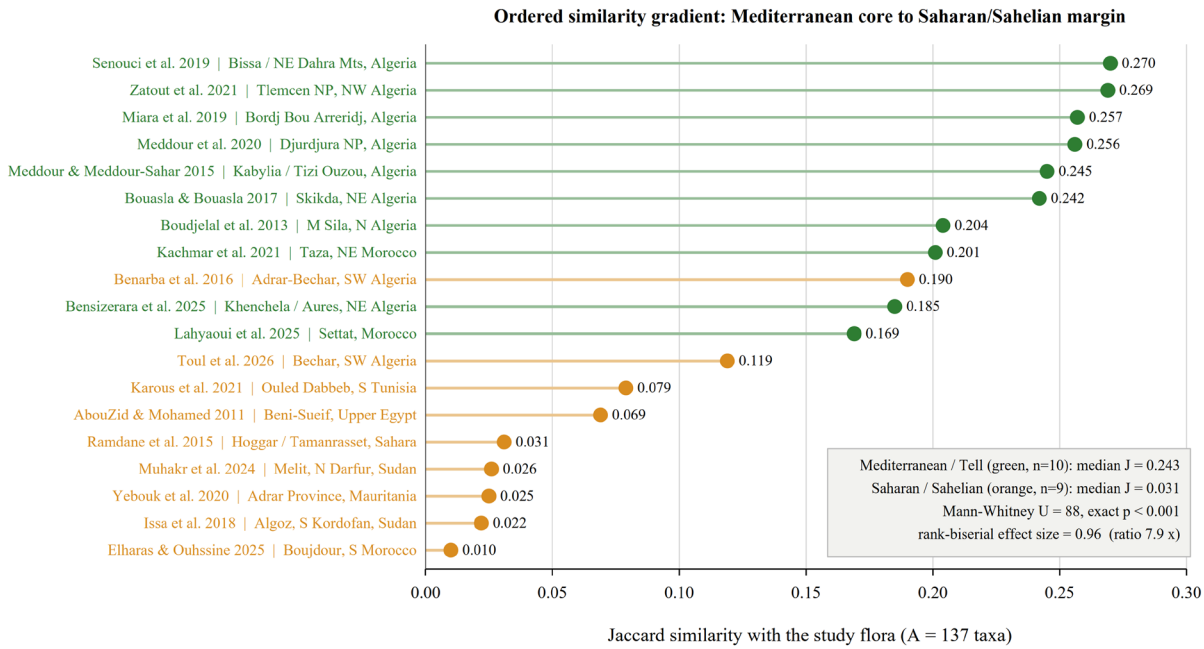

Fig. 8 Jaccard similarity between the study flora and each comparator, ranked and coloured by bioclimatic zone. The Mediterranean/Tell and Saharan/Sahelian groups separate almost perfectly, with only the Saharan margin of Algeria (Benarba 2016) intruding into the Mediterranean range

lying at comparable distances from the study area (1140–1498 km against 1098–1524 km).

The Kruskal–Wallis test on J across the four combinations of geographic level and bioclimatic zone confirms the contrast ($H = 14.56$, $df = 3$, $p = 0.002$). In Dunn's post hoc comparisons, the only difference that remains significant after Holm correction is that between Algerian Mediterranean/Tell comparators (median $J = 0.250$, $n = 8$) and Saharan/Sahelian comparators outside Algeria (median $J = 0.026$, $n = 6$; $z = 3.76$, adjusted $p = 0.001$), whereas neither Algerian and non-Algerian Mediterranean floras (median 0.250 versus 0.185; adjusted $p = 0.857$) nor Algerian and non-Algerian Saharan floras (0.119 versus 0.026; adjusted $p = 0.857$) differ significantly.

The redundancy analysis gives the same picture in multivariate form (Fig. 10). The three explanatory variables together account for 24.4% of the variation in the composition of the shared flora (adjusted $R^2 = 0.093$; $F = 1.61$, $p = 0.003$), and the first constrained axis (14.6% of the total variation) separates the Mediterranean/Tell from the Saharan/Sahelian comparators. Bioclimatic zone (adjusted $R^2 = 0.080$, $p < 0.001$) and log distance (adjusted $R^2 = 0.077$, $p < 0.001$) are each significant on their own, whereas comparator inventory size is not ($p = 0.208$). Variation partitioning shows that most of the variation explained by zone and distance is shared between them (adjusted $R^2 = 0.064$, against 0.016 for zone alone and 0.013 for distance alone), and neither remains significant once the other is controlled ($p = 0.110$ and $p = 0.086$). At the regional scale, therefore, bioclimate and distance cannot be separated in compositional terms, because the gradient from the Tell to the Sahara is also a gradient of distance from Souk Ahras. The evidence that bioclimate rather than distance organises the pattern comes from the analyses above: distance decay disappears within the Mediterranean group, and comparators at similar distances differ sharply across the bioclimatic boundary.

Finally, distance decay survives the change from a study-centric row to a full matrix. Across the 21 pairs formed by the seven digitised sites, Jaccard similarity declines with log distance (Mantel $r = -0.508$,

Table 8 Comparison of the dataset collected in the present study with previous ethnobotanical studies

Senouci et al. (2019) (Bissa/NE Dahra Mountains, Algeria)—44 shared

Ajuga iva, *Ammoides pusilla*, *Ampelodesmos mauritanicus*, *Arbutus unedo*, *Asphodelus ramosus*, *Atriplex halimus*, *Borago officinalis*, *Bunium bulbocastanum*, *Calendula arvensis*, *Capparis spinosa*, *Ceratonia siliqua*, *Cistus monspeliensis*, *Clinopodium nepeta*, *Cupressus sempervirens*, *Dittrichia viscosa*, *Erica arborea*, *Eucalyptus globulus*, *Ferula communis*, *Globularia alypum*, *Laurus nobilis*, *Lavandula stoechas*, *Malva sylvestris*, *Marrubium vulgare*, *Mentha pulegium*, *Myrtus communis*, *Olea europaea*, *Opuntia ficus-indica*, *Papaver rhoeas*, *Peganum harmala*, *Pinus halepensis*, *Pistacia lentiscus*, *Quercus ilex*, *Quercus suber*, *Rubus ulmifolius*, *Ruta chalepensis*, *Salvia officinalis*, *Salvia rosmarinus*, *Scolymus hispanicus*, *Silybum marianum*, *Taraxacum officinale*, *Teucrium polium*, *Thymus vulgaris*, *Urtica dioica*, *Ziziphus lotus*

