



# Ethnobotanical investigation of medicinal plants used for wound management in the semi-arid steppe of El Bayadh, Algeria

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## Research

### Abstract

**Background:** This investigation documented ethnobotanical knowledge of medicinal plants used for wound healing in El Bayadh, Algeria. Semi-structured interviews with 94 participants provided comprehensive data on 25 plant species used in traditional wound-treatment practices. The objective of this study is to identify medicinal plant species used in wound healing and evaluate their cultural importance, therapeutic roles, and preparation methods.

**Methods:** Semi-structured interviews conducted between January and June 2023 gathered information on plant species, growth forms, parts used, and preparation techniques. The Relative Frequency of Citation (RFC) index was used to quantify the cultural significance of the documented species.

**Results:** The Lamiaceae family showed the highest consensus (RFC = 0.98). *Lagenaria siceraria* (RFC = 0.51) and *Capsicum annum* (RFC = 0.45) were the most frequently cited species. Herbaceous plants (72%) and whole-plant use (72%) predominated. Powdering (52%) and decoction (40%) were the principal preparation methods. Demographic analysis showed that women (68.09%) and individuals aged 41–60 (67.02%) were the primary holders of traditional knowledge.

**Conclusions:** The recorded plants support wound healing through antimicrobial, anti-inflammatory, and antioxidant properties. Local preparation techniques optimize the extraction and bioavailability of therapeutic compounds. This inventory highlights the region's biocultural richness and provides a foundation for future pharmacological research aimed at developing plant-based wound-management strategies.

**Keywords:** Ethnobotany; Medicinal plants; Wound healing; Traditional knowledge; El Bayadh; Lamiaceae

### Background

Medicinal plants have long been a pivotal resource in human healthcare, as they offer sustainable sources of bioactive compounds for the treatment of diverse diseases (Phumthum 2020, Antonio Demetrio *et al.* 2025). Ethnobotanical knowledge has evolved over centuries across different regions, reflecting the distinctive interactions between communities, flora, and local ecosystems. In recent decades, there has been considerable scientific interest in medicinal plants, driven by the pursuit of novel therapeutic agents and the recognition of plant-derived remedies as integral components of cultural heritage (Choi *et al.* 2001, Bhaskar & Nithya 2012). Ethnobotanical studies play a crucial role in documenting and preserving

indigenous knowledge related to the use of medicinal plants, especially in regions with rich but vulnerable biodiversity such as North Africa. These studies offer valuable insights into the sustainable use of plant resources by local communities and serve as a bridge between traditional knowledge and modern scientific research (Larit & León 2023, Baali *et al.* 2024). Moreover, ethnobotany contributes to the discovery of bioactive compounds with potential applications in drug development, particularly for wound healing and infection prevention, which remain global health priorities (Huang *et al.* 2023, Nandhini *et al.* 2024).

The steppe flora of North Africa, although limited in species diversity due to arid conditions, presents a highly adapted plant community whose medicinal potential warrants thorough investigation and documentation. North African countries are notable for their remarkable biodiversity and tradition of natural medicine, establishing the region as a noteworthy locus for ethnopharmacological investigations. North Africa's heterogeneous landscapes, spanning Mediterranean coastlines to arid Saharan zones, sustain an extensive array of plant species and traditional healing practices in the region. Algeria is characterized by exceptional ecological richness and a deeply embedded community reliance on plant-based remedies (Cheriti *et al.* 1995, Boudjelal *et al.* 2013, Benarba *et al.* 2015, Ouelbani *et al.* 2016, Bouasla & Bouasla 2017, Miara *et al.* 2018, Larit & León 2023). Numerous ethnobotanical surveys have underscored the therapeutic efficacy of indigenous plants in addressing infections, gastrointestinal disorders, and wound management (Baali *et al.* 2024). Although certain species, including *Phlomis crinita* (Lamiaceae) and *Pistacia vera*, have garnered attention because of their documented bioactive profiles, a substantial number of additional species contribute to local wound-healing practices (Addoun *et al.* 2021, Belhouala & Benarba 2021). These plants, predominantly belonging to the Lamiaceae and Asteraceae families, exhibit beneficial effects through antioxidant, anti-inflammatory, and antimicrobial mechanisms (Benarba *et al.* 2015). Phytochemical constituents, notably phenolics, terpenoids, and polysaccharides, facilitate wound repair by mitigating oxidative stress, inhibiting bacterial colonisation, and promoting tissue regeneration (Belwal *et al.* 2018, Mukherjee 2019).

In Algeria, ethnopharmacological knowledge exhibits substantial regional variation shaped by distinct environmental conditions and cultural practices (Boudjelal *et al.* 2013, Belhouala & Benarba 2021). Coastal territories incorporate maritime influences and shared Mediterranean traditions, whereas the semi-arid and Saharan regions demonstrate localised therapeutic approaches adapted to more extreme climatic conditions. The consistent prominence of the Lamiaceae family, among the most frequently documented families in Algerian wound-healing studies, reflects both its ecological prevalence and remarkable phytochemical diversity (Benarba *et al.* 2015, Baali *et al.* 2024). Lamiaceae species typically produce terpenoid-rich essential oils and phenolic compounds that enhance tissue repair through microbial inhibition and inflammatory modulation (Addoun *et al.* 2021). A fundamental principle persists across taxonomic families: medicinal plants facilitate wound healing through multifaceted mechanisms of protection and stimulation, ranging from antimicrobial activity to fibroblast proliferation enhancement (Bhaskar & Nithya 2012, Mukherjee 2019).

