Medicinal plants used in the treatment of asthma in western Algeria: an ethnobotanical survey in Sidi Bel Abbès, Oran, and Mascara

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Research

Abstract

Background: Respiratory diseases, particularly asthma, remain a significant public health challenge worldwide. In Algeria, they rank among the leading causes of medical consultations. While modern medicine offers symptomatic treatments, their limitations and adverse effects drive many communities toward herbal remedies. In this context, documenting traditional knowledge of plant use for respiratory disorders is essential for pharmacological innovation. This study aimed to document traditional knowledge on the use of medicinal plants for respiratory diseases, with a particular focus on asthma, in the regions of Sidi Bel Abbès, Oran, and Mascara in western Algeria.

Methods: An ethnobotanical survey was carried out from October to December 2024 among 400 randomly selected informants. Data were collected using semi-structured interviews and free-listing techniques regarding species used, plant parts, and preparation methods. Botanical identification was performed using reference literature and recognized plant databases, and were validated by taxonomic specialists. Relative Frequency of Citation (RFC) and Therapeutic Use Value (UV) indices were calculated.

Results: A total of 73 species across 36 botanical families were recorded. The most frequently cited species were *Salvia argentea L.*, *Lepidium sativum L.,* and *Origanum vulgare L.*, primarily prepared as infusions or decoctions. Leaves were the most commonly used plant part, and the Lamiaceae family was predominant. Several previously undocumented uses were reported, reflecting a rich and dynamic traditional knowledge system.

Conclusion: This study confirms the continued use of several well-known medicinal plants for asthma management while documenting additional species and practices previously unreported in western Algeria. These findings not only reinforce the cultural and therapeutic significance of traditional knowledge but also offer valuable insights for future pharmacological investigations.

Keywords: Ethnobotanical survey; Asthma management; Medicinal plants; respiratory diseases; Traditional knowledge; Western Algeria; UV; RFC.

Background

Asthma is a chronic inflammatory disease of the respiratory system, characterized by airway hyperresponsiveness, reversible obstruction, and recurrent episodes of wheezing, coughing, and breathlessness (Braunwalder *et al.* 2025; GINA 2023). Despite advances in pharmacological management, including inhaled corticosteroids and β2-agonists, asthma remains a major global health concern, affecting over 260 million people worldwide and causing nearly 500,000 deaths annually (WHO 2022). In North Africa, epidemiological data on asthma are scarce and often outdated, which limits accurate assessment of its burden. Nevertheless, a multicenter study conducted in 2009 estimated asthma prevalence to range between 3% and 12% across the region (Nafti *et al*. 2009).

In many low- and middle-income countries, limited access to conventional treatments, coupled with strong cultural traditions, encourage populations to rely on medicinal plants as primary remedies for asthma and other respiratory disorders (Bussmann & Sharon 2021; Kalaci *et al.* 2019; Rajizadeh *et al.* 2024). Such remedies are often perceived as affordable, accessible, and culturally acceptable. Recent reviews have highlighted more than 50 plant species and over 30 bioactive compounds with antiasthmatic effects, including anti-inflammatory, bronchodilatory, and immunomodulatory properties (Rajizadeh *et al.* 2024). Moreover, both preclinical and clinical studies have validated the therapeutic potential of several traditionally used taxa (Alshammari *et al.* 2023; Chen *et al.* 2022). However, issues of safety, dosage variability, and lack of pharmacovigilance remain major challenges requiring careful evaluation (Ekor 2014).

In Algeria, medicinal plants are an integral component of primary healthcare and are widely employed against respiratory conditions. Previous ethnobotanical surveys have reported their frequent use in different parts of the country (Benarba *et al.* 2015; Bouras *et al.* 2025; Dihia & Belaid 2023; Salhi *et al.* 2010). Nevertheless, available data remain fragmented, geographically restricted, and in many cases outdated.

Algeria's diverse geography and Mediterranean climate support a rich flora of more than 4,000 vascular plant species, offering substantial potential for use in traditional medicine (Azzi *et al.* 2012; Hamel *et al.* 2018; Samir *et al.* 2023). The studied regions, situated at the crossroads of Berber and Arab cultural traditions, preserve a wealth of empirical knowledge which remains underexplored. The present study was therefore undertaken to document and analyze the use of medicinal plants for asthma in western Algeria, specifically in the wilayas of Sidi Bel Abbès, Oran, and Mascara. By doing so, it aims to contribute to the preservation of ethnobotanical heritage and provide a foundation for future pharmacological and clinical validation.

Materials and Methods

Study area

This ethnobotanical survey was carried out in three wilayas (provinces) of western Algeria: Sidi Bel Abbès, Oran, and Mascara (Fig. 1). These regions exhibit notable biogeographic diversity, encompassing rural, peri-urban, and urban environments with varying degrees of healthcare access. The Mediterranean climate, combined with diverse geomorphological features, supports a rich and diverse medicinal flora.

Ethnobotanical survey and ethical considerations

Fieldwork was conducted from October to December 2024. A total of 400 informants were randomly selected, with priority given to individuals with traditional knowledge of medicinal plants. Data collection employed a structured questionnaire administered through face-to-face interviews, conducted in Arabic or French according to participants' linguistic and cultural preferences. No time constraints were imposed, which ensured spontaneous and accurate responses.
The questionnaire consisted of two sections:

1.Sociodemographic information: age, gender, education level, and marital status.
2.Medicinal plant uses for asthma and respiratory disorders: vernacular names, plant parts used, preparation methods.

Botanical identification

Plant specimens were identified primarily by the authors, all of whom possess expertise in botany and taxonomy. The identification process was supported by specialized botanical literature and confirmed by other university botanists and traditional herbalists. Scientific names were verified using authoritative databases such as Plants of the World Online (POWO), The Plant List, and the African Plant Database. Voucher specimens of freshly collected species were deposited in the herbarium of the Eco-Development of Spaces Research Laboratory, faculty of natural and life sciences, Djilali Liabès

University, Sidi Bel Abbès. Vernacular names were cross-checked using classical references, including “Répertoire des noms des plantes du Maghreb” (Louis Trabut, reissued by Rebahi 2015) and “Contribution à l’étude de la pharmacopée traditionnelle au Maroc” (Bellakhdar 1997).

Figure 1. Location of the cities of Sidi Bel Abbès, Oran, and Mascara in Algeria

Cultural importance indices

Two ethnobotanical indices were calculated:

Relative Frequency of Citation (RFC):

$$RFC = (\text{Number of informants mentioning the use of species}) / (\text{total number of informants})$$

RFC values range from 0 to 1 and reflect the relative cultural importance of each species (Leonti 2022).

Use Value (UV):

$$UV = (\text{total number of use-reports across all use-categories for species}) / (\text{total number of informants})$$

UV provides an estimate of the versatility and significance of each species within the local pharmacopoeia (Leonti 2022).

Statistical analysis

Data were analyzed using descriptive statistics with Microsoft Excel 2016. Multivariate analyses, including Principal component analysis (PCA) and Correspondence Analysis (CA), were performed with PAST software (V4.03) to explore relationships between variables.

Results and discussion

Socio-demographic profile of respondents

A total of 400 respondents participated, representing diverse ages, educational levels, and social backgrounds (Table 1). Women formed the majority, emphasizing their central role in family healthcare and the transmission of medicinal knowledge (Belhacini *et al*. 2024; Gherib *et al*. 2024; Mohammadi *et al*. 2023). Adults aged 40-60 were the largest group, followed by elders (≥60) and young adults (20-40), reflecting both preservation and intergenerational transfer of ethnobotanical knowledge. Married participants predominated, likely due to greater involvement in household healthcare (Belhouala *et al.* 2021; Haba *et al*. 2023; Prinsloo *et al*. 2023). Most informants had formal education, with university and secondary graduates comprising the majority, suggesting that medicinal plant knowledge spans all social strata (Bouras *et al.* 2025; da Silva *et al*. 2024; Rahim *et al*.2023).

Table 1. Sociodemographic characteristics of respondents interviewed in Sidi Bel Abbès, Oran, and Mascara

	Oran	Sidi bel Abbes	Mascara	Total	Proportion %
Number	150	150	100	**400**	
Age					
20-40	41	38	25	**104**	**26**
40-60	70	76	50	**196**	**49**
60-80	35	34	23	**92**	**23**
80-100	4	2	2	**8**	**2**
Sexe					
Male	40	42	32	**114**	**29**
Female	110	108	68	**286**	**71**
Marital status					
Single	55	61	42	**158**	**40**
Married	95	89	58	**242**	**60**
Educational level					
Illiterate	8	9	7	**24**	**6**
Primary school	15	19	14	**48**	**12**
Secondary school	41	39	32	**112**	**28**
University	86	83	47	**216**	**54**

Principal component analysis (PCA) between socio-demographic variables and the level of ethnobotanical knowledge

In this study, ethnobotanical knowledge was assessed using the number of citations of plant parts and preparation methods. A principal component analysis was conducted to examine how these indicators were distributed across socio-demographic groups. The first principal component (PC1) accounted for 99.39% of the total variance, indicating that most of the variability in the dataset is explained along this dimension. Given the negligible contribution of the subsequent axes, the interpretation was focused on PC1 (Fig 2).