Zatout et al. (2021) (Tlemcen National Park, NW Algeria)—52 shared

Ajuga iva, *Aloysia citrodora*, *Ammoides pusilla*, *Ampelodesmos mauritanicus*, *Anacyclus pyrethrum*, *Anchusa azurea*, *Arbutus unedo*, *Aristolochia fontanesii*, *Artemisia herba-alba*, *Asphodelus ramosus*, *Ceratonia siliqua*, *Cistus monspeliensis*, *Cistus salviifolius*, *Clinopodium nepeta*, *Crataegus monogyna*, *Cupressus sempervirens*, *Cynara cardunculus*, *Daphne gnidium*, *Dittrichia viscosa*, *Echinops bovei*, *Foeniculum vulgare*, *Globularia alypum*, *Herniaria hirsuta*, *Juniperus oxycedrus*, *Laurus nobilis*, *Lavandula stoechas*, *Mentha pulegium*, *Mentha spicata*, *Mentha suaveolens*, *Myrtus communis*, *Nerium oleander*, *Olea europaea*, *Opuntia ficus-indica*, *Origanum majorana*, *Papaver rhoeas*, *Peganum harmala*, *Phillyrea angustifolia*, *Pinus halepensis*, *Pistacia lentiscus*, *Plantago major*, *Quercus rotundifolia*, *Quercus suber*, *Rosa canina*, *Rubus ulmifolius*, *Salvia argentea*, *Salvia officinalis*, *Salvia rosmarinus*, *Scolymus hispanicus*, *Teucrium polium*, *Urtica urens*, *Verbascum sinuatum*, *Ziziphus lotus*

Miara et al. (2019) (Bordj Bou Arreridj highlands, Algeria)—45 shared

Ajuga iva, *Ampelodesmos mauritanicus*, *Artemisia absinthium*, *Artemisia herba-alba*, *Asphodelus ramosus*, *Atriplex halimus*, *Ceratonia siliqua*, *Chamaemelum nobile*, *Crataegus azarolus*, *Crataegus monogyna*, *Cynara cardunculus*, *Dittrichia viscosa*, *Eucalyptus globulus*, *Foeniculum vulgare*, *Globularia alypum*, *Juniperus oxycedrus*, *Juniperus phoenicea*, *Laurus nobilis*, *Lavandula stoechas*, *Malva sylvestris*, *Marrubium vulgare*, *Mentha pulegium*, *Mentha spicata*, *Nerium oleander*, *Olea europaea*, *Opuntia ficus-indica*, *Origanum vulgare*, *Papaver rhoeas*, *Peganum harmala*, *Petroselinum crispum*, *Pinus halepensis*, *Pistacia lentiscus*, *Quercus ilex*, *Rubus ulmifolius*, *Ruta chalepensis*, *Ruta montana*, *Spinacia oleracea*, *Tamarix africana*, *Teucrium polium*, *Thapsia garganica*, *Trigonella foenum-graecum*, *Urtica dioica*, *Urtica urens*, *Visnaga daucoides*, *Ziziphus lotus*

Meddour et al. (2020) (Djurdjura National Park, Algeria)—44 shared

Ajuga iva, *Allium ampeloprasum*, *Allium triquetrum*, *Apium graveolens*, *Arbutus unedo*, *Artemisia absinthium*, *Borago officinalis*, *Calicotome spinosa*, *Crataegus monogyna*, *Cydonia oblonga*, *Cynara cardunculus*, *Cynodon dactylon*, *Daphne gnidium*, *Dittrichia viscosa*, *Erica arborea*, *Eucalyptus globulus*, *Ferula communis*, *Foeniculum vulgare*, *Globularia alypum*, *Juniperus oxycedrus*, *Laurus nobilis*, *Lavandula stoechas*, *Lonicera etrusca*, *Marrubium vulgare*, *Melissa officinalis*, *Mentha pulegium*, *Mentha spicata*, *Mentha suaveolens*, *Nerium oleander*, *Ocimum basilicum*, *Olea europaea*, *Origanum vulgare*, *Papaver rhoeas*, *Petroselinum crispum*, *Pistacia lentiscus*, *Quercus ilex*, *Rosa canina*, *Rubus ulmifolius*, *Salvia rosmarinus*, *Sambucus nigra*, *Scolymus hispanicus*, *Teucrium polium*, *Thapsia garganica*, *Urtica dioica*

Meddour and Meddour-Sahar (2015) (Kabylia/Tizi Ouzou, Algeria)—46 shared

Ajuga iva, *Allium ampeloprasum*, *Allium triquetrum*, *Arbutus unedo*, *Artemisia absinthium*, *Borago officinalis*, *Calicotome spinosa*, *Capsella bursa-pastoris*, *Cistus salviifolius*, *Crataegus monogyna*, *Cynara cardunculus*, *Cynodon dactylon*, *Daphne gnidium*, *Dittrichia viscosa*, *Erica arborea*, *Eucalyptus globulus*, *Foeniculum vulgare*, *Globularia alypum*, *Laurus nobilis*, *Lavandula stoechas*, *Lonicera etrusca*, *Malva sylvestris*, *Marrubium vulgare*, *Melissa officinalis*, *Mentha pulegium*, *Mentha spicata*, *Mentha suaveolens*, *Myrtus communis*, *Nerium oleander*, *Olea europaea*, *Opuntia ficus-indica*, *Origanum vulgare*, *Papaver rhoeas*, *Pinus halepensis*, *Pistacia lentiscus*, *Quercus ilex*, *Rosa canina*, *Rubus ulmifolius*, *Ruta montana*, *Salvia rosmarinus*, *Sambucus nigra*, *Scolymus hispanicus*, *Teucrium polium*, *Thapsia garganica*, *Urtica dioica*, *Verbascum sinuatum*

Bouasla and Bouasla (2017) (Skikda, NE Algeria)—44 shared

Ajuga iva, *Allium ampeloprasum*, *Aloysia citrodora*, *Apium graveolens*, *Artemisia absinthium*, *Artemisia herba-alba*, *Asphodelus ramosus*, *Brassica oleracea*, *Camellia sinensis*, *Carthamus tinctorius*, *Ceratonia siliqua*, *Chamaemelum nobile*, *Cupressus sempervirens*, *Cydonia oblonga*, *Cynara cardunculus*, *Daucus carota*, *Dittrichia viscosa*, *Eucalyptus globulus*, *Foeniculum vulgare*, *Globularia alypum*, *Juniperus phoenicea*, *Laurus nobilis*, *Lavandula stoechas*, *Malva sylvestris*, *Melissa officinalis*, *Mentha pulegium*, *Myrtus communis*, *Nerium oleander*, *Olea europaea*, *Opuntia ficus-indica*, *Peganum harmala*, *Petroselinum crispum*, *Pinus halepensis*, *Pistacia lentiscus*, *Salvia officinalis*, *Salvia rosmarinus*, *Sinapis alba*, *Spergularia rubra*, *Teucrium polium*, *Thapsia garganica*, *Thymus vulgaris*, *Trigonella foenum-graecum*, *Urtica dioica*, *Visnaga daucoides*