El Bayadh—a semi-arid province in western Algeria—presents a particularly compelling case study within these diverse ecological contexts. Its steppe environment harbours numerous indigenous and naturalized species used by local populations to treat wounds, burns, and cutaneous infections (Dif *et al.* 2023). Ethnobotanical investigations in this region have consistently identified plants from the Lamiaceae and Asteraceae families, although additional taxonomic groups feature prominently depending on ecological availability and cultural preferences (Kefifa *et al.* 2019, Amel *et al.* 2022). Traditional preparation methodologies in El Bayadh, frequently involving pulverized formulations, decoctions, or macerations, demonstrate sophisticated empirical knowledge of extraction principles that optimize the bioactive potential of each botanical species (Mukherjee 2019, Nasrallah *et al.* 2020). Thermal processing enhances the liberation of hydrophilic compounds, whereas mechanically reduced powders preserve lipophilic constituents for topical applications (Belwal *et al.* 2018).

Despite the extensive documentation of Algerian medicinal flora, comprehensive analyses specifically addressing wound-healing practices in El Bayadh remain insufficient. A detailed investigation of the plant species used, application modalities, and cultural significance attributed to each remedy is essential for knowledge preservation and assessment of broader medical applicability. The global escalation of antimicrobial resistance further heightens the relevance of such studies, as they potentially reveal novel phytochemical approaches for infection management (Addoun *et al.* 2021). Documentation of these botanical resources and associated traditional practices not only safeguards indigenous heritage but may also substantially inform future pharmacological research and therapeutic innovations. This study addresses a fundamental research question: Which medicinal plant species are used by indigenous communities in El-Bayadh for wound treatment, and how do traditional practices inform their preparation and application? This study sought to elucidate the medicinal plant

heritage of the region, illuminate culturally embedded therapeutic methodologies, and establish a foundation for subsequent investigations that utilize these phytochemical resources for contemporary wound management protocols.

## Materials and Methods

### Study area

El Bayadh Province (wilaya), situated in northwestern Algeria (33°41'N, 1°01'E), encompasses a semi-arid ecosystem in the High Plateaus region. The topography is characterized by mountainous formations to the south, north, and northeast, creating microclimatic variations throughout the province. The region experiences a continental Mediterranean climate characterized by extreme thermal amplitude, with winter temperatures frequently falling below 0°C and summer temperatures exceeding 40°C. This harsh ecological environment supports diverse xerophytic and drought-resistant flora that have been traditionally utilized by local communities for various ethnomedicinal applications. The province has a population of approximately 300,000 inhabitants, distributed across 22 municipalities and eight administrative departments (Fig. 1).