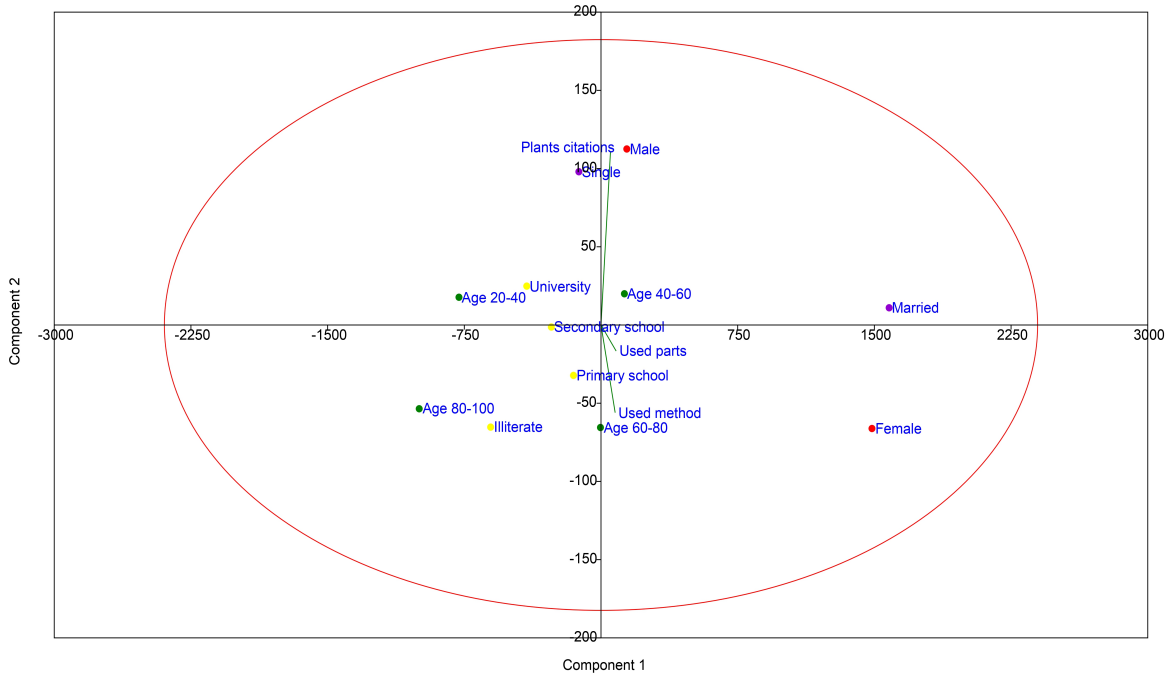

Figure 2. Principal component analysis of socio-demographic variables and ethnobotanical knowledge related to asthma

Long PC1, women clustered strongly on the positive side, confirming their dominant role as custodians and transmitters of ethnobotanical knowledge related to asthma. This trend was particularly evident among married informants, who also aligned positively, suggesting that marital responsibilities enhance engagement in healthcare practices. Men, although not strongly separated, were positioned close to the Y-axis and slightly on the positive side, reflecting a moderate contribution. However, their knowledge was often less detailed, as they tended to cite plant species without systematically specifying the plant parts or preparation methods.

Age was another structuring variable: informants aged 40-60 years and 60-80 years showed the highest positive coordinates, indicating that these groups hold the most comprehensive knowledge. Younger participants (20-40 years) clustered negatively, reflecting reduced reliance on traditional practices, while the small number of very elderly informants (≥80 years) explains their weaker contribution to the overall analysis.

Educational level followed a consistent gradient: illiterate and primary-level informants were placed positively, demonstrating richer and more detailed citations of plant uses, whereas respondents with secondary or university education shifted toward the negative side, highlighting the erosion of traditional knowledge with higher formal schooling.

Overall, the PCA revealed that ethnobotanical knowledge related to asthma is unevenly distributed, being particularly concentrated among women, married individuals, and middle-aged to older informants with lower educational levels. These findings are consistent with previous reports indicating that traditional knowledge is predominantly transmitted through women and tends to decline among younger, urbanized, and more educated generations (Benamar *et al*.2023; Dahmane *et al*. 2023; Jan *et al*. 2023; Jeddi *et al*.2024; Sharafatmandrad & Khosravi Mashizi .2020).

Diversity of medicinal plant species

Seventy-three medicinal plant species belonging to 36 families were documented (Table 2), including 38 natives, 12 introduced, and 23 imported species (Fig. 3). Lamiaceae was the most frequently represented family (14 species), followed by Apiaceae, Asteraceae, and Fabaceae (Fig. 4), consistent with Mediterranean ethnobotanical patterns (Benarba *et al*. 2015; Bensizerara *et al*. 2025; Senoussi *et al*. 2021; Sharafatmandrad & Khosravi Mashizi 2020; Zouaoui *et al*. 2020). The predominance of native species highlights reliance on local biodiversity, while introduced taxa reflect cultural and trade influences.

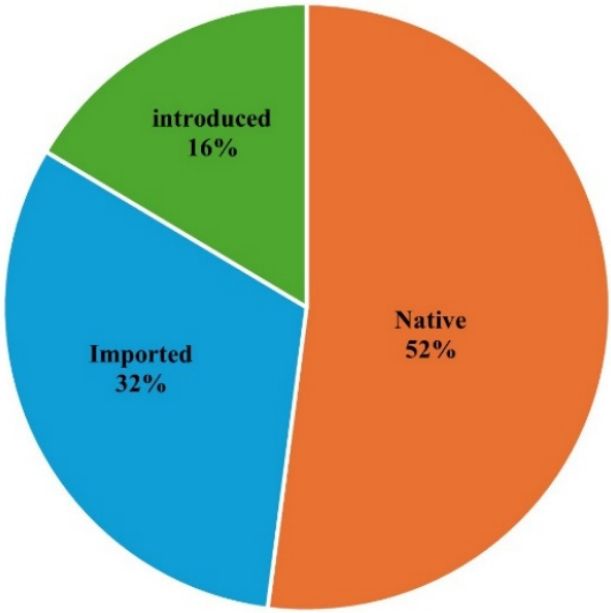

Figure 3. Distribution of native, introduced, and imported species

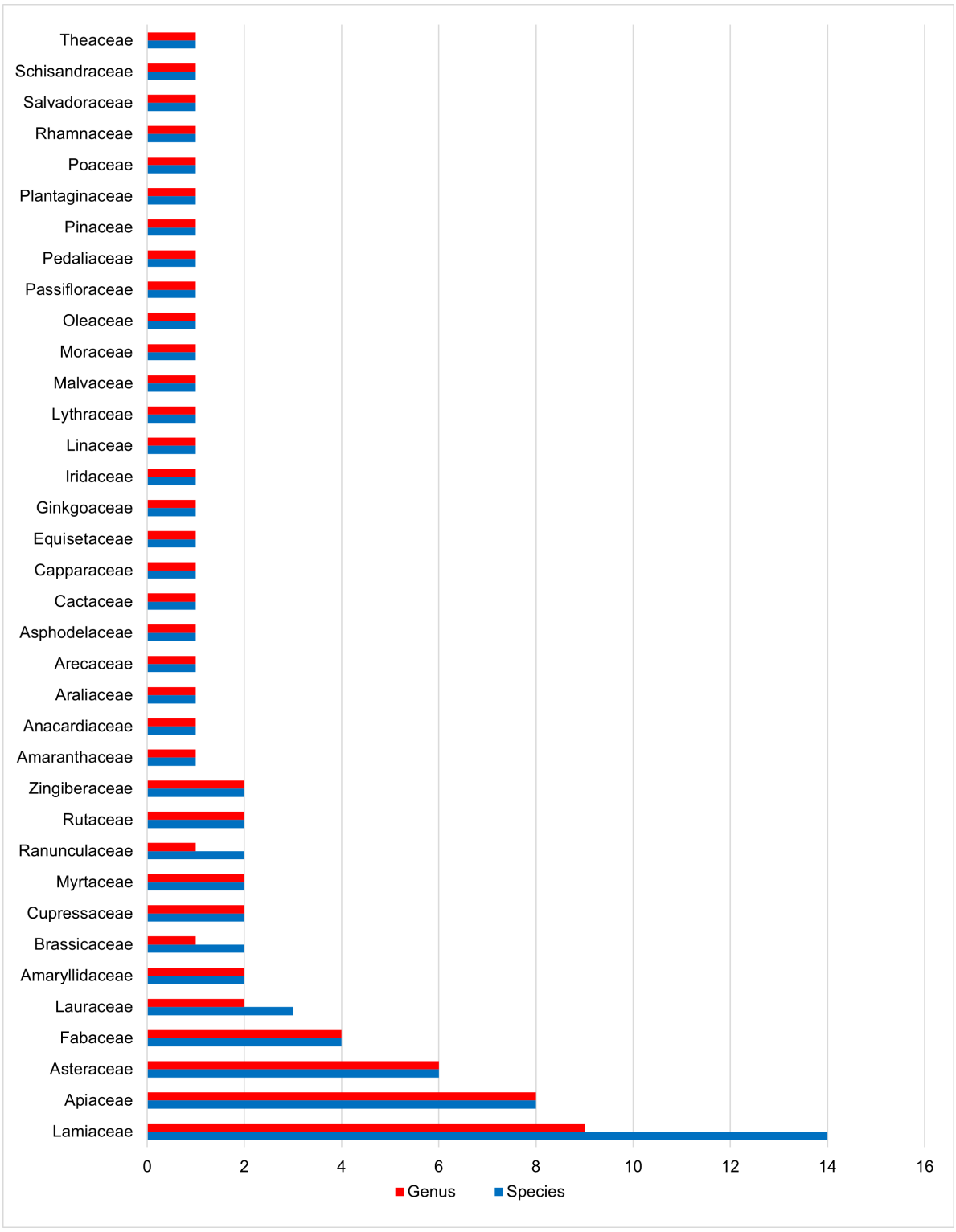

Figure 4. Botanical families and genera of plants used in the treatment of asthma in Western Algeria

Table 2. Ethnomedicinal data of medicinal plant species used for asthma treatment in the regions of Sidi Bel Abbès, Oran, and Mascara (Western Algeria).