Table 8 (continued)

Boudjelal et al. (2013) (M'Sila, northern Algeria)—33 shared

Ajuga iva, *Ampelodesmos mauritanicus*, *Anchusa azurea*, *Anethum graveolens*, *Artemisia absinthium*, *Artemisia herba-alba*, *Atriplex halimus*, *Chamaemelum nobile*, *Daphne gnidium*, *Eucalyptus globulus*, *Ferula communis*, *Globularia alypum*, *Juniperus oxycedrus*, *Juniperus phoenicea*, *Malva sylvestris*, *Marrubium vulgare*, *Mentha pulegium*, *Mentha suaveolens*, *Myrtus communis*, *Nerium oleander*, *Olea europaea*, *Origanum vulgare* subsp. *glandulosum*, *Peganum harmala*, *Ruta chalepensis*, *Salvia officinalis*, *Salvia rosmarinus*, *Spinacia oleracea*, *Tamarix africana*, *Taraxacum officinale*, *Teucrium polium*, *Thapsia garganica*, *Urtica dioica*, *Ziziphus lotus*

Belhouala and Benarba (2021) (multiregional Algeria: west, Kabylia, Sahara)—49 shared

Ajuga iva, *Ammoides pusilla*, *Anacyclus pyrethrum*, *Apium graveolens*, *Aristolochia fontanesii*, *Artemisia herba-alba*, *Atriplex halimus*, *Borago officinalis*, *Calendula arvensis*, *Camellia sinensis*, *Carthamus tinctorius*, *Ceratonia siliqua*, *Clinopodium nepeta*, *Crataegus azarolus*, *Cupressus sempervirens*, *Cydonia oblonga*, *Cynara cardunculus*, *Daphne gnidium*, *Dittrichia viscosa*, *Eucalyptus globulus*, *Foeniculum vulgare*, *Laurus nobilis*, *Lavandula angustifolia*, *Lavandula stoechas*, *Marrubium vulgare*, *Matricaria chamomilla*, *Melissa officinalis*, *Mentha pulegium*, *Mentha suaveolens*, *Myrtus communis*, *Nerium oleander*, *Ocimum basilicum*, *Olea europaea*, *Opuntia ficus-indica*, *Origanum majorana*, *Peganum harmala*, *Petroselinum crispum*, *Pistacia lentiscus*, *Ruta chalepensis*, *Salvia officinalis*, *Salvia rosmarinus*, *Silybum marianum*, *Taraxacum officinale*, *Teucrium polium*, *Thapsia garganica*, *Thymus vulgaris*, *Trigonella foenum-graecum*, *Urtica dioica*, *Verbascum sinuatum*

Benarba (2016) (Adrar–Béchar, SW Algeria)—35 shared

Ajuga iva, *Aloysia citrodora*, *Ammoides pusilla*, *Anacyclus pyrethrum*, *Artemisia absinthium*, *Artemisia herba-alba*, *Atriplex halimus*, *Borago officinalis*, *Chamaemelum nobile*, *Cupressus sempervirens*, *Daphne gnidium*, *Eucalyptus globulus*, *Ferula communis*, *Foeniculum vulgare*, *Globularia alypum*, *Juniperus phoenicea*, *Laurus nobilis*, *Lavandula stoechas*, *Marrubium vulgare*, *Mentha pulegium*, *Myrtus communis*, *Nerium oleander*, *Origanum majorana*, *Peganum harmala*, *Pinus halepensis*, *Pistacia lentiscus*, *Rosa canina*, *Ruta chalepensis*, *Salvia officinalis*, *Salvia rosmarinus*, *Teucrium polium*, *Thymus vulgaris*, *Trigonella foenum-graecum*, *Urtica dioica*, *Ziziphus lotus*

Bensizerara et al. 2025 (Khenchela/Aurès, NE Algeria)—46 shared

Agrimonia eupatoria, *Ajuga iva*, *Aloysia citrodora*, *Anethum graveolens*, *Apium graveolens*, *Artemisia absinthium*, *Artemisia herba-alba*, *Avena sativa*, *Capparis spinosa*, *Capsella bursa-pastoris*, *Ceratonia siliqua*, *Chamaemelum nobile*, *Clinopodium nepeta*, *Cupressus sempervirens*, *Cynara cardunculus*, *Eucalyptus globulus*, *Foeniculum vulgare*, *Globularia alypum*, *Juniperus oxycedrus*, *Laurus nobilis*, *Lavandula angustifolia*, *Malva sylvestris*, *Marrubium vulgare*, *Matricaria chamomilla*, *Melissa officinalis*, *Myrtus communis*, *Nerium oleander*, *Ocimum basilicum*, *Olea europaea*, *Opuntia ficus-indica*, *Origanum majorana*, *Papaver rhoeas*, *Peganum harmala*, *Petroselinum crispum*, *Pinus halepensis*, *Pistacia lentiscus*, *Salvia officinalis*, *Salvia rosmarinus*, *Silybum marianum*, *Smilax aspera*, *Taraxacum officinale*, *Teucrium polium*, *Thapsia garganica*, *Thymus vulgaris*, *Trigonella foenum-graecum*, *Visnaga daucoides*

Toul et al. (2026) (Béchar, SW Algeria)—25 shared

Ajuga iva, *Artemisia herba-alba*, *Atriplex halimus*, *Avena sativa*, *Carthamus tinctorius*, *Ceratonia siliqua*, *Chamaemelum nobile*, *Daphne gnidium*, *Daucus carota*, *Foeniculum vulgare*, *Lavandula angustifolia*, *Marrubium vulgare*, *Melissa officinalis*, *Mentha pulegium*, *Myrtus communis*, *Ocimum basilicum*, *Olea europaea*, *Origanum majorana*, *Origanum vulgare* subsp. *glandulosum*, *Peganum harmala*, *Pinus halepensis*, *Pistacia lentiscus*, *Salvia rosmarinus*, *Visnaga daucoides*, *Zea mays*

Ramdane et al. (2015) (Hoggar/Tamanrasset, Sahara)—5 shared

Atriplex halimus, *Capparis spinosa*, *Teucrium polium*, *Tribulus terrestris*, *Ziziphus lotus*