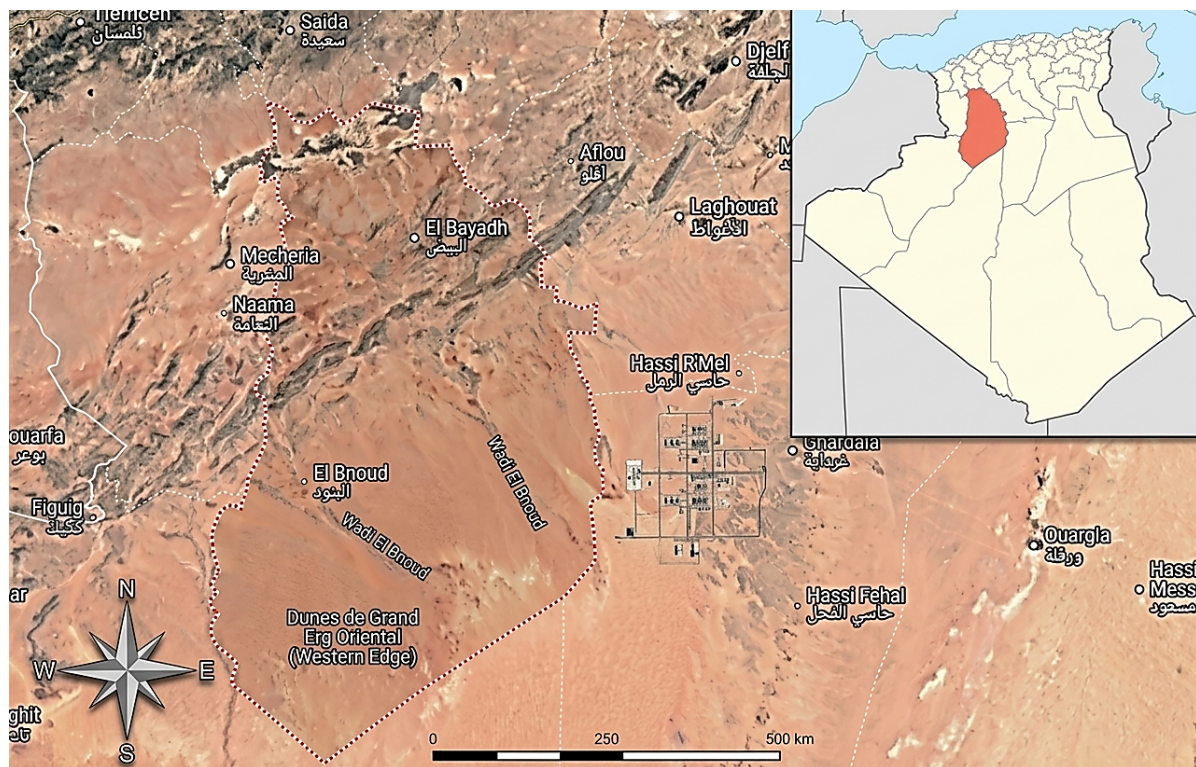


Figure 1. Map showing the areas of study

### Ethnobotanical Data Collection

This study employed a descriptive and analytical ethnobotanical approach to document and analyze the indigenous knowledge of medicinal plants used for wound healing in El Bayadh, Algeria. Data were collected over six months (January to June 2023) through semi-structured interviews with 94 key informants identified through purposive and snowball sampling techniques. The sample comprised local healers, herbalists, farmers, housewives, and employees from diverse regions of El Bayadh. The interviews documented demographic data (age, sex, and occupation), including taxonomic classification (family, genus, and species), local vernacular nomenclature, growth characteristics, plant parts utilized for therapeutic applications, and preparation techniques. The herbarium specimens referenced in this study have been carefully identified by Professor Dif Mustapha Mahmoud, a recognized expert affiliated with the Research Laboratory on Ecodevelopment of Spaces and Valorization of Resources. This laboratory is part of the University of Djilali Liabes university. The specimens are securely preserved and stored in the Herbarium of the Plant Biology Laboratory at the University of El Bayadh. This well-maintained herbarium ensures the proper cataloging and long-term conservation of the plant samples, supporting ongoing botanical research and verification (Fig. 2).



**FLORA OF ALGERIA [ HERBARIUM ]**

Region: El Bayadh Date: April 2023

Voucher No: EB-23-004

RFC: 0.12

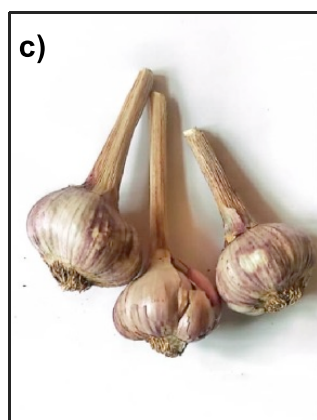


**FLORA OF ALGERIA [ HERBARIUM ]**

Region: El Bayadh Date: April 2023

Voucher No: EB-23-002

RFC: 0.22



**FLORA OF ALGERIA [ HERBARIUM ]**

Region: El Bayadh Date: April 2023

Voucher No: EB-23-010

RFC: 0.10



**FLORA OF ALGERIA [ HERBARIUM ]**

Region: El Bayadh Date: April 2023

Voucher No: EB-23-018

RFC: 0.14

Figure 2. Typical photos of herbarium specimens of four medicinal plants from the El Bayadh region, Algeria: a) *Rosmarinus officinalis* L.; b) *Mentha spicata* L.; c) *Allium sativum* L.; d) *Artemisia herba-alba* Asso.

### Data Analysis

Quantitative ethnobotanical indices were calculated to assess the cultural significance of each species in the study. The Relative Frequency of Citation (RFC) was determined using the following formula:

$$\text{RFC} = \text{FC}/\text{N}$$

Where FC represents the number of informants mentioning a specific plant species and N denotes the total number of informants interviewed (Tardío & Pardo-de-Santayana 2008, Bano *et al.* 2014). RFC values range from 0 to 1, with higher values indicating greater consensus regarding the importance of a plant in local wound healing traditions. This quantitative approach facilitates the prioritization of species for potential pharmacological investigations.

## Results

### Demographic Profile of Traditional Knowledge Holders

The demographic analysis (Table 1) showed a pronounced sex distribution, with female participants constituting a significant majority (68.09%, n=64) compared with male participants (31.91%, n=30). The age distribution demonstrated a concentration within the middle-aged cohorts (41-60 years, 67.02%). Occupational stratification indicated that traditional healers, herbalists, and housewives collectively represented 78.72% of respondents.

Table 1. Demographic Characteristics of the Participants

Social Group	Variables	Number of people interviewed	Percentage (%)
Gender	Female	64	68.09
Gender	Male	30	31.91
Age (years)	30-40	20	21.28
Age (years)	41-50	35	37.23
Age (years)	51-60	28	29.79
Age (years)	61-70	11	11.70
Occupation	Local Healer	24	25.53
Occupation	Herbalist	21	22.34
Occupation	Farmer	8	8.51

### Taxonomic Distribution

Table 2 presents the medicinal plants reported by 94 participants from El Bayadh communities for traditional wound healing, organized by botanical families with their scientific names, growth characteristics, utilized parts, and preparation methods.

Table 2. Medicinal Plants Used for Traditional Wound Healing

Family	Scientific name	Voucher No.	Form of growth	Used parts	Preparation methods	RFC per plant	RFC per family
Amaranthaceae	<i>Hammada scoparia</i> (Pomel) Iljin	EB-23-011	Herb	Whole plant	Decoction	0.16	0.16
Amaryllidaceae	<i>Allium cepa</i> L.	EB-23-003	Herb	Fruits (Bulb)	Steaming	0.13	0.23
Amaryllidaceae	<i>Allium sativum</i> L.	EB-23-010	Herb	Fruits (Bulb)	Powder	0.10	0.23
Anacardiaceae	<i>Pistacia atlantica</i> Desf.	EB-23-020	Shrub	Whole plant	Decoction	0.05	0.14
Anacardiaceae	<i>Pistacia lentiscus</i> L.	EB-23-021	Shrub	Whole plant	Powder	0.09	0.14
Apiaceae	<i>Petroselinum crispum</i> (Mill.) Fuss	EB-23-017	Herb	Whole plant	Powder	0.10	0.10
Asteraceae	<i>Anvillea radiata</i> Coss. & Durieu	EB-23-005	Herb	Whole plant	Decoction	0.07	0.21
Asteraceae	<i>Artemisia herba-alba</i> Asso	EB-23-018	Herb	Whole plant	Powder	0.14	0.21
Boraginaceae	<i>Echium humile</i> Desf.	EB-23-008	Herb	Whole plant	Decoction	0.06	0.06
Brassicaceae	<i>Eruca vesicaria</i> subsp. <i>sativa</i> (Mill.) Thell.	EB-23-009	Herb	Whole plant	Powder	0.02	0.02
Crassulaceae	<i>Sedum telephium</i> L.	EB-23-024	Herb	Whole plant	Steaming	0.24	0.24
Cucurbitaceae	<i>Lagenaria siceraria</i> (Molina) Standley	EB-23-012	Herb	Seeds	Powder	0.51	0.51
Fabaceae	<i>Ceratonia siliqua</i> L.	EB-23-007	Tree	Whole plant	Decoction	0.09	0.21