No.	Scientific name Family	Local name	Part used (%)	Use method (%)	Specimen	UV	RFC
1	*Salvia argentea* L. Lamiaceae	***فراش الندى*** ***Furāsh an-nadā***	Leaves (90%), Roots (10%)	Infusion (80%) D.consumption (14%) Decoction (6%)	H-ECODEV-037	0,500	0,500
2	*Lepidium sativum* L. ** Brassicaceae	***حب الرشاد/حرف*** ***Horf / Hab rachad***	Seeds (100%)	D.consumption (69%) Decoction (17%) Infusion (14%)		0,400	0,400
3	*Origanum vulgare* L. Lamiaceae	***زعتر*** ***Zaatar***	Leaves (85%) Aerial part (15%)	Infusion (84%) Decoction (11%) Inhalation (5%)	H-ECODEV-011	0,390	0,390
4	*Nigella arvensis* L. ** Ranunculaceae	**حبة البركة** ***Habat el baraka***	Seeds (100%)	Decoction (69%) D.consumption (21%) Infusion (10%)		0,300	0,300
5	*Syzygium aromaticum* L. Merr. & L.M. Perry ** Myrtaceae	**قرنفل** ***Kronfol***	Buds (100%)	Infusion (58%) D.consumption (23%) Decoction (10%) Poultice (5%) Inhalation (2%) Maceration (2%)		0,275	0,275
6	*Glycyrrhiza glabra* L.** Fabaceae	**عرق السوس** ***Areq souss***	Stem (100%)	Decoction (60%) Infusion (20%) D.consumption (20%)		0,272	0,273
7	*Juniperus phoenicea* L. Cupressaceae	**عرعار** ***Arʿār***	Leaves (72%) Cones (28%)	Decoction (71%) Infusion (12%) D.consumption (8%) Inhalation (7%) Poultice (2%)	H-ECODEV-029	0,237	0,238
8	*Allium cepa* L. * Amaryllidaceae	**بصل** ***Bssal***	Bulb (100%)	D.consumption (63%) Decoction (26%) Infusion (7%) Inhalation (4%)	H-ECODEV-006	0,187	0,188
9	*Bunium pachypodum* Coss. & Durieu Apiaceae	***تالغودة*** ***Talrhouda***	Roots (100%)	Decoction (60%) D.consumption (33%) Infusion (7%)	H-ECODEV-045	0,175	0,175
10	*Eucalyptus globulus* Labill.* Myrtaceae	**كاليتوس** ***Kalitous***	Leaves (100%)	Inhalation (65%) Infusion (30%) Decoction (5%)	H-ECODEV-019	0,175	0,175

11	*Allium Sativum* L. * Amaryllidaceae	ثوم ***Thoum***	Bulb (100%)	D.consumption (79%) Infusion (20%) Poultice (1%)	H-ECODEV-002	0,175	0,175
12	*Vicia faba* L. * Fabaceae	فول ***Foul***	Seeds (50%) Fruits (50%)	D.consumption (86%) Decoction (14%)	H-ECODEV-041	0,167	0,168
13	*Saussurea costus* (Falc.) Lipsch.** Asteraceae	قسط هندي ***kast henndi***	Roots (100%)	Infusion (45%) Decoction (24%) Inhalation (16%) D.consumption (15%)		0,165	0,165
14	*Pinus halepsensis* Mill. Pinaceae	صنوبر /تايدة ***Teida / Sanoubar***	Seeds (41%) Bark (32%) Leaves (27%)	Decoction (70%) D.consumption (24%) Inhalation (5%) Rubbing (1%)	H-ECODEV-009	0,162	0,163
15	*Acacia senegalensis*(Willd.) Willd. Fabaceae	علك الطلح ***Alk el talh***	Resin (100%)	D.consumption (100%)	H-ECODEV-028	0,162	0,163
16	*Pistacia lentiscus* L. Anacardiaceae	ضرو ***Darw***	Leaves (100%)	Infusion (66%) Decoction (28%) Maceration (2%) D.consumption (3%) Poultice (1%)	H-ECODEV-014	0,150	0,150
17	*Artemisia herba alba* Asso. Asteraceae	شيح ***Chih***	Leaves (75%) Aerial part (25%)	Infusion (76%) Decoction (17%) D.consumption (3%) Inhalation (3%) Maceration (1%)	H-ECODEV-043	0,140	0,140
18	*Salvia rosmarinus* Spenn. Lamiaceae	أكليل الجبل/ يازير ***Iklil el-jabal / Yazir***	Leaves (85%) Aerial part (15%)	Infusion (79%) Decoction (11%) D.consumption (6%) Inhalation (3%) Poultice (1%)	H-ECODEV-035	0,137	0,138
19	*Citrus limon* Osbeck * Rutaceae	ليمون ***Laymoun***	Fruits (100%)	D.consumption (72%) Infusion (21%) Decoction (4%) Maceration (3%)	H-ECODEV-013	0,137	0,138
20	*Ammoides pusilla*(Brot.) Breistr. Apiaceae	نوخة ***Noukha***	Aerial part (100%)	Infusion (80%) Decoction (14%) Inhalation (5%) D.consumption (1%)	H-ECODEV-008	0,130	0,130
21	*Matricaria chamomilla* L. Asteraceae	بابونج ***Baboundj***	Flowers (85%) Leaves (15%)	Infusion (90%) Decoction (4%)	H-ECODEV-030	0,112	0,113

				Inhalation (3%) D.consumption (3%)			
22	*Salvia officinalis* L. Lamiaceae	مريمية ***Marimiyya***	Leaves (90%) Aerial part (10%)	Infusion (86%) Inhalation (5%) Decoction (4%) D.consumption (5%)	H-ECODEV-047	0,112	0,113
23	*Linum usitatissimum* L. ** Linaceae	زريعة الكتان ***Zriʿat el-Kittān***	Seeds (100%)	Infusion (75%) D.consumption (25%)		0,090	0,090
24	*Nigella sativa* L. ** Ranunculaceae	حبة السوداء/سانوج ***Sanoudj / Haba sawda***	Seeds (100%)	D.consumption (66%) Infusion (20%) Inhalation (14%)		0,087	0,088
25	*Zingiber officinale* Roscoe ** Zingiberaceae	زنجبيل ***Zendjabil***	Rhizome (100%)	Infusion (70%) D.consumption (22%) Decoction (8%)		0,075	0,075
26	*Lavandula dentata* L. Lamiaceae	حلحال ***Halhal***	Leaves (80%) Stem (10%) Flowers (10%)	Infusion (77%) Decoction (15%) Inhalation (5%) D.consumption (3%)	H-ECODEV-017	0,070	0,070
27	*Phoenix dactylifera* L. Arecaceae	تمر/نخل ***Nakhl / Tmar***	Fruits (91%) Seeds (9%)	D.consumption (81%) Infusion (15%) Decoction (4%)	H-ECODEV-026	0,067	0,068
28	*Cupressus sempervirens* L. * Cupressaceae	سرو **Sarou,**	Seeds (50%) Leaves (50%)	Decoction (100%)	H-ECODEV-003	0,060	0,060
29	*Lavandula stoechas* L. Lamiaceae	خزامة ***Khezzama***	Leaves (64%) Flowers (28%) Aerial part (8%)	Infusion (86%) Decoction (14%)	H-ECODEV-034	0,052	0,053
30	*Origanum majorana* L. Lamiaceae	بردقوش ***Bardaqūsh***	Leaves (100%)	Infusion (70%) Decoction (30%)	H-ECODEV-020	0,050	0,050
31	*Pimpinella anisum* L. ** Apiaceae	يانسون/حبة حلاوة ***Habbat ḥalāwa / Yansoun***	Seeds (100%)	Decoction (80%) Infusion (15%) D.consumption (5%)		0,050	0,050
32	*Cinnamomum verum* J. Presl ** Lauraceae	قرفة ***Karfa***	Bark (100%)	Decoction (69%) D.consumption (19%) Infusion (12%)		0,050	0,050
33	*Sesamum indicum* L. ** Pedaliaceae	جلجلان /سمسم ***Semsem / Jaljlan***	Seeds (100%)	D.consumption (88%) Infusion (12%)		0,047	0,048
34	*Curcuma longa* L. ** Zingiberaceae	كركم ***Kourkoum***	Rhizome (100%)	Infusion (61%) D.consumption (20%) Decoction (6%) Rubbing (3%)		0,042	0,043