Kachmar et al. (2021) (Taza, NE Morocco)—32 shared

Ajuga iva, *Aloysia citrodora*, *Aristolochia fontanesii*, *Artemisia absinthium*, *Artemisia herba-alba*, *Capparis spinosa*, *Chamaeleon gummifer*, *Daphne gnidium*, *Dittrichia viscosa*, *Eucalyptus globulus*, *Foeniculum vulgare*, *Juniperus phoenicea*, *Laurus nobilis*, *Lavandula stoechas*, *Marrubium vulgare*, *Matricaria chamomilla*, *Mentha pulegium*, *Mentha spicata*, *Mentha suaveolens*, *Myrtus communis*, *Nerium oleander*, *Ocimum basilicum*, *Origanum majorana*, *Peganum harmala*, *Petroselinum crispum*, *Pistacia lentiscus*, *Salvia officinalis*, *Salvia rosmarinus*, *Thymus vulgaris*, *Trigonella foenum-graecum*, *Urtica dioica*, *Ziziphus lotus*

Lahyaoui et al. (2025) (Settat, Morocco)—27 shared

Ajuga iva, *Aloysia citrodora*, *Apium graveolens*, *Artemisia absinthium*, *Artemisia herba-alba*, *Ceratonia siliqua*, *Chamaemelum nobile*, *Lavandula angustifolia*, *Marrubium vulgare*, *Melissa officinalis*, *Mentha pulegium*, *Mentha spicata*, *Nerium oleander*, *Ocimum basilicum*, *Olea europaea*, *Origanum majorana*, *Origanum vulgare*, *Peganum harmala*, *Petroselinum crispum*, *Salvia officinalis*, *Salvia rosmarinus*, *Thymus vulgaris*, *Trigonella foenum-graecum*, *Urtica dioica*, *Urtica urens*, *Visnaga daucoides*, *Zea mays*

Table 8 (continued)

Karous et al. (2021) (Ouled Dabbeb, southern Tunisia)—15 shared

Ajuga iva, *Allium ampeloprasum*, *Atriplex halimus*, *Calicotome villosa*, *Capparis spinosa*, *Cynodon dactylon*, *Globularia alypum*, *Juniperus phoenicea*, *Mentha pulegium*, *Myrtus communis*, *Olea europaea*, *Peganum harmala*, *Ruta chalepensis*, *Trigonella foenum-graecum*, *Ziziphus lotus*

AbouZid and Mohamed (2011) (Beni-Suef, Upper Egypt)—12 shared

Artemisia herba-alba, *Camellia sinensis*, *Ceratonia siliqua*, *Foeniculum vulgare*, *Matricaria chamomilla*, *Origanum majorana*, *Petroselinum crispum*, *Salvia officinalis*, *Salvia rosmarinus*, *Thymus vulgaris*, *Trigonella foenum-graecum*, *Visnaga daucoides*

Muhakr et al. (2024) (Melit, North Darfur, western Sudan)—5 shared

Eucalyptus globulus, *Foeniculum vulgare*, *Ocimum basilicum*, *Tribulus terrestris*, *Trigonella foenum-graecum*

Yebouk et al. (2020) (Adrar Province, northern Mauritania)—5 shared

Mentha spicata, *Ocimum basilicum*, *Tribulus terrestris*, *Zea mays*, *Ziziphus lotus*

Issa et al. (2018) (Algoz, South Kordofan, Sudan)—5 shared

Mentha spicata, *Opuntia ficus-indica*, *Thymus vulgaris*, *Tribulus terrestris*, *Trigonella foenum-graecum*

Elharas and Ouhssine (2025) (Boujdour Province, southern Morocco)—2 shared

Atriplex halimus, *Teucrium polium*

Every count *C* in Table 7 equals the length of the corresponding list, so each coefficient is fully auditable

$p = 0.040$, 9999 permutations) and the Simpson overlap behaves the same way ($r = -0.559$, $p = 0.016$) (Table 9; Fig. 11). The most similar pair is not one involving the study area but the two Kabylian floras of Djurdjura and Tizi Ouzou, 32 km apart ($J = 0.290$), which is what a distance-structured regional flora predicts. With only seven sites the test has little power—a leave-one-site-out jackknife returns a negative coefficient in all seven runs but only two remain significant at the 5% level—so it corroborates the direction of the relationship rather than establishing it independently.

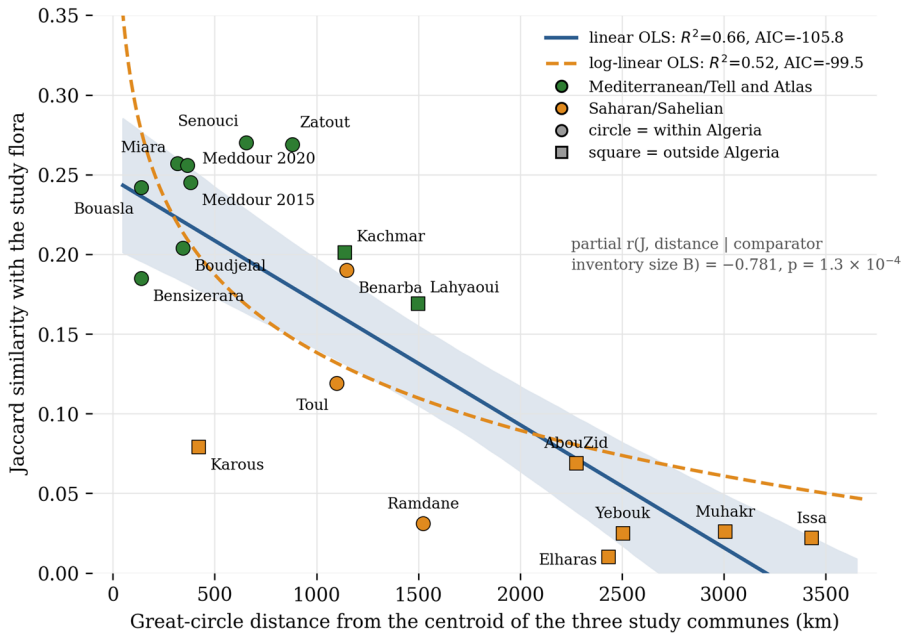

Fig. 9 Distance-decay of floristic similarity. Jaccard similarity with the study flora is plotted against great-circle distance from the centroid of the three study communes for the 19 georeferenced comparators, with the AIC-preferred linear fit, its 95% confidence band and the log-linear alternative. Circles are Algerian comparators, squares comparators from outside Algeria. The partial correlation controlling for comparator inventory size is given on the right