<b>Fabaceae</b>	<i>Retama raetam</i> (Forssk.)	EB-23-023	Herb	Whole plant	Decoction	0.12	0.21
<b>Lamiaceae</b>	<i>Ajuga iva</i> (L.) Schreb.	EB-23-001	Herb	Whole plant	Powder	0.04	0.98
<b>Lamiaceae</b>	<i>Lavandula officinalis</i> Chaix	EB-23-013	Herb	Whole plant	Decoction	0.10	0.98
<b>Lamiaceae</b>	<i>Marrubium vulgare</i> L.	EB-23-015	Herb	Whole plant	Decoction	0.10	0.98
<b>Lamiaceae</b>	<i>Mentha spicata</i> L.	EB-23-002	Herb	Whole plant	Powder	0.22	0.98
<b>Lamiaceae</b>	<i>Phlomis bovei</i> subsp. <i>bovei</i>	EB-23-019	Shrub	Flower	Decoction	0.23	0.98
<b>Lamiaceae</b>	<i>Rosmarinus officinalis</i> L.	EB-23-004	Herb	Whole plant	Powder	0.12	0.98
<b>Lamiaceae</b>	<i>Teucrium polium</i> L.	EB-23-025	Herb	Whole plant	Powder	0.17	0.98
<b>Lythraceae</b>	<i>Lawsonia inermis</i> L.	EB-23-014	Shrub	Leaves	Powder	0.18	0.29
<b>Lythraceae</b>	<i>Punica granatum</i> L.	EB-23-022	Tree	Fruits	Powder	0.11	0.29
<b>Solanaceae</b>	<i>Capsicum annuum</i> L.	EB-23-006	Shrub	Fruits	Powder	0.45	0.45
<b>Zygophyllaceae</b>	<i>Peganum harmala</i> L.	EB-23-016	Herb	Whole plant	Decoction	0.05	0.05

The quantitative assessment of medicinal plant utilization revealed a taxonomically diverse pharmacopoeia dominated by Lamiaceae (RFC = 0.98), which substantially outranked all other families (Fig. 3). The prominence of this family is attributed to its exceptional species diversity (seven species) and the moderate-to-high citation frequencies of its constituent taxa, particularly *Phlomis bovei* (RFC = 0.23) and *Mentha spicata* (RFC = 0.22). Despite the collective importance of Lamiaceae, individual species analysis demonstrated that *Lagenaria siceraria* (Cucurbitaceae, RFC = 0.51) and *Capsicum annuum* (Solanaceae, RFC = 0.45) had the highest individual citation frequencies, highlighting how therapeutic value transcends taxonomic boundaries (Fig. 4).