35	*Trigonella foenum graecum* L. * Fabaceae	***حلبة*** ***Helba***	Seedss (100%)	Infusion (78%) D.consumption (15%) Decoction (5%) Poultice (1%) Rubbing (1%)	H-ECODEV-050	0,042	0,043
36	*Marrubium vulgar* L. Lamiaceae	**مريوة** ***Mriywa***	Leaves (84%), Aerial part (16%)	Infusion (75%) Decoction (24%) Rubbing (1%)	H-ECODEV-001	0,040	0,040
37	*Camellia sinensis* (L.) Kuntze ** Theaceae	**أتاي** ***Atai***	Leaves (100%)	Decoction (96%) Infusion (4%)		0,037	0,038
38	*Opuntia ficus-indica* (L.) Mill. Cactaceae	**تشيمبو/هندية** ***Hendia / Tchinbo***	Fruits (75%) Leaves (15%)	Infusion (35%) Decoction (20%) D.consumption (25%) Maceration (10%)	H-ECODEV-012	0,037	0,038
39	*Foeniculum vulgare* Mill. Apiaceae	**بسباس** ***Besbas***	Seeds (84%) Leaves (16%)	Decoction (79%) D.consumption (13%) Inhalation (8%)	H-ECODEV-005	0,035	0,035
40	*Zizphus lotus* (L.) Lam. Rhamnaceae	**نبق/سدرة** **Sedra / Nbag**	Leaves (51%) Fruits (49%)	D.consumption (55%) Infusion (19%) Decoction (21%) Rubbing (5%)	H-ECODEV-033	0,035	0,035
41	*Olea europaea* L. Oleaceae	**زيتون** ***Zitoun***	Leaves (89%), Fruits (11%)	Infusion (50%) Macération (25%) Decoction (25%)	H-ECODEV-024	0,030	0,030
42	*Cuminum cyminum* L. ** Apiaceae	**كمون** **Kamoun**	Seeds (100%)	Infusion (74%) Decoction (14%) D.consumption (12%)		0,027	0,028
43	*Taraxacum officinale* F.H. Wigg. Asteraceae	**الهندبة البرية** ***Hendba***	Leaves (67%) Flowers (33%)	Decoction (70%) Infusion (18%) D.consumption (12%)	H-ECODEV-046	0,027	0,028
44	*Mentha pulegium* L. Lamiaceae	**فليو** ***Fliou***	Leaves (100%)	Infusion (100%)	H-ECODEV-022	0,025	0,025
45	*Salvadora persica* L. ** Salvadoraceae	**سواك** ***Siwak***	Stem (100%)	D.consumption (100%)		0,025	0,025
46	*Mentha spicata* L. * Lamiaceae	***نعناع اخضر*** ***Na'na' akhdar***	Leaves (93%) Aerial part (7%)	Infusion (93%) D.consumption (7%)	H-ECODEV-010	0,022	0,023
47	*Ficus carica* L. moraceae	**تين** ***Tine***	Fruits (100%)	D.consumption (100%)	H-ECODEV-016	0,022	0,023

48	*Cinnamomum camphora* (L.) J. Presl ** Lauraceae	كافور ***kafour***	Leaves (100%)	Decoction (52%) Infusion (33%) Inhalation (15%)		0,022	0,023
49	*Aloe vera* Burm.f. Asphodelaceae	صبار ***Sabar***	Aerial part (100%)	Poultice (92%) Rubbing (8%)	H-ECODEV-044	0,020	0,020
50	*Coraindrum sativum* L.* Apiaceae	قصبر ***Kesbour***	Leaves (56%) Seeds (44%)	Infusion (61%) D.consumption (23%) Maceration (16%)	H-ECODEV-027	0,020	0,020
51	*Ruta chalepensis* L. Rutaceae	فيجل ***Fidjel***	Leaves (77%) Aerial part (23%)	Infusion (100%)	H-ECODEV-038	0,017	0,018
52	*Carum carvi* L. ** Apiaceae	كروية ***Karwiya***	Seeds (100%)	Infusion (86%) Decoction (9%) D.consumption (5%)		0,017	0,018
53	*Tussilago farfara* L. Asteraceae	حشيشةالسعال ***Hachichat el souaal***	Flowers (100%)	Infusion (100%)	H-ECODEV-031	0,017	0,018
54	*Ginkgo biloba* L. * Ginkoaceae	الجنكة **eljenka**	Leaves (100%)	Infusion (100%)	H-ECODEV-004	0,015	0,015
55	*Borago officinalis* L. Boraginaceae	لسان الفرد ***Lissan el ferd***	Leaves (100%)	Infusion (100%)	H-ECODEV-025	0,012	0,013
56	*Eleusine coracana* (L.) Gaertn.** Poaceae	لنجبار ***Lenjbar***	Seeds (100%)	Maceration (26%) D.consumption (74%)		0,012	0,013
57	*Capparis spinosa* L. Capparaceae	الكبار ***El kabar***	Fruits (100%)	D.consumption (100%)	H-ECODEV-048	0,012	0,013
58	*Crocus sativus L*** Iridaceae	زعفران ***Zaafran***	Flowers (100%)	D.consumption (54%) Infusion (46%)		0,012	0,013
59	*Apium graveolens* L. Apiaceae	كرافس ***Krafas***	Leaves (61%), Seeds (39%)	Infusion (100%)	H-ECODEV-021	0,010	0,010
60	*Laurus nobilis* L. Lauraceae	رند ***Rand***	Leaves (100%)	Infusion (100%)	H-ECODEV-036	0,010	0,010
61	*Urtica dioica* L. Urticaceae	حريق ***Horiq***	Leaves (100%)	Infusion (100%)	H-ECODEV-049	0,010	0,010
62	*Tilia cordata* Mill.** Malvaceae	زيزفون ***Zizfone***	Flowers (100%)	Infusion (100%)		0,010	0,010
63	*Passiflora caerulea* L. * Passifloraceae	نوار الساعة ***Nouar saa***	Leaves (100%)	Infusion (100%)	H-ECODEV-023	0,010	0,010
64	*Illicium verum* Hook.f.** Schisandraceae	نجمة الأرض/حبة طيبة **Haba tayiba / Nedjmet lard**	Seeds (100%)	Decoction (50%) D.consumption (50%)		0,010	0,010
65	*Ocimum basilicum* L. Lamiaceae	ريحان/حبق ***ḥabaq / rīḥān***	Leaves (100%)	Infusion (100%)	H-ECODEV-015	0,007	0,008

66	*Hedera helix* L. * Araliaceae	لبلاب ***Leblab***	Leaves (100%)	Infusion (72%)	H-ECODEV-007	0,007	0,008
67	*Sinapis arvensis* L. Brassicaceae	خردل ***Khardel***	Seeds (100%)	Infusion (100%)	H-ECODEV-039	0,007	0,008
68	*Paronychia argentea* Lam. Lythraceae	رجل الحمام ***Rijl el hamem***	Flowers (100%)	Infusion (100%)	H-ECODEV-018	0,007	0,008
69	*Salvia hispanica* L. ** Lamiaceae	بدور الشيا ***Chia***	Seeds (100%)	Infusion (100%)		0,007	0,008
70	*Atriplex halimus* L. Amaranthaceae	قطف ***Qṭef***	Leaves (100%)	Infusion (100%)	H-ECODEV-040	0,005	0,005
71	*Ajuga iva(L.)* Schreb. Lamiaceae	شندقورة ***Chendgoura***	Leaves (100%)	Infusion (100%)	H-ECODEV-032	0,005	0,005
72	*Equisetum arvense* L. Equisetaceae	كنبات ***Knbat***	Seeds (100%)	Infusion (100%)	H-ECODEV-042	0,005	0,005
73	*Clinopodium nepeta* (L.) Kuntze Lamiaceae	نابطة ***Nabta***	Leaves (100%)	D.consumption (100%)	H-ECODEV-052	0,002	0,003

Legend: * Introduced species; ** Imported species; no asterisk: native species.

Biological and taxonomic Analysis

Among the 73 species recorded, angiosperms dominate (69 taxa, 95.89%) across 33 families and 61 genera (Table 3). Herbaceous plants are most prevalent (80.82%), followed by shrubs (10.96%) and trees (4.11%), reflecting Mediterranean ecosystems rich in secondary metabolites (Benarba *et al.* 2015; Bensizerara *et al*. 2025; Fakchich & El Achouri 2014).

The dominance of herbs is linked to their abundance, easy collection, rapid regeneration, and versatility in traditional preparations (Bensizerara *et al*. 2025; Li *et al*. 2024; Lin et *al.* 2021). Major families include Lamiaceae, Apiaceae, Asteraceae, Fabaceae, and Brassicaceae. Shrubs and trees, such as *Myrtus communis* L**.** and *Pistacia lentiscus* L**.**, add valuable phenolics and volatile compounds (Hamel *et al*. 2018; Sehaki *et al.* 2023). Gymnosperms are limited to four species (*Pinus halepensis* Mill*., Cupressus sempervirens* L*., Juniperus phoenicea* L*., Ginkgo biloba*L.), illustrating selective traditional use (Ait Atmane *et al*. 2024; Benarba *et al*. 2015; Soltani *et al*. 2019).

Table 3. Classification of plants used against asthma according to their botanical category and growth habit

Category	Habit	Number of families	Number of genera	Number of species	Percentage of total species (%)
Angiospermae	Tree	2	4	3	4,11
	Shrub	4	6	8	10,96
	Herb	26	50	58	80,82
Gymnosperms	Tree and Shrub	3	4	4	5,48
Total	—	35	64	73	100

Plant parts used

Leaves were most commonly used (36.9%), followed by seeds, stems, bulbs, roots, fruits, buds, and flowers (Fig. 5), consistent with previous studies (Bensizerara *et al*. 2025; Khusna *et al*. 2023; Tahri *et al*. 2020; Uzun & Koca 2020). The preference for leaves is explained by easy harvesting without harming plants, high bioactive compound content, and year-round availability (Daoudi *et al*. 2015; El Hachlafi *et al*. 2022; Francis Xavier *et al*. 2015). Moderate use of roots reduces destructive harvesting, reflecting sustainable traditional practices (Bensizerara *et al*. 2025).