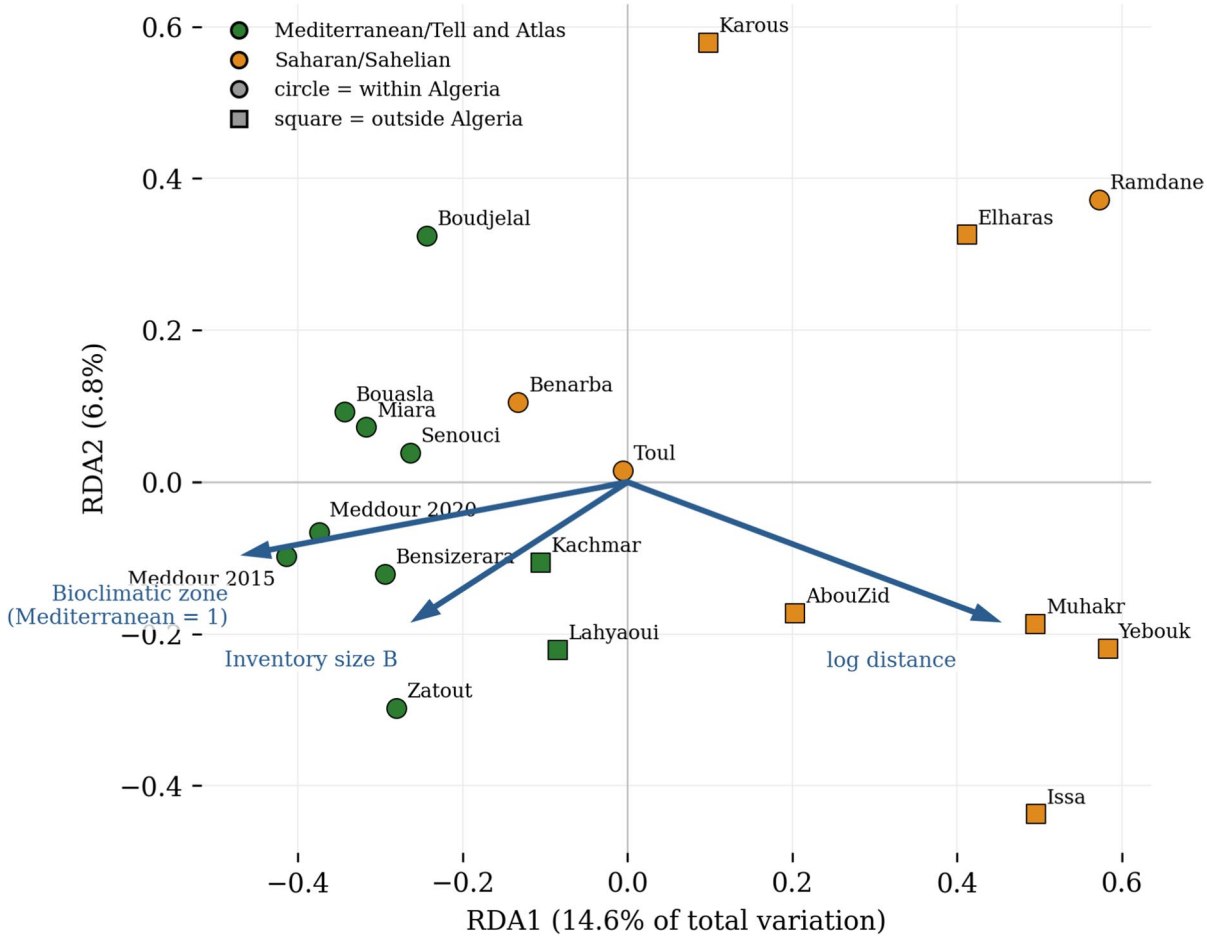

Fig. 10 Redundancy analysis (RDA) of the presence or absence of the 108 taxa of the study inventory recorded in at least one of the 19 georeferenced comparators (Hellinger-transformed), constrained by bioclimatic zone, log distance from the study area and comparator inventory size. Points are comparators (circles, Algeria; squares, outside Algeria; green, Mediterranean/Tell and Atlas; orange, Saharan/Sahelian); arrows show the correlations of the explanatory variables with the first two constrained axes. The model explains 24.4% of the total variation (adjusted $R^2 = 0.093$; permutation $p = 0.003$)

Discussion

A rich Mediterranean pharmacopoeia in an underdocumented corner of the Tell

With 137 taxa and 1838 use-reports the medicinal flora of Heddada, Khedara and Ouled Moumen is among the richest documented in Algeria, ranking 4th of 17 national and 6th of 31 North African datasets, above the third quartile but well within the regional range and below five comparators. Because that position is not explained by interview effort, it is best read as a well-sampled Mediterranean Maghreb assemblage rather than an exceptional case. Its richness is consistent with its setting: the eastern Tell around Souk Ahras receives 600–900 mm of rainfall, supports cork oak, holm oak and Aleppo pine woodlands with a rich Mediterranean shrub layer, and retains a largely rural, agro-pastoral population—three conditions that elsewhere in the Maghreb coincide with the richest local pharmacopoeias (Bellakhdar 1997; Bouasla and Bouasla 2017; Bensizerara et al. 2025). The persistence of a large wild-harvested component, of specialised handling of toxic taxa and of orchid tuber collection indicates that this is a living repertoire rather than a residue.

Table 9 Pairwise similarity matrix for the seven independently digitised sites (union scenario), ranked by decreasing Jaccard similarity

Site A	Site B	|A|	|B|	C	J	O	km
Djurdjura (Meddour et al. 2020)	Kabylia (Meddour and Meddour-Sahar 2015)	85	146	52	0.290	0.612	32
Souk Ahras (this study)	Djurdjura (Meddour et al. 2020)	137	85	42	0.233	0.494	366
Souk Ahras (this study)	B.B. Arreridj (Miara et al. 2019)	137	99	43	0.223	0.434	317
M'Sila (Boudjelal et al. 2013)	B.B. Arreridj (Miara et al. 2019)	57	99	28	0.219	0.491	46
Djurdjura (Meddour et al. 2020)	B.B. Arreridj (Miara et al. 2019)	85	99	33	0.218	0.388	66
B.B. Arreridj (Miara et al. 2019)	Adrar–Béchar (Benarba 2016)	99	86	29	0.186	0.337	900
Souk Ahras (this study)	Kabylia (Meddour and Meddour-Sahar 2015)	137	146	43	0.179	0.314	382
M'Sila (Boudjelal et al. 2013)	Adrar–Béchar (Benarba 2016)	57	86	20	0.163	0.351	856
Souk Ahras (this study)	M'Sila (Boudjelal et al. 2013)	137	57	27	0.162	0.474	343
Souk Ahras (this study)	Adrar–Béchar (Benarba 2016)	137	86	30	0.155	0.349	1147
Djurdjura (Meddour et al. 2020)	Adrar–Béchar (Benarba 2016)	85	86	23	0.155	0.271	903
Béchar (Toul et al. 2026)	Adrar–Béchar (Benarba 2016)	87	86	22	0.146	0.256	232
B.B. Arreridj (Miara et al. 2019)	Kabylia (Meddour and Meddour-Sahar 2015)	99	146	30	0.140	0.303	95
M'Sila (Boudjelal et al. 2013)	Djurdjura (Meddour et al. 2020)	57	85	15	0.118	0.263	89
Béchar (Toul et al. 2026)	B.B. Arreridj (Miara et al. 2019)	87	99	19	0.114	0.218	812
Béchar (Toul et al. 2026)	Djurdjura (Meddour et al. 2020)	87	85	16	0.103	0.188	799
Souk Ahras (this study)	Béchar (Toul et al. 2026)	137	87	20	0.098	0.230	1098
M'Sila (Boudjelal et al. 2013)	Béchar (Toul et al. 2026)	57	87	12	0.091	0.210	772
Kabylia (Meddour and Meddour-Sahar 2015)	Adrar–Béchar (Benarba 2016)	146	86	19	0.089	0.221	920
M'Sila (Boudjelal et al. 2013)	Kabylia (Meddour and Meddour-Sahar 2015)	57	146	14	0.074	0.246	121
Béchar (Toul et al. 2026)	Kabylia (Meddour and Meddour-Sahar 2015)	87	146	16	0.074	0.184	808