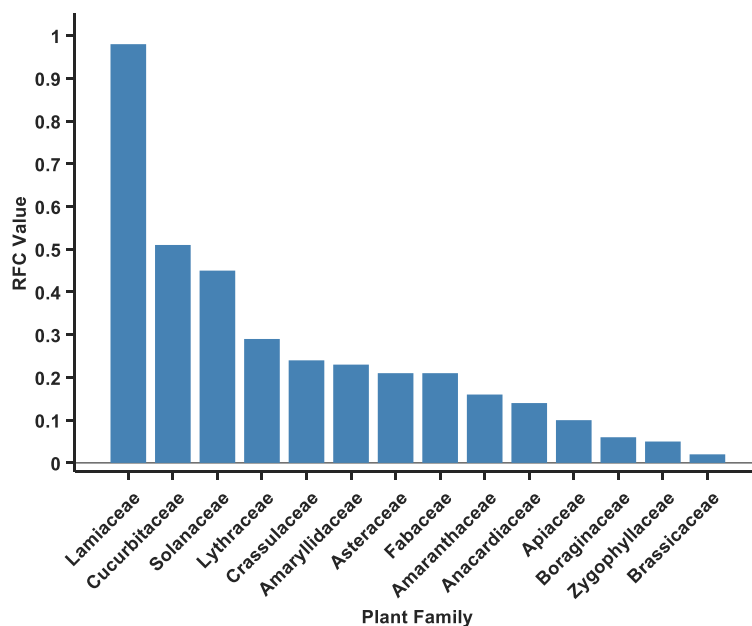


Figure 3. RFC Values per Plant Family

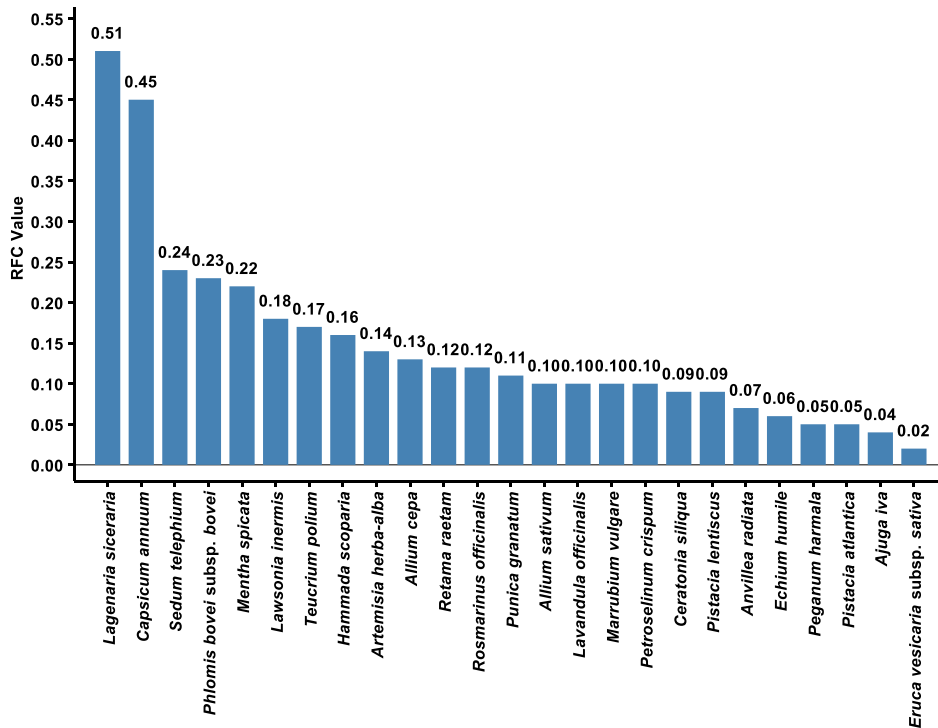


Figure 4. RFC Values per Plant

The growth form distribution across the documented species reveals a strong preference for herbaceous plants in traditional medicine, with herbs representing the predominant life form used. This pattern likely reflects both the greater abundance of herbs in local ecosystems and their typically higher concentrations of bioactive compounds compared to woody species. The prevalence of herbs may also indicate sustainable harvesting practices, as herbaceous species generally regenerate more rapidly than shrubs or trees following collection.

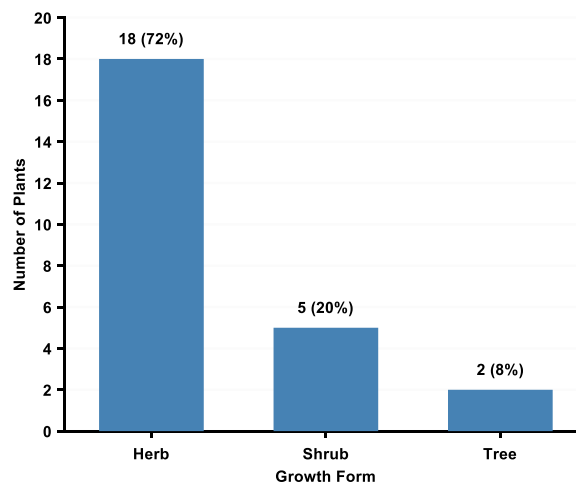


Figure 5. Distribution of Medicinal Plants by Growth Form

Analysis of plant organ utilization demonstrated a marked preference for whole-plant preparations (especially among herbaceous species), suggesting a holistic therapeutic approach that values the potential synergistic effects between different plant parts (Fig. 6). The figure illustrates this pattern clearly, with whole-plant utilization predominating across multiple families, particularly in Lamiaceae (Fig. 7). However, specific plant organs are selectively targeted in certain high-RFC species, such as fruits in *Capsicum annuum* and Solanaceae, seeds in *Lagenaria siceraria* and several Fabaceae species, and leaves in *Lawsonia inermis* and notably within Lythraceae. Amaryllidaceae species are consistently utilized for their bulbs, while Anacardiaceae species are valued for their whole plant efficacy. This organ-specific utilization correlates strongly

with both plant morphology and targeted therapeutic applications, reflecting the sophisticated ecological knowledge embedded in traditional medicine practices.