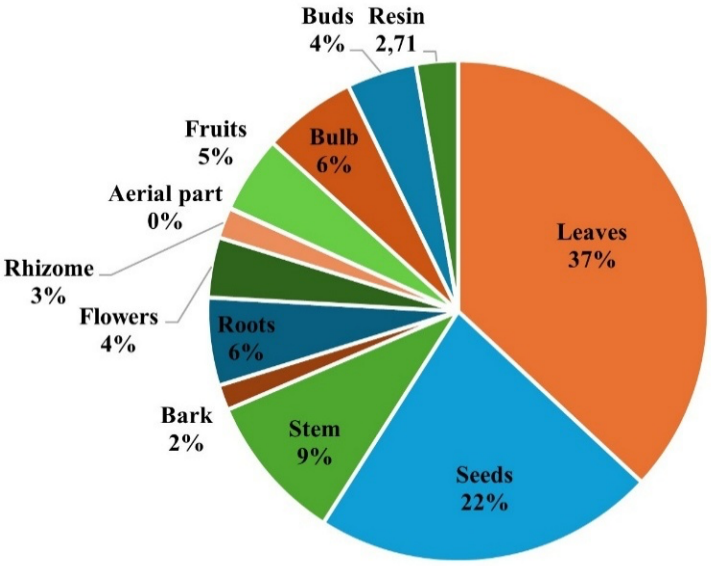

Figure 5. Distribution spectrum of plant parts used.

Preparation methods

Infusions were the main preparation method (36.8%), followed by decoctions (29%) and direct consumption (26.4%) (Fig. 6). Less frequent methods included inhalation, bandaging, topical application, and maceration. Infusions are preferred due to their simplicity and efficiency in extracting thermo-sensitive compounds, while decoctions are suited for rigid plant parts (Bensizerara *et al*. 2025; Jan *et al*. 2023; Kechidi *et al*. 2021; Uzun & Koca .2020).

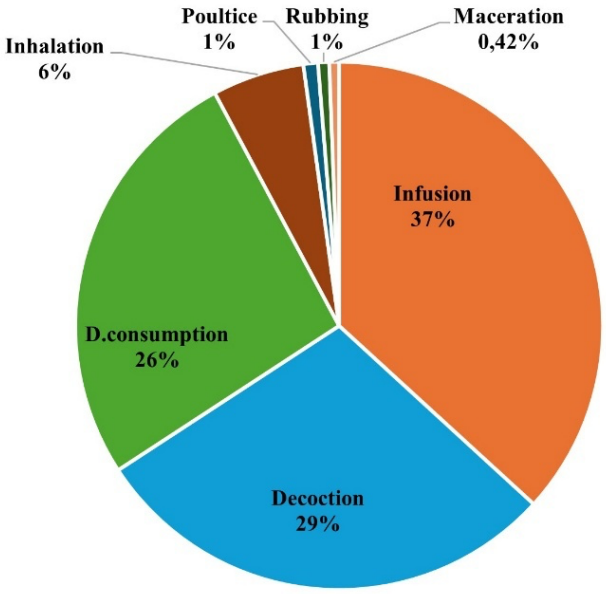

Figure 6. Spectrum of preparation techniques used.

Correspondence Analysis of Botanical Families and Ethnomedicinal Practices

The correspondence analysis (CA) performed on botanical families, plant parts used, and preparation methods provides a structured view of the associations that shape ethnobotanical knowledge in the study region. The first two axes explained 29.34% of the total inertia (Axis 1: 14.98%, Axis 2: 14.36%), which is sufficient to identify the major gradients in the data, even if a considerable proportion of variability is spread across higher dimensions (Fig. 7).

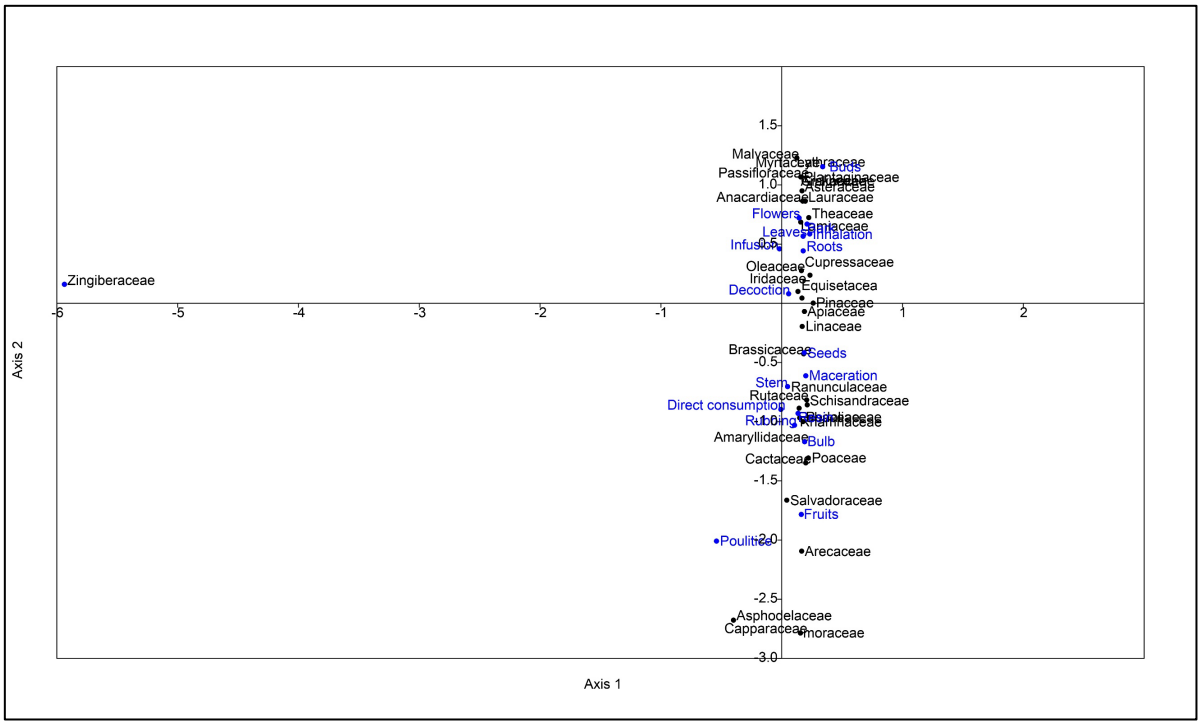

Figure 7. Correspondence Analysis of Botanical Families and Ethnomedicinal Practices.

On Axis 1, a clear separation emerges between the most represented plant families and their preferred ethnomedicinal uses. In particular, Lamiaceae, Apiaceae, and Asteraceae are strongly projected in the positive direction, reflecting their central role in traditional pharmacopoeia. These families are widely recognized in Mediterranean ethnobotany for their abundance of aromatic and bioactive compounds, which explains their recurrent presence across traditional remedies.

Lamiaceae aligned closely with leaves and infusions, indicating that this family is primarily exploited through herbal teas and decoctions prepared from aerial parts. This matches global ethnopharmacological trends, where Lamiaceae (e.g., *Salvia argentea* L. , *Origanum vulgare* L.) are prominent in treating respiratory and digestive disorders.

Apiaceae showed associations with fruits/seeds and infusion or decoction methods, reflecting the widespread use of spices and aromatic seeds (e.g., *Pimpinella anisum* L., *Cuminum cyminum* L.) in both culinary and medicinal contexts. Their linkage with digestive complaints is well established in North African and Mediterranean ethnobotany.

Asteraceae were positioned closer to flowers and aerial parts, often prepared through decoction or maceration, underlining their role in treating inflammatory and respiratory ailments. The prominence of this family echoes its global reputation as one of the largest medicinal plant groups, with taxa such as *Artemisia* commonly reported.

In contrast, other families such as Zingiberaceae and Moraceae were projected in more distant quadrants, suggesting specialized or less frequent uses, possibly linked to introduced or less culturally embedded taxa.

Axis 2 introduced further nuances. It differentiated preparation modes, with topical applications (e.g., poultices, rubs) appearing in opposition to oral uses (infusion, decoction). Families like Apiaceae clustered toward oral remedies, whereas some Asteraceae species extended toward external treatments.

Overall, the CA biplot highlights the central cultural position of Lamiaceae, Apiaceae, and Asteraceae, confirming their role as "core families" in local ethnomedicine. Their strong alignment with common preparation modes (infusion, decoction) and easily accessible plant parts (leaves, seeds, flowers) reflects a practical and sustainable knowledge system. These findings reinforce earlier Mediterranean and North African ethnobotanical research, which consistently reports these three families as keystones of traditional health care (Ouelbani *et al*. 2016; Ramdani *et al*. 2020; Bouafia *et al*. 2023).

Finally, the spread of less represented families across peripheral quadrants illustrates the breadth of the pharmacopoeia, but also suggests that knowledge concentration remains focused on a handful of dominant, culturally salient families.

Most valued species

Among the recorded plants, certain species stand out due to their high RFC and UV values, indicating significant cultural and therapeutic importance. These include *Salvia argentea* L**.** *(Lamiaceae), Lepidium sativum* L**.** (Brassicaceae)*, Origanum vulgare* L**.** (Lamiaceae)*,* and *Nigella arvensis* L**.** (Ranunculaceae).

Salvia argentea: This species, endemic to the Mediterranean basin, is traditionally used as an infusion or inhalation to relieve cough, bronchitis, and asthma symptoms. Its essential oils, rich in monoterpenes (thujone, cineole), confer expectorant, antiseptic, and anti-inflammatory properties (Benabdesslem *et al*. 2020; Hachem *et al*. 2020; Lakhal *et al*. 2023). Additionally, its flavonoid content provides strong antioxidant activity (Mamache *et al*. 2025), which contributes to respiratory protection.