C = shared taxa after harmonisation; O = Simpson overlap $C/\min(|A|, |B|)$; J, Jaccard index; km, great-circle distance between locality centroids, the centroid of the three study communes being used for Souk Ahras. $|A|$ and $|B|$ are the sizes of the union-scenario checklists digitised independently from the primary sources for this matrix test; they differ from the published and harmonised inventory sizes given in Tables 2, 3 and 7, because the union scenario retains every name recoverable from the article, and the two sets of coefficients are therefore not interchangeable

A shared Maghreb medical culture

Lamiaceae prominence, leaf-based remedies and aqueous extraction recur across the comparator set, and the present inventory falls in the modal category of all three. This convergence is what one expects of a shared cultural-ecological tradition operating on a shared flora, and it justifies treating the region as a single comparative field rather than a collection of national literatures. It is not a trivial consequence of floristics alone. Lamiaceae are abundant in Mediterranean garrigue and matorral everywhere, yet the specific set of aromatic Lamiaceae that dominates Maghreb pharmacopoeias—*Ajuga iva* (*Chendgoura*), *Marrubium vulgare* (*Meriouet*), *Mentha pulegium* (*Fliou*), *Teucrium polium* (*Djaada*), *Thymus* spp. (*Zaatar*), *Salvia rosmarinus* (*Iklil el-jabal*) and *Origanum* spp.—is remarkably constant in its vernacular names and its therapeutic indications (digestive, antidiabetic, febrifuge) from the Rif to the Aurès, and many of those names are of Amazigh or dialectal Arabic origin shared across the Maghreb (Bellakhdar 1997; Chami and Side Larbi 2025). This indicates a common, largely oral layer of transmission that predates and underlies the learned Arab–Islamic tradition and that has been continuously reinforced by the mobility of pastoralists, pilgrims and herbalists (*Attarine*) whose stalls in Souk Ahras, Tunis, Constantine or Fez sell essentially the same dried material. The border location of the study area is relevant here: Heddada and Ouled Moumen lie within a few kilometres of Tunisia, and the herbal material circulating in the local markets is drawn from both sides of a frontier that is ecologically invisible. The prevalence of

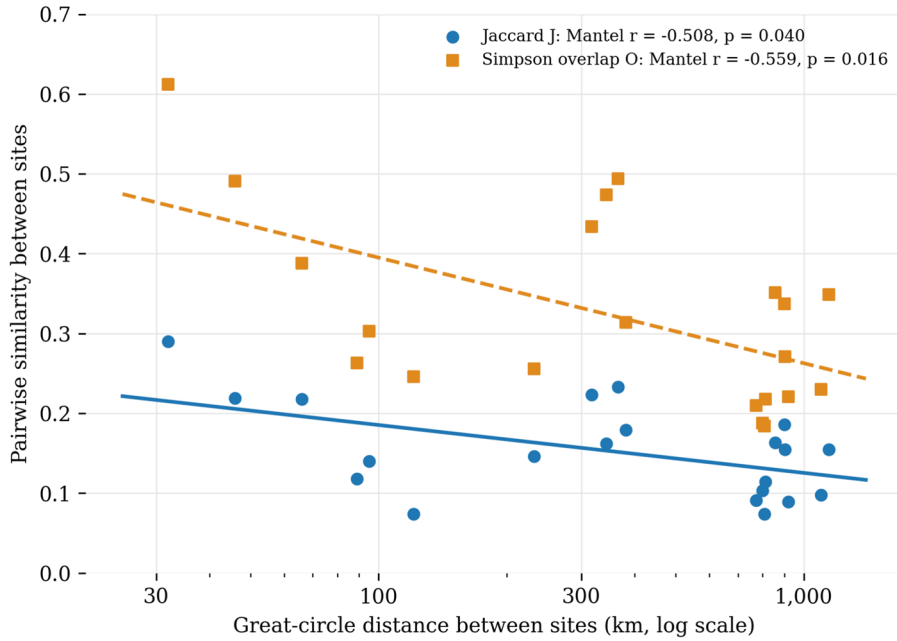

Fig. 11 Matrix-level verification of distance decay. Jaccard similarity (circles) and Simpson overlap (squares) are plotted against log geographic distance for all 21 pairs formed by the seven sites whose checklists were digitised from primary sources, under the union digitisation scenario, with the Mantel coefficient and permutation *p* value (9999 permutations) for each index. The corresponding pairwise values are given in Table 9

leaves and of simple aqueous preparations rather than compound remedies is likewise characteristic of a domestic, family-based medicine largely practised by women, a feature repeatedly documented in Algerian and Moroccan surveys (Benarba et al. 2015; Ouelbani et al. 2016; Kachmar et al. 2021).

Two layers of sharing: the traded and the wild

A second cultural stratum emerges at the southern and eastern margins of the comparison. The taxa that Souk Ahras still shares with Darfur, Kordofan, Mauritania and Upper Egypt (*Trigonella foenum-graecum*, *Ocimum basilicum*, *Mentha spicata*, *Foeniculum vulgare*, *Matricaria chamomilla*, *Origanum majorana*, *Salvia officinalis* L.) are not part of the local wild flora anywhere in that set; they are the cultivated or traded remedies of the Arab–Islamic and Prophetic medical tradition (Saad and Said 2011), which travel with the *Unani* pharmacopoeia and with trans-Saharan and Nilotic trade rather than with the landscape. The floristic overlap between Mediterranean and Saharan–Sahelian comparators therefore collapses precisely to the layer of the pharmacopoeia that is culturally rather than ecologically transmitted. Conversely, the wild-harvested core (*Pistacia lentiscus*, *Myrtus communis*, *Globularia alypum*, *Lavandula stoechas*, *Cistus* spp., *Quercus* spp., *Arbutus unedo*, *Daphne gnidium*, *Thapsia garganica*) is confined to the Mediterranean bioclimatic group. The comparison thus separates, empirically, a shared textual and mercantile tradition from a shared ecological one, a distinction that comparative ethnobotany has often argued for but rarely quantified across so wide a region (Leonti 2011; Leonti and Casu 2013).