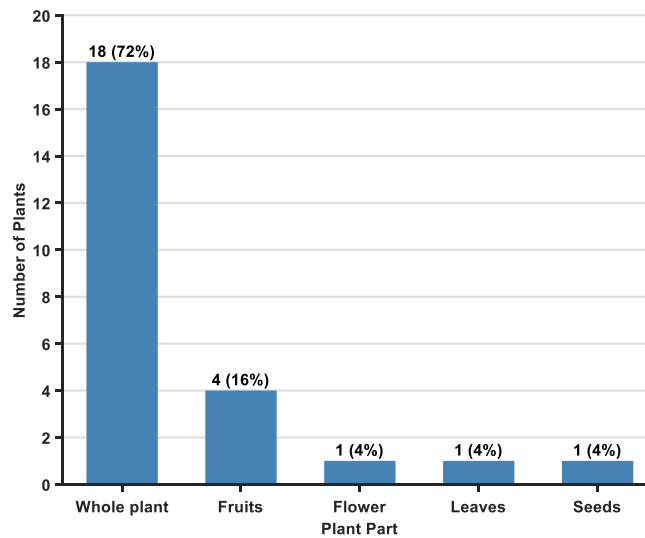


Figure 6. Distribution of Plant Parts Used for Medicinal Purposes

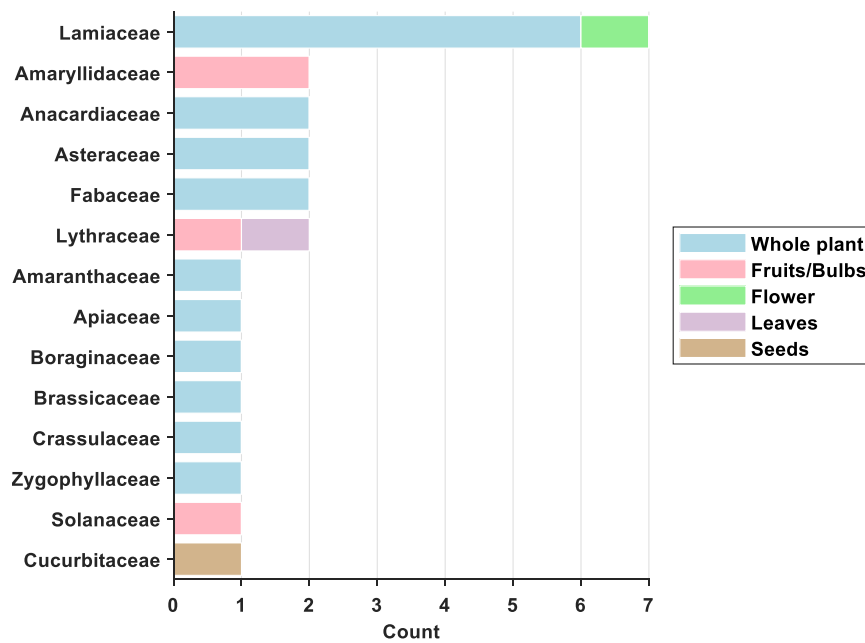


Figure 7. Distribution of Utilized Plant Parts by Family

The preparation methodologies exhibited clear patterns, with powdering techniques predominating in plants containing volatile compounds (Fig. 8). As illustrated in the figure, this powder preparation method is overwhelmingly dominant in Lamiaceae and is also extensively employed in Lythraceae, Apiaceae, Brassicaceae, Cucurbitaceae, and Solanaceae (Fig. 9).

Decoctions are favored for extracting water-soluble constituents, particularly evident in Fabaceae (exclusively using decoction), Amaranthaceae, Boraginaceae, and Zygophyllaceae. Asteraceae and Anacardiaceae demonstrate a balanced utilization of both powder and decoction methods, suggesting versatility in their therapeutic applications. The specialized application of steaming, most prominently observed in Crassulaceae and partially in Amaryllidaceae, represents a distinct preparation technique primarily associated with specific taxa such as *Allium cepa* and *Sedum telephium*. This taxonomic differentiation in preparation methodologies indicates empirically developed knowledge systems that optimize the extraction efficacy of bioactive compounds characteristic of different plant families.