Lepidium sativum (garden cress): Seeds are widely used for their expectorant, mucolytic, and anti-inflammatory effects. They are commonly administered as decoctions or mixed with honey; a practice deeply rooted in North African cultures (Hadj Rabia *et al*.2024; Khalid *et al*. 2025; Moustafa *et al.*2025). Pharmacological studies confirm the presence of bioactive compounds (glucosinolates, flavonoids), which justify their role in reducing airway inflammation (Chaachouay *et al.* 2019; Saleh *et al*. 2023; Tufail *et al.* 2024).

Origanum vulgare (oregano): Consumed as an infusion, inhalation, or diluted essential oil, oregano owes its effectiveness to phenolic compounds such as carvacrol and thymol, which are well known for their antimicrobial, antioxidant, and anti-inflammatory activities (Aazza *et al*. 2011; Badekova *et al*. 2023; Nurzyńska-Wierdak & Walasek-Janusz 2025). These bioactive properties support its widespread traditional use for chronic respiratory disorders, including asthma. Beyond ethnomedicinal claims, recent clinical investigations have further highlighted the therapeutic potential of carvacrol. In asthmatic patients, treatment for two months was shown to improve respiratory symptoms and pulmonary function tests, as well as to alleviate lung wheezing. Moreover, in a randomized, double-masked clinical trial, carvacrol significantly enhanced pulmonary function parameters, improved oxidant/antioxidant balance, and modulated cytokine levels, thereby confirming its pharmacological relevance in asthma management (Rajizadeh *et al*.2024).

Nigella arvensis: Although less well-known than *Nigella sativa*, this local species is traditionally prepared as a decoction or maceration. Its seeds contain alkaloids, flavonoids, and essential oils, providing pharmacological potential similar to *Nigella sativa* L. (Alshwyeh *et al.*2022; Jaradat *et al*. 2016; Tariq *et al*. 2016; Salehi *et al*. 2021). It is used for its bronchodilatory and immunomodulatory effects in asthma and bronchitis.

Other globally recognized species for respiratory health were also cited by informants, including *Syzygium aromaticum*L., *Glycyrrhiza glabra*L., *Zingiber officinale* Roscoe, *Bunium pachypodum* Post, *Juniperus phoenicea*, *Allium cepa* L., *Allium sativum* L., and *Eucalyptus globulus* Labill., further confirming the consistency between local knowledge and ethnopharmacological literature (Batiha *et al.* 2020; Elattar *et al*. 2024; Sarkissian *et al.* 2025; Soltani *et al.* 2019).

Original contributions and therapeutic innovations

The study documented several therapeutic applications rarely reported in the literature, including the use of *Ammoides pusilla* Brot. infusion for asthma, *Pistacia lentiscus* leaf decoction, *Phoenix dactylifera* seed decoction, and thoracic poultices made from *Ziziphus lotus* mixed with honey.

These findings indicate that local populations do not merely replicate ancestral knowledge but actively adapt and renew their traditional pharmacopoeia (Popovic *et al.* 2014).

The four most valued plants illustrate a functional combination of therapeutic roles:

- Aromatic and antiseptic plants: *Salvia argentea, Origanum vulgare*
- Expectorant and tonic plants: *Lepidium sativum*
- Immunostimulant and anti-allergic plants: *Nigella arvensis*
- Their ranking reflects accessibility, established use, and empirical value, which supports the need for further pharmacological investigation, particularly of *Nigella arvensis*, whose therapeutic potential remains underexplored.

These observations align with ethnobotanical surveys conducted in Kabylia, Algeria (Boudjelal *et al*. 2013; Dihia & Belaid, 2023), the Moroccan Rif (Fakchich & El Achouri, 2014), northern Tunisia (El-Darier & Yahia, 2016), and the Middle East (Kayani *et al.* 2015; Rehman *et al.* 2015). The frequent citation of *Nigella sativa*, *Origanum vulgare*, and *Eucalyptus globulus* reflects a shared Mediterranean medicinal heritage. Nevertheless, marked regional variations exist, shaped by ecological and sociocultural factors. For instance, western Algeria emphasizes *Salvia argentea, Lepidium sativum, Origanum vulgare*, and *Nigella arvensis*, whereas Kabylia prioritizes *Mentha* species alongside *Origanum vulgare* (Dihia & Belaid, 2023). This complementarity enriches the national phytotherapeutic repertoire, representing both a cultural and ecological asset that deserves documentation and pharmacological exploration.

Conclusion

This ethnobotanical survey across the wilayas of Sidi Bel Abbès, Oran, and Mascara reveals a rich and dynamic traditional knowledge regarding the use of medicinal plants for respiratory disorders, particularly asthma. A total of 73 species belonging to 36 botanical families were recorded, with a strong dominance of herbaceous angiosperms and a clear preference for leaf-based preparations, mainly in the form of infusions and decoctions. *Salvia argentea*, *Lepidium sativum*, and *Origanum vulgare* exhibited the highest UV and RFC, confirming their central cultural and therapeutic roles. Additionally, the documentation of rarely reported uses, such as *Ammoides pusilla* infusion, *Ziziphus lotus* poultices, and *Phoenix dactylifera* seed decoctions, highlights the adaptive and innovative nature of local pharmacopoeias rather than a mere repetition of ancestral practices.

The active intergenerational transmission of this knowledge, particularly through women as primary custodians of household phytotherapy, and its growing adoption by educated individuals, underscores a renewed societal interest in natural, culturally embedded healthcare alternatives. These findings offer a robust basis for pharmacological investigations aimed at isolating and characterizing bioactive compounds from promising species.

At the same time, certain limitations should be acknowledged. Although the study covered three wilayas, the results cannot fully capture the diversity of Algerian ethnomedicinal practices; additional surveys in other regions would help provide a more comprehensive national picture. Moreover, while some of the culturally important species identified here have already been supported by pharmacological studies, others remain insufficiently investigated, opening promising avenues for future

biomedical validation. Finally, as with all ethnobotanical surveys, reliance on self-reported data may introduce some recall bias, although the consistency of responses across informants supports the reliability of the dataset.
These findings both document a vital and still active cultural heritage and point toward new research directions that can strengthen the dialogue between traditional knowledge and modern pharmacology.

Declarations

Ethics approval and consent to participate: Oral informed consent was obtained from all participants prior to data collection. The study adhered to the principles outlined in the Code of Ethics of the International Society of Ethnobiology (ISE 2008).
Consent for publication: Not applicable.
Availability of data and materials: All data generated or analyzed during this study are included in this published article. Additional datasets are available from the corresponding author upon reasonable request.
Competing interests: The authors declare that they have no competing interests.
Funding: This research received no external funding.
Authors' contributions: Yamina Soltani designed the study, conducted fieldwork, analyzed data, and wrote the manuscript. Benyamina Abdelfettah, Toumi Manel Nardjes, and Mansouri Asma contributed to data collection and botanical identification. Bouzidi Mohamed Ali and Toumi Fawzia assisted with statistical analysis and manuscript revision. All authors read and approved the final manuscript.

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Literature Cited

Aazza S, Lyoussi B, Maria M. 2011. Antioxidant activity of some Moroccan hydrosols. Journal of Medicinal Plants Research 5(30): 6688-6696.

Ait Atmane S, Batir MB, Aksoylu Özbek Z, Günç Ergönül P, Balcan E, Ait Eldjoudi D, Özkale E, Bribi N, Khettal B. 2024. Cold-pressed seed oil of *Pinus halepensis* Mill. for potential health applications: Analgesic and anti-inflammatory effects and evaluation of inflammatory mediators by RT-qPCR in cutaneous wound healing. Journal of Ethnopharmacology 319(Pt 1):117157. doi: 10.1016/j.jep.2023.117157.

Alshammari AM, Alasmari AF, Alasmari SA, Alasmari FA, Alshammari KT. 2023. Phytochemicals with therapeutic effects on asthma: evidence from preclinical and clinical studies. Pharmaceuticals 16:1123.

Alshwyeh HA, Aldosary SK, Ilowefah MA, Shahzad R, Shehzad A, Bilal S, Lee I-J, Mater JAA, Al-Shakhoari FN, Alqahtani WA, et al. 2022. Biological potentials and phytochemical constituents of raw and roasted *Nigella arvensis* and *Nigella sativa*. Molecules 27(2):550. doi: 10.3390/molecules27020550.

Azzi R, Djaziri R, Lahfa F, Sekkal FZ, Benmehdi H, Belkacem N. 2012. Ethnopharmacological survey of medicinal plants used in the traditional treatment of diabetes mellitus in the North Western and South Western Algeria. Journal of Medicinal Plants Research 6:2041-2050.

Badekova K, Atazhanova G, Losseva I, Medeshova A, Aitkenova A, Brazhanova A. 2023. Acute toxicity of *Origanum vulgare* dental gel in mice. Journal of Toxicology 2023:6691694.

Batiha GE-S, Alkazmi LM, Wasef LG, Beshbishy AM, Nadwa EH, Rashwan EK. 2020. *Syzygium aromaticum* L. (Myrtaceae): Traditional uses, bioactive chemical constituents, pharmacological and toxicological activities. Biomolecules 10(2):202. doi: 10.3390/biom10020202.

Belhacini F, Anteur D, Zohra R. 2024. Ethnobotanical study of the therapeutic plants of the Beni Haoua region in the wilaya of Chlef (Algeria). Ethnobotany Research and Applications 29:1-15. doi: 10.32859/era.29.49.1-15.

Belhouala K, Benarba B. 2021. Medicinal plants used by traditional healers in Algeria: A multiregional ethnobotanical study. Frontiers in Pharmacology 12: Article 760492.