Ecology, not national borders

Two analyses converge on an ecological rather than a national organisation of the flora: similarity separates almost perfectly by bioclimatic zone (rank-biserial 0.96) and declines with distance across the pooled comparator set, while within the Mediterranean/Tell group distance carries no signal at all. The redundancy analysis adds that, in compositional terms, bioclimate and distance are largely confounded at the regional scale, so that the ecological reading rests on the within-zone comparisons and on comparators at similar distances rather than on the ordination alone. The defensible reading is that the gradient from the Mediterranean Tell to the Sahara is the primary organiser of both the species pool and the associated knowledge, and that distance is informative mainly because it correlates with that gradient at the regional scale. This parallels findings from other regions in which environmental filtering of the available flora,

rather than cultural distance per se, drives differences between local medicinal floras (Saslis-Lagoudakis et al. 2014), and it echoes cross-border comparisons in south-eastern Europe and the Middle East where shared ecology and long-standing exchange have generated common regional repertoires despite ethnic and linguistic boundaries (Pieroni et al. 2014, 2015). It also has a practical consequence for how the literature of the region is synthesised: national reviews are indispensable bibliographic tools, but a synthesis that treats the Tell of Morocco, Algeria and Tunisia as one biocultural unit, and the Saharan margins of all three as another, would describe the underlying pattern far more faithfully.

What the comparison adds to the local inventory

The two-level comparison changes the reading of the local inventory in three ways. First, it sorts the 137 taxa along a gradient of sharing (Table 8). Eighteen taxa recur in ten or more of the 20 harmonised checklists—*Ajuga iva*, *Mentha pulegium* and *Salvia rosmarinus* in 13–14 of them, followed by *Olea europaea*, *Peganum harmala*, *Teucrium polium*, *Foeniculum vulgare*, *Eucalyptus globulus*, *Marrubium vulgare*, *Myrtus communis*, *Pistacia lentiscus*, *Artemisia herba-alba*, *Nerium oleander*, *Trigonella foenum-graecum*, *Globularia alypum*, *Laurus nobilis* L., *Salvia officinalis* and *Urtica dioica*—whereas 29 taxa (21%) are recorded in none of the 20 comparators and a further 14 in only one. The first tier is the aromatic matorral and household core discussed above; the second is dominated by meadow, wetland and ruderal plants of the humid Tell (*Heracleum sphondylium* L., *Lythrum salicaria* L., *Bellis perennis* L., *Lamium amplexicaule* L., *Fumaria officinalis*, *Populus alba* L., *Anacamptis morio*), by forest-edge taxa such as *Chamaeleon gummifer*, Phlomis herba-venti L. and Ephedra fragilis Desf.; and by a small set of weedy or feral crop relatives (*Brassica nigra*, *Medicago sativa*, *Trifolium pratense*, *Malva neglecta*, *Asparagus albus*). Local specificity therefore has an ecological signature of its own: it reflects the sub-humid, forested setting of the eastern Tell and the agro-pastoral use of its meadows and field margins, not cultural isolation.

Second, the comparison is asymmetric in an instructive way. Souk Ahras shares more taxa with Tlemcen, some 880 km to the west, than with Khenchela, 140 km to the south-west, and it resembles the Moroccan Tell more than the Algerian Sahara; yet within the Mediterranean group similarity is essentially flat with distance. What the Mediterranean Maghreb communities share is therefore not a gradient of neighbourly borrowing but a common pool drawn upon wherever the same vegetation occurs—the pattern expected where a body of knowledge has been stabilised over centuries by oral transmission within a shared landscape and by the circulation of dried material through regional markets, and the pattern that environmental-filtering models of medicinal-plant selection predict (Saslis-Lagoudakis et al. 2014).

Third, the comparison makes explicit what a presence–absence comparison cannot see. The coefficients compare which taxa are used, not how: a taxon shared across bioclimatic zones may be wild-harvested in one and purchased in another, and may serve different indications in each, so that the cultural distance between the Tell and the Sahara is certainly larger than the floristic one. A relevant ethnobotanical survey was conducted at Ouled Sedra, within the Kroumirie and close to the Algerian border (Jdaidi and Hasnaoui 2016). The study documented 24 medicinal plants, but its stated objective was to identify the most-used taxa and those subject to the greatest anthropogenic pressure, rather than to provide a comprehensive inventory of the local medicinal flora; it was therefore excluded from the richness and presence–absence comparisons, which require complete, non-selective species checklists. A cross-border survey there would test directly whether the locally exclusive tier of Souk Ahras is in fact a Tell-border repertoire shared across the frontier, and it is the most obvious next step of the comparative programme begun here.

Implications for plant genetic resources

The crop wild relatives of Table 6 are distributed across both tiers of sharing. The most frequently cited among them—*Trigonella foenum-graecum* (RFC 0.30), *Pistacia lentiscus* (0.28), *Olea europaea* (0.28), *Thymus vulgaris* (0.26), *Mentha pulegium* (0.19), *Ceratonia siliqua*, *Salvia rosmarinus* and *Ziziphus lotus* (0.17 each) and *Cynara cardunculus* (0.13)—belong to the shared Maghreb core, whereas *Brassica nigra*, *B. oleracea*, *Sinapis alba*, *Medicago sativa*,

Trifolium pratense, *Malva neglecta* and *Asparagus albus* are recorded in at most one other checklist. The overlap with the Saharan–Sahelian comparators involves the cultivated or traded forms of these taxa (fenugreek, fennel, basil, spearmint), not their wild populations. Three consequences follow for plant genetic resources.

First, the ethnobotanical use record is a direct measure of current harvesting pressure on, and of the cultural value of, wild CWR populations—information that the North African CWR checklists and prioritisation exercises for Tunisia, Morocco and the region as a whole (Lala et al. 2018; El Mokni et al. 2022; Labrighli et al. 2025) do not yet incorporate systematically, although the prioritisation frameworks from which they derive explicitly admit use value as a criterion (Maxted et al. 2006; Vincent et al. 2013). Table 4 supplies two variables that those frameworks lack. Frequency of citation ranks demand: eleven CWR or wild gene-pool taxa are cited by more than 15% of participants. The harvested organ ranks vulnerability: leaf, flower and fruit collection (*Olea europaea*, *Pistacia lentiscus*, *Thymus vulgaris*, *Mentha pulegium*, *Ceratonia siliqua*) is compatible with population persistence, whereas root, tuber and whole-plant harvest is not, and it concentrates on precisely the taxa that are already scarce: *Anacyclus pyrethrum*, whose roots are cited by 11% of participants and which is assessed as Vulnerable on the IUCN Red List because of root collection for trade (Rankou et al. 2015); *Bunium bulbocastanum* L., whose tubers (*Talghouda*) are dug up by 12.5% of participants; *Thapsia garganica* and *Scolymus hispanicus*, both root-harvested; and *Cynara cardunculus*, taken as leaves, aerial parts and whole plants. Combining the two variables yields a short, evidence-based list of CWR populations for which in situ monitoring in the study area is urgent, and the same procedure can be applied to any of the 20 comparators whose checklists were harmonised here.