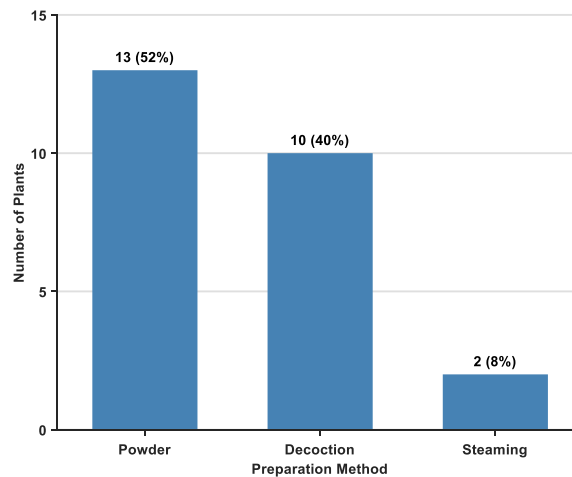


Figure 8. Distribution of Traditional Preparation Methods

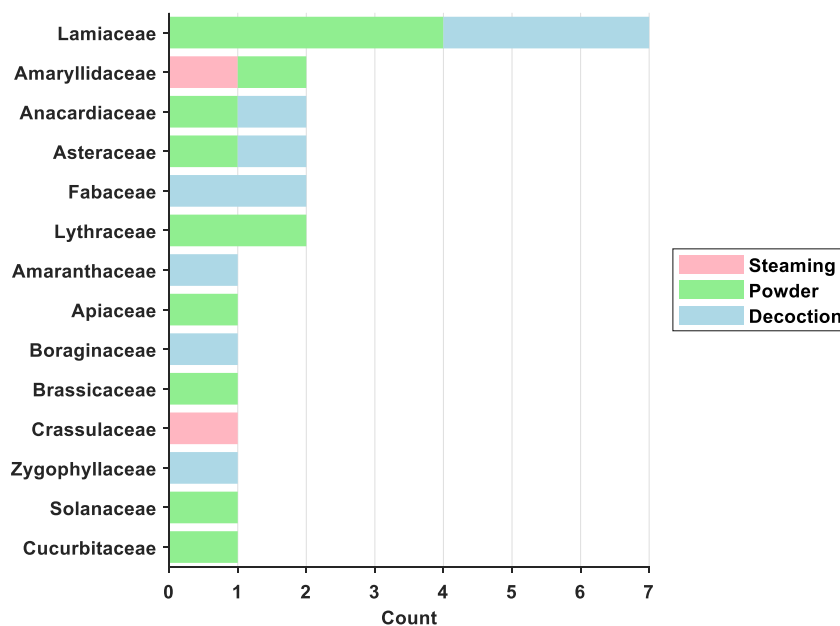


Figure 9. Distribution of Preparation Techniques by Plant Family

## Discussion

The results revealed a significant reliance on the Lamiaceae family for wound healing applications, as evidenced by its species richness and consistent local use. This corroborates the established observation that Lamiaceae members contain high concentrations of phenolics, flavonoids, and terpenoids, which facilitate antimicrobial, antioxidant, and anti-inflammatory processes (Frezza *et al.* 2019, Kowalczyk *et al.* 2023, Tsitsigianni *et al.* 2023). *Phlomis bovei* (RFC = 0.23) and *Mentha spicata* (RFC = 0.22) demonstrate how local practitioners differentiate among closely related taxa based on subtle differences in chemical profiles. In El Bayadh, Lamiaceae is predominant in the treatment of both skin and gastrointestinal disorders (Boukhobza *et al.* 2021), with decoctions and macerations reflecting a longstanding cultural preference for orally administered herbal teas (Kefifa *et al.* 2019, Dif *et al.* 2023). Other Lamiaceae taxa in Algeria have similar wound-healing properties. *Phlomis crinita* has been recognized for its antioxidant activities in addressing skin lesions (Baali *et al.* 2024), whereas *Teucrium polium* L. subsp. *geyrii* shares comparable anti-inflammatory and tissue-regenerative attributes (Boukhobza *et al.* 2021). These convergent ethnopharmacological themes across regions reflect an emerging consensus on the efficacy of Lamiaceae, validated by chemical analyses highlighting the phenolic and terpenoid profiles of the family.

Despite the importance of Lamiaceae, notable non-Lamiaceae outliers, *Lagenaria siceraria* (RFC = 0.51) and *Capsicum annum* (RFC = 0.45), illustrate the complexity of ethnopharmacological knowledge. *Lagenaria siceraria* seeds have potent immunomodulatory and collagen-enhancing properties at wound sites (Agyare *et al.* 2016, Meguellati *et al.* 2019), whereas

*Capsicum annuum* employs capsaicinoids to alleviate neurogenic inflammation and reduce bacterial proliferation (Mehboob *et al.* 2022, Huang *et al.* 2023). These "outlier" species in local remedies highlight an adaptive botanical selection system driven by efficacy rather than taxonomic proximity. Similar patterns emerged for *Urtica dioica* (nettle) in northern Algeria, which garners a high wound-healing consensus, sometimes exceeding commercial products in experimental settings (Abubakar & Haque 2020, Nandhini *et al.* 2024). Herbaceous growth forms predominated in our dataset, which is consistent with broader patterns observed in North Africa, where herbs regenerate quickly and are ecologically abundant (Boudjelal *et al.* 2013, Dastyar & Lysiuk 2023). Selected shrubs and trees, such as *Pistacia lentiscus*, *Lawsonia inermis*, and *Punica granatum*, are harvested for their high phenolic or terpenoid concentrations.

In El Bayadh, *Artemisia herba-alba* (Asteraceae) serves as a flagship species with antifungal and antimicrobial properties and is used for respiratory ailments and diverse conditions (Kefifa *et al.* 2019, Dif *et al.* 2023). Region-specific preferences for *Phlomis crinita* (Lamiaceae) and *Hammada scoparia* (Amaranthaceae) in other Algerian semi-arid zones demonstrate how morphological adaptations, particularly in desert-adapted shrubs, provide critical wound-care resources in harsh climates (Frei *et al.* 2000, Abubakar & Haque 2020). Our findings revealed a preference for whole-plant utilisation (72%), complemented by organ-specific approaches for high-RFC species such as *Lagenaria siceraria* (seeds) and *Capsicum annuum* (fruits). Whole-plant use leverages synergistic phytochemical interactions, whereas targeted organ harvesting exploits concentrated bioactive compounds, as exemplified in El Bayadh, where leaf-based decoctions predominate for Lamiaceae species (Chaima *et al.* 2025). This precision extends to other Algerian regions, where polysaccharide-rich leaves of *P. ciliata* are specifically utilised for their anti-inflammatory and wound-protective properties (Addoun *et al.* 2021).

The preparation methods included powdering (52%), decoction (40%), and steaming (8%) balance bioactive extraction optimisation with cultural accessibility. Powdering facilitates storage and dosing, whereas decoction extracts water-soluble constituents that are essential for infection control and inflammation modulation (Mukherjee 2019, Yassine *et al.* 2022). Steaming preserves volatile oils from aromatic plants, such as *Rosmarinus officinalis*, particularly in El Bayadh, where essential oil extraction is common (Amel *et al.* 2022, Dif *et al.* 2023). Beyond this region, numerous Algerian communities employ maceration and cold infusions to preserve thermolabile compounds in plants, such as *Aloe vera* and *Hypericum perforatum* (Bhaskar & Nithya 2012, Abubakar & Haque 2020). These patterns parallel research on plant-based wound care across North Africa. The prominence of Lamiaceae aligns with multiple Algerian studies, highlighting its high citation index in semi-arid contexts (Benarba *et al.* 2015, Addoun *et al.* 2021). El Bayadh's reliance on Lamiaceae and Asteraceae for both dermatological and gastrointestinal applications reflects their multipurpose usage, with species such as *Artemisia herba-alba* addressing conditions ranging from bacterial infections to scalp disorders (Dif *et al.* 2023). This finding is consistent with broader findings on the antimicrobial terpenoids and phenolic acids of Lamiaceae, which expedite tissue repair through oxidative stress reduction (Kowalczyk *et al.* 2023). Additional examples include the use of *Retama raetam* (Fabaceae) in southern Algeria for skin injuries, demonstrating how local ecologies influence species selection (Agyare *et al.* 2016).