Bellakhdar D. 1997. Contribution to the study of traditional pharmacopoeia in Morocco: current situation, products, and sources of knowledge. Doctoral thesis, University of Metz, France.

Benabdesslem Y, Hachem K, Kahloula K, Belakredar A, Slimani M. 2020. In vitro antimicrobial activity of aqueous, ethanolic and methanolic leaves extracts from *Salvia argentea*. Systematic Reviews in Pharmacy 11(11):1683-1691.

Benamar K, Koraichi SI, Benamar S, Fikri-Benbrahim K. 2023. Ethnobotanical study of medicinal plants used by the population of Ain Chkef (North central Morocco). Ethnobotany Research and Applications 26:4. doi: 10.32859/era.26.4.1-23.

Benarba B, Meddah S, Tir Touil A. 2015. Ethnobotanical study of medicinal plants used by traditional healers in Mascara (North West of Algeria). Journal of Ethnopharmacology 175:626-637.

Bensizerara D, Khemili A, Hassad R, Aroua K, Mellal H, Chenchouni H. 2025. Ethnobotanical survey and ecological approach of medicinal and aromatic plants in Algeria. Ethnobotany Research and Applications 32:05. doi: 10.32859/era.32.5.1-31.

Bouafia A, Meneceur S, Chami S, Laouini SE, Daoudi H, Legmairi S, Mohammed HAMM, Aoun N, Menaa F. 2023. Removal of hydrocarbons and heavy metals from produced water by modern green nanotechnology methods. Scientific Reports 13: Article 5637.

Boudjelal A, Henchiri C, Sari M, Sarri D, Hendel N, Benkhaled A, Ruberto G. 2013. Herbalists and wild medicinal plants in M'Sila (North Algeria): An ethnopharmacology survey. Journal of Ethnopharmacology 148:395-402.

Bouras A, Aissaoui R, Hamoud F, Driouche Y, Dridi A, Becheker A, Ferfar M, Slimani A, Bouslama Z. 2025. Contemporary ethnobotany of *Opuntia ficus-indica* in Algeria: perceptions, practices, and trust across sociodemographic groups. *Ethnobotany Research and Applications* 32:03. doi: 10.32859/era.32.3.1-18.

Braunwalder C, Ertl J, Wullschleger M, Timm E, Wolf U. 2025. Efficacy and safety of phytotherapy and anthroposophic medicine in bronchial asthma: a systematic review. Respiratory Medicine 245:108202. doi: 10.1016/j.rmed.2025.108202.

Bulut G, Haznedaroğlu MZ, Doğan A, Koyu H, Tuzlacı E. 2017. An ethnobotanical study of medicinal plants in Acipayam (Denizli-Turkey). Journal of Herbal Medicine 10:64-81. doi: 10.1016/j.hermed.2017.08.001.

Bussmann RW, Sharon D. 2021. Traditional medicinal plant use in Northern Peru: tracking two decades of changes. Journal of Ethnopharmacology 267:113-129.

Chaachouay N, Benkhnigue O, Fadli M, Ibaoui HE, Ayadi RE, Zidane L. 2019. Ethnobotanical and ethnopharmacological study of medicinal and aromatic plants used in the treatment of respiratory system disorders in the Moroccan Rif. Ethnobotany Research and Applications 18:1-16.

Chen Y, Zhou Q, Wang H, Li Z. 2022. Emerging pharmacological evidence of herbal medicine for asthma therapy. Frontiers in Pharmacology 13:934567.

Daoudi A, Bammou M, Zarkani S, Slimani I, Ibijbijen J, Nassiri L. 2015. Ethnobotanical study of medicinal flora in rural municipality of Aguelmouss - Khenifra province (Morocco). Phytothérapie 14:220-228.

da Silva C, Pereira F, Amorim JP. 2024. The integration of indigenous knowledge in school: a systematic review. Compare: A Journal of Comparative and International Education 54(7):1210-1228. doi: 10.1080/03057925.2023.2184200.

Dahmane Th, Kaci Z, Hadj Mohamed N, Abed A, Mebkhout F. 2023. Ethnobotanical study of spontaneous medicinal plants Gouraya's National Park (Bejaia-Algeria). Egyptian Journal of Botany 63(3):1083-1100. doi: 10.21608/ejbo.2023.202565.2294.

Dihia H, Belaid B. 2023. Medicinal plants used for the treatment of respiratory diseases in Kabylia, north of Algeria: an ethnomedicinal survey. *Journal of Herbal Medicine* 40:100685. Ekor M. 2014. The growing use of herbal medicines: issues relating to adverse reactions and challenges in monitoring safety. Frontiers in Pharmacology 4:177.

Elattar MM, Darwish RS, Hammoda HM, Dawood HM. 2024. An ethnopharmacological, phytochemical, and pharmacological overview of onion (*Allium cepa* L.). Journal of Ethnopharmacology 324:117779. doi: 10.1016/j.jep.2024.117779.

El Hachlafi N, Benkhaira N, Ferioun M, Kandsi F, Jeddi M, Chebat A, Addi M, Hano C, Fikri-Benbrahim K. 2022. Moroccan medicinal plants used to treat cancer: Ethnomedicinal study and insights into pharmacological evidence. Evidence-Based Complementary and Alternative Medicine 2022:1645265. doi: 10.1155/2022/1645265.

Fakchich J, Elachouri M. 2014. Ethnobotanical survey of medicinal plants used by people in Oriental Morocco to manage various ailments. Journal of Ethnopharmacology 154:76-87.

Francis Xavier T, Kannan M, Auxilia A. 2015. Observation on the traditional phytotherapy among the Malayali tribes in Eastern Ghats of Tamil Nadu, South India. Journal of Ethnopharmacology 165:198-214.

Gebru MG, Lulekal E, Bekele T, Demissew S. 2021. Use and management practices of medicinal plants in and around mixed woodland vegetation, Tigray Regional State, Northern Ethiopia. Ethnobotany Research and Applications 21:1-26. doi: 10.32859/era.21.43.1-26.

Gherib I, Lazli A, Guenadil F, Seraoui H. 2024. Ethnobotanical knowledge of *Achillea ligustica* All. in El Tarf region (Northeastern Algeria). Ethnobotany Research and Applications 29:1-16. doi: 10.32859/era.29.73.1-1.

GINA (Global Initiative for Asthma). 2023. Global Strategy for Asthma Management and Prevention. https://ginasthma.org (consulted 28/09/2025).

Haba HF, Bredillet C, Dastane O. 2023. Green consumer research: trends and way forward based on bibliometric analysis. Cleaner and Responsible Consumption 8: 100089.

Hamel T, Sadou N, Seridi R, Boukhdir S, Boulemtafes A. 2018. Traditional practice of using medicinal plants in the population of the Edough Peninsula (northeastern Algeria). Ethnopharmacologia 59: 65-71.

Hachem K, Benabdesslem Y, Adli DEH, Chikhi A, Kahloula K. 2020. A review on the phytochemical composition and the traditional medicinal uses of *Salvia argentea* (Lamiaceae). Systematic Reviews in Pharmacy 11(7):113-118. doi: 10.31838/srp.2020.7.18.

Hadj Rabia S, Labsi M, Zaouani M, BenMoussa F, Messaoudi M. 2024. Potential hepatoprotective effect of the crude extract of *Lepidium sativum* on an experimental model of hepatotoxicity. Algerian Journal of Biosciences 5(2):44-54.

Hamel T, Sadou N, Seridi R, Boukhdir S, Boulemtafes A. 2018. Traditional practice of using medicinal plants in the population of the Edough Peninsula (northeastern Algeria). Ethnopharmacologia 59: 65-71.

International Society of Ethnobiology (ISE). 2008. The International Society of Ethnobiology Code of Ethics (with 2006 additions). https://www.ethnobiology.net/what-we-do/core-programs/ise-ethics-program/code-of-ethics/ (Accessed 07/08/2025).

Jan HA, Mir TA, Bussmann RW, Jan M, Hanif U, Wali S. 2023. Cross-cultural ethnomedicinal study of the wild species of the genus *Berberis* used by the ethnic communities living along both sides of the Indo-Pak border in Kashmir. Ethnobotany Research and Applications 26:1-14. doi: 10.32859/era.26.3.1-14

Jaradat NA, Al-Ramahi R, Zaid AN, Ayesh OI, Eid AM. 2016a. Ethnopharmacological study of plant remedies used for the treatment of various types of cancer and their preparation methods in the West Bank and Palestine. BMC Complementary and Alternative Medicine 16:93. doi: 10.1186/s12906-016-1070-8.

Jeddi S, Ferioun M, Benkhaira N, Jeddi M, El Hachlafi N, Fikri-Benbrahim K. 2024. Ethnobotanical appraisal of indigenous medicinal plants used in the Taounate region (Northern Morocco): qualitative and quantitative approaches. Ethnobotany Research and Applications 28:1-26. doi: 10.32859/era.28.34.1-26.

Kalaci O, Giangioppo S, Leung G, Radhakrishnan A, Fleischer E, Lyttle B, Price A, Radhakrishnan D. 2019. Complementary and alternative medicine use in children with asthma. Complementary Therapies in Clinical Practice 35:272-277.

Kayani S, Ahmad M, Sultana S, Khan Shinwari Z, Zafar M, Yaseen G, Hussain M, Bibi T. 2015. Ethnobotany of medicinal plants among the communities of alpine and sub-alpine regions of Pakistan. Journal of Ethnopharmacology 164: 186-202.

Kechidi S, Colaco A, Costa PA, Castro JM, Marques M. 2021. Modelling of soil-structure interaction in OpenSees: a practical approach for performance-based seismic design. Structures 30: 75-88.