Second, because the shared core is organised by bioclimatic zone and not by country, its in situ conservation value is regional rather than national. The wild olive, wild leek, wild cardoon and wild carrot of the Tell belong to the primary gene pools, in the sense of Harlan and de Wet (1971), of crops domesticated around the Mediterranean and in the Near East (Zohary et al. 2012), and Mediterranean and North African populations of such taxa remain under-represented in ex situ collections (Castañeda-Álvarez et al. 2016). Genetic-reserve networks for CWR in the Maghreb should therefore be designed along the Mediterranean-to-Saharan gradient, with sites in the Tell of all three central Maghreb countries treated as replicates of a single conservation unit and the semi-arid steppe and Saharan margins as distinct units in which a different, Fabaceae- and Asteraceae-rich set of wild useful plants is at stake. The cork oak forests and intact matorral of Souk Ahras, contiguous with the Kroumirie across the border, are a plausible location for such a reserve, and the use data presented here provide the baseline against which its effect on harvesting could be assessed.

Third, the medicinal use record is also a record of a food–medicine continuum. Wild leek, wild cardoon, golden thistle, mallows, *Bunium* tubers, wild asparagus, fennel, azarole, jujube and the fruits of *Arbutus unedo* are well-known wild food plants of the Maghreb as well as remedies, so that the populations at stake underpin the dietary diversity and the food sovereignty of the agro-pastoral households, while the pasture legumes (*Medicago sativa*, *Trifolium pratense*, *Bituminaria bituminosa* (L.) C.H.Stirt.) and the ethnoveterinary uses recorded in Table 5 tie the same flora to livestock health. Conserving these populations is therefore a matter of more-than-human health for the whole agro-pastoral system, not only of medicinal-plant supply.

Translating this into practice is a community-centred task rather than a regulatory one. The people who cited *Anacyclus pyrethrum* and *Bunium bulbocastanum* are the same shepherds and gatherers who know where the populations are; participatory monitoring of the root-harvested taxa, agreed with the local forest administration and with the communal assemblies that authorised this study, is the most realistic first step. Cultivation of the most heavily harvested root taxa in home gardens would relieve wild populations while keeping the plants and the associated knowledge in local hands; the intergenerational transmission that once took place through herding can be supported through school programmes and through the women who hold most of the domestic pharmacopoeia; and any benefit arising from the use of these genetic resources should return to the communes in accordance with the Nagoya Protocol. Because the resource is cross-border, Algerian and Tunisian forest services and communities on either

side of the Medjerda would be natural partners in such an initiative.

Limitations

The local dataset rests on a single fieldwork season and on purposive sampling, so rare or highly specialised knowledge held by a few practitioners may be under-represented; the use-reports were pooled at the level of the study area, so possible differences between the three communes could not be tested; a seasonal repeat and a market survey in Souk Ahras would complement it. The comparative part inherits the heterogeneity of its sources: comparator surveys differ in sampling design, in the completeness with which species lists are reported and in the taxonomic rigour of the original identifications, and harmonisation against POWO and WFO removes nomenclatural but not identification error. Coefficients were computed only for the 20 comparators whose checklists could be fully recovered, and the seven-site matrix test has low power. Bioclimatic classification was binary, whereas the Tell-to-Sahara gradient is continuous; moreover, the redundancy analysis could use only the taxa of the study inventory, because complete checklists could not be assembled for all comparators, and a full comparator-by-comparator matrix with continuous climatic variables would be needed to separate bioclimate from distance. Finally, the comparison is floristic: it compares which species are used, not how they are used, and a use-level comparison across the same comparator set remains an obvious next step, for which the detailed use-reports presented in Table 4 provide the material on the Algerian side. The assignment of taxa to crop wild relative categories in Table 6 is genus-based and does not distinguish gene-pool levels; a taxon-by-taxon assessment against the North African CWR checklists would refine it.

Conclusions

The rural communes of Heddada, Khedara and Ouled Moumen retain a living medicinal flora of 137 taxa in 49 families, documented here through 1838 use-reports from 200 members of agro-pastoral households: a repertoire dominated by Asteraceae and Lamiaceae, built on leaves and on aqueous preparations, and drawn overwhelmingly from the wild forest and matorral of the eastern Tell. Benchmarked against 30 comprehensive surveys at two nested geographic levels, that repertoire proves to be a representative, well-sampled member of the Mediterranean Maghreb pattern rather than an outlier, and its floristic affinities are organised by ecology rather than by nationality: bioclimatic zone separates Mediterranean from Saharan comparators by a factor of 7.9 in similarity, whereas national borders do not. The overlap that survives across the bioclimatic boundary is confined to cultivated and traded remedies of the Arab–Islamic medical tradition, whereas the wild-harvested core—rich in crop wild relatives and in the wild gene pools of medicinal and aromatic crops—is a Mediterranean Maghreb heritage shared across three countries. Local specificity is real but bounded, and the conservation of the wild populations that sustain this pharmacopoeia is a cross-border task in which the communities documented here are the first stakeholders. The use-reports assembled here—frequency of citation, harvested organ and mode of preparation for each taxon—supply precisely the use-weighted evidence that North African crop wild relative prioritisation has so far lacked, and they single out a short list of intensively harvested, root-collected taxa for which monitoring is urgent.

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Data availability The datasets generated and analysed during the current study are available from the first author on reasonable request, together with the Python (NumPy and SciPy) scripts that reproduce all statistics reported here.

Declarations

Conflict of interest The authors declare no competing interests.

Consent for publication Not applicable.

Ethics approval and consent to participate This study did not require formal approval from an institutional ethics committee, as no such authorisation is mandated under Algerian regulations for non-invasive ethnobotanical surveys involving traditional knowledge. The research was conducted in accordance with the Code of Ethics of the International Society of Ethnobiology (2006, with 2008 additions). Prior informed consent was obtained verbally from all participants before each interview, after the aims and scope of the study had been explained; participation was voluntary and anonymous, and no personal identifiers were recorded. Authorisation to conduct the fieldwork was obtained from the local authorities (the Popular Communal Assemblies) of the three communes of Heddada, Khedara and Ouled Moumen.

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