The individual species in our study corresponded with those documented in the Algerian literature. *Rosmarinus officinalis* has emerged as a key species in El Bayadh for its antioxidant and antibacterial essential oils containing eucalyptol and borneol (Bano *et al.* 2014, Amel *et al.* 2022). *Mentha spicata* (RFC = 0.22) is used for dermatological and respiratory issues (Song *et al.* 2024, Chaima *et al.* 2025), whereas *Thymus vulgaris* demonstrates similar versatility in other regions of Algeria (Benarba *et al.* 2015). El Bayadh-specific surveys confirm the reliance on plant leaf decoctions and macerations to treat conditions ranging from skin diseases to gastrointestinal disorders (Hosseinkhani *et al.* 2016, Dif *et al.* 2023). *Artemisia herba-alba* features prominently, with essential oils active against *Bacillus cereus* and *Staphylococcus aureus* (Dif *et al.* 2023), supporting our emphasis on antimicrobial efficacy in wound healing. *Althaea officinalis*, with its mucilaginous roots, mitigates inflammation and protects wound sites (Nasrallah *et al.* 2020), exemplifying the region's diverse herbal strategies. Similarly, mucilage-producing plants, such as *Plantago ciliata*, contribute to the soothing of inflamed skin across Algeria (Addoun *et al.* 2021).

The use of Asteraceae species for nervous system and sensory organ conditions (Kefifa *et al.* 2019) complements our results, showing *Artemisia herba-alba* (RFC = 0.14) and *Anvillea radiata* (RFC = 0.07) to be effective. Although primarily associated with wound healing, the anti-inflammatory and analgesic properties of these plants have extended their utility to a broader health domain. Similar applications have been observed in other Algerian regions, where *Echinops spinosus* provides antimicrobial tannins and astringent effects (Nabti *et al.* 2023). Synergy between ethnobotanical knowledge and scientific validation appears consistently, whether examining *Teucrium polium* for wound closure (Boukhobza *et al.* 2021) or *Pistacia atlantica* in El Bayadh (Nesrine *et al.* 2022). Shared mechanisms of antioxidant, antimicrobial, and anti-inflammatory activities have been documented across species, families, and geographical regions (Mehboob *et al.* 2022, Huang *et al.* 2023).

This convergence validates local practices, as plants are selected based on their utilization of fundamental biochemical pathways (Kefifa *et al.* 2019). Less-studied taxa, such as *Hammada scoparia* (Amaranthaceae), demonstrate similar multi-phase wound support, from anti-inflammatory action to enhanced collagen deposition, as scientifically corroborated in desert environments (Zitouni-Nourine *et al.* 2022).

This study highlights the ethnobotanical significance of steppe flora in North Africa, emphasizing how harsh environmental factors such as aridity shape the composition and medicinal uses of local plants. Although the number of species documented may appear limited, these species exhibit strong adaptation mechanisms that support their therapeutic efficacy (Huang *et al.* 2023). The documentation of active compounds and traditional uses in this ecosystem enriches the understanding of plant-based medicine and supports future pharmacological research. Similar findings have been reported in comparable arid regions where indigenous knowledge provides a foundation for developing novel therapeutic agents (Larit & León 2023, Nandhini *et al.* 2024). The preservation of this knowledge, coupled with scientific validation, is essential for promoting sustainable healthcare solutions rooted in biodiversity conservation.

Sustainability concerns merit attention, as overharvesting threatens biodiversity in El Bayadh, potentially undermining both healthcare options and ecological stability through the disappearance of key plants, such as *Artemisia herba-alba* and *Rosmarinus officinalis* (Nasrallah *et al.* 2020, Addoun *et al.* 2021). Although the medicinal flora of the region offers substantial value, conservation strategies must balance therapeutic needs with plant preservation. Similar challenges are encountered in other Algerian regions where high-demand species exist, for example, *Pistacia vera* and *Urtica dioica* face unsustainable exploitation, necessitating integrative conservation frameworks that protect both botanical resources and ethnopharmacological knowledge (Fetati & Lassouani 2018, Degola *et al.* 2019). The significance of Lamiaceae transcends both global and regional contexts. These species are prominent in wound healing studies, providing phytochemicals that combat infection and support collagen synthesis (Bano *et al.* 2014, Frezza *et al.* 2019). In El Bayadh, family members such as *Rosmarinus officinalis* and *Mentha spicata* are indispensable for infection management, particularly for skin and gastrointestinal conditions (Amel *et al.* 2022, Yassine *et al.* 2022). Ethnobotanical surveys document leaf decoctions and macerations, which is consistent with plant chemistry that concentrates essential oils and phenolics in the aerial parts (Kefifa *et al.* 2019). Beyond this region, *Phlomis crinita* demonstrates comparable wound-healing attributes in North-Central Algeria (Baali *et al.* 2024).

*Lagenaria siceraria* (RFC = 0.51) and *Capsicum annuum* (RFC = 0.45) demonstrated how specialized plants sometimes exceeded the recognition afforded to Lamiaceae. These high citation frequencies indicate practitioner prioritization of specific wound types, particularly those prone to chronic infection or severe inflammation (Mehboob *et al.* 2022). In El Bayadh's semi-arid environment, this selection extends to species such as *Artemisia herba-alba*, which combine drought tolerance with antimicrobial and antifungal properties (Belwal *et al.* 2018). The indigenous knowledge of the region effectively merges ecological suitability and therapeutic efficacy. Similar adaptability appears in desert endemics, such as *Hammada scoparia*, in southern Algeria, where local knowledge and plant resilience converge in wound-healing practices (Zitouni-Nourine *et al.* 2022). Despite the predominance of whole-plant usage (72%), certain species have more targeted applications, such as the seeds of *Lagenaria siceraria*, leaves of *Rosmarinus officinalis*, and roots of