Khalid L, Jabeen I, Inam-ur-Raheem M, Mir Khan U, Mousavi Khaneghah A, Aadil RM. 2025. Garden cress (*Lepidium sativum*) seeds: an overview of their functional and medicinal properties. Journal of Food and Agriculture Research 21:101894.

Khusna U, Jumari J, Prihastani E. 2023. Ethnobotany of medicinal plants in the Jalawastu cultural village community, Brebes, Central Java, Indonesia. Egyptian Journal of Botany 457-474.

Lakhal H, Kabouche A, Kabouche Z, Bechkri S, AlabdulMagid A, Voutquenne-Nazabadioko L. 2023. A new triterpene saponin and known compounds from the polar extract of *Salvia argentea* L. and evaluation of their antioxidant activity. Natural Product Research 38(21):3859-3864. doi: 10.1080/14786419.2023.2262716

Leonti M. 2022. The relevance of quantitative ethnobotanical indices for ethnopharmacology and ethnobotany. Journal of Ethnopharmacology 288: 115008.

Li H, Huang C, Li Y, Wang P, Sun J, Bi Z, Xia S, Xiong Y, Bai X, Huang X. 2024. Ethnobotanical study of medicinal plants used by the Yi people in Mile, Yunnan, China. Journal of Ethnobiology and Ethnomedicine 20:22. doi: 10.1186/s13002-024-00656-1

Lin Y, Wang SP, Zhang JY, Zhuo ZY, Li XR, Zhai CJ, Li XX, Qi FH, Ding X, Chen CY, Zhou J, Li J, Liu Q, Qiu LL, Zhang YQ. 2021. Ethnobotanical survey of medicinal plants in Gaomi, China. Journal of Ethnopharmacology 265: 113228.

Mamache W, Bencheikh A, Benslama A, Bencheikh F, Benabdallah H, Amira S. 2025. Sage extracts: deciphering phenolic compounds and evaluation of their antiglycation, anti-inflammatory, and cytotoxic properties. Research Results in Pharmacology 11(2):1-16. doi: 10.18413/rrpharmacology.11.534.

Mohammadi T, Moazzeni H, Pirani A, Vaesi J, Motahhari K, Joharchi MR, Bussmann RW. 2023. Ethnobotany of plants used by indigenous communities in Birjand, a dry region with rich local traditional knowledge in eastern Iran. Ethnobotany Research and Applications 26:1-40. doi: 10.32859/era.26.21.1-40.

Moustafa MA, Mohamed AS, Dakrory AI, Abdelaziz MH. 2025. *Lepidium sativum* extract alleviates reproductive and developmental toxicity in polycystic ovary syndrome induced by letrozole and high-fat diet in rats. Reproductive Sciences 32:1338-1361. doi: 10.1007/s43032-025-01820-y.

Nafti S, Taright S, El Ftouh M, Yassine N, Benkheder A, Bouacha H, Fakhfakh H, Ali-Khoudja M, Texier N, El Hasnaoui A. 2009. Prevalence of asthma in North Africa: the Asthma Insights and Reality in the Maghreb (AIRMAG) study. Respiratory Medicine 103(Suppl 2):S2-S11. doi: 10.1016/S0954-6111(09)70022-8.

Nurzyńska-Wierdak R, Walasek-Janusz M. 2025. Chemical composition, biological activity, and potential uses of *Origanum vulgare* L. and its essential oil. Pharmaceuticals 18(2):267. doi: 10.3390/ph18020267.

Ouelbani R, Bensari S, Mouas TN, Khelifi D. 2016. Ethnobotanical investigations on plants used in folk medicine in the regions of Constantine and Mila (North-East of Algeria). Journal of Ethnopharmacology 194: 196-218.

Prinsloo KL, Kleynhans R, Jansen R. 2023. Medicinal ethnobotanical knowledge across urban cultural groups: a case study in a South African township. Ethnobotany Research and Applications 26:1-10. doi: 10.32859/era.27.5.1-10

Popovic D, Vucic D, Dikic I. 2014. Ubiquitination in disease pathogenesis and treatment. Nature Medicine 20: 1242-1253.

Rebahi A. 2015. *Répertoire des noms des plantes du Maghreb*. Alger: Alger-Livres Editions.

Rahim S, Shah A, Iqbal S. 2023. Ethnobotany of medicinal plants in Surghar Range of Pakistan. Ethnobotany Research and Applications 26:1-72. doi: 10.32859/era.26.6.1-72.

Rajizadeh MA, Najafipour H, Bejeshk MA. 2024. An updated comprehensive review of plants and herbal compounds with antiasthmatic effect. Evidence-Based Complementary and Alternative Medicine 2024: Article ID 8815297.

Ramdani I, Pescatore KA, Bouazza B. 2020. Causes of hospitalization and characteristics of Algerian chronic obstructive pulmonary disease patients in Tizi-Ouzou: a retrospective study. Monaldi Archives for Chest Disease 90(3): 403-408.

Rehman K, Rehman Mashwani Z, Ali Khan M, Ullah Z, Javed Chaudhary H. 2015. An ethnobotanical perspective of traditional medicinal plants from the Khattak tribe of Chonthra Karak, Pakistan. Journal of Ethnopharmacology 165: 251-259.

Saleh M, Ramadan M, Elmadawy R, Morsi M, El-Akabawy L. 2023. Efficacy of alcoholic extracts of *Morus macroura* (mulberries), *Lepidium sativum* (garden cress seeds) and diclazuril against *Eimeria stiedae* in experimentally infected rabbits. International Journal of Veterinary Science 12(6):869-878. doi:10.47278/journal.ijvs/2023.049.

Salehi B, Quispe C, Imran M, Ul-Haq I, Živković J, Abu-Reidah IM, Sen S, Taheri Y, Acharya K, Azadi H, Contreras MdM, Segura-Carretero A, Mnayer D, Sethi G, Martorell M, Faizal Abdull Razis A, Sunusi U, Kamal RM, Suleria HAR, Sharifi-Rad J. 2021. *Nigella* plants - Traditional uses, bioactive phytoconstituents, preclinical and clinical studies. Frontiers in Pharmacology 12:625386. doi: 10.3389/fphar.2021.625386.

Salhi S, Fadli M, Zidane L, Douira A. 2010. Études floristique et ethnobotanique des plantes médicinales de la ville de Kénitra (Maroc). Lazaroa 31:133-146.

Samir M, Khellaf N, Benidir M, Djemai S, Aissaoui Z, Fekik A. 2023. Potential of Opuntia ficus-indicacladodes in M'sila (North Algeria) as feed for ruminants: Chemical composition and in vitro assessment. Acta Agriculturae Scandinavica, Section A—Animal Science 73:48-58. doi: 10.1080/09064702.2023.2191603.

Sarkissian T, Simonyan HM, Stepanyan L, Tsaturyan A, Vicidomini C, Pastore R, Guerra G, Roviello GN. 2025. Neuroprotective properties of clove (*Syzygium aromaticum*): State-of-the-art and future pharmaceutical applications for Alzheimer's disease. Biomolecules 15(3):452. doi: 10.3390/biom15030452.

Sehaki C, Jullian N, Ayati F, Fernane F, Gontier E. 2023. A review of *Pistacia lentiscus* polyphenols: Chemical diversity and pharmacological activities. Plants 12(2):279. doi: 10.3390/plants12020279.

Senoussi A, Schadt I, Hioun S, Chenchouni H, Saoudi Z, Aissaoui Zitoun Hamama O, Zidoune MN, Carpino S, Rapisarda T. 2021. Botanical composition and aroma compounds of semi-arid pastures in Algeria. Grass and Forage Science 76(2):282–299. doi: 10.1111/gfs.12510

Sharafatmandrad M, Khosravi Mashizi A. 2020. Ethnopharmacological study of native medicinal plants and the impact of pastoralism on their loss in arid to semiarid ecosystems of southeastern Iran. Scientific Reports 10:15526. doi: 10.1038/s41598-020-72536-z.

Soltani Y, Bouzidi MA, Toumi F, Benyamina A. 2019. Evaluation of the antibacterial activity (in vitro) and the antipyretic activity (in vivo) of three organs of *Juniperus phoenicea* L. from Western Algeria. Phytothérapie. doi: 10.3166/phyto-2019-0203.

Tahri D, Elhouiti F, Ouinten M, Yousfi M. 2020. Historical perspective of Algerian pharmacological knowledge. Advances in Traditional Medicine 20: 279-290.

Tariq K, Ghias K. 2016. Colorectal cancer carcinogenesis: A review of mechanisms. Cancer Biology & Medicine 13(1): 120-135.

Tufail T, Khan T, Bader Ul Ain H, Morya S, Shah MA. 2024. Garden cress seeds: a study on nutritional composition, therapeutic potential, and industrial use. Food Science & Nutrition. doi:10.1002/fsn3.4096.

Uzun SP, Koca C. 2020. Ethnobotanical survey of medicinal plants traded in herbal markets of Kahramanmaraş. Plant Diversity 42(6):443-454. doi: 10.1016/j.pld.2020.12.003.

World Health Organization (WHO). 2022. Asthma fact sheet. https://www.who.int/news-room/fact-sheets/detail/asthma (consulted 28/09/2025).

Zouaoui N, Chenchouni H, Bouguerra A, Massouras T, Barkat M. 2020. Characterization of volatile organic compounds from six aromatic and medicinal plant species growing wild in North African drylands. NFS Journal 18:19-28. doi: 10.1016/j.nfs.2019.12.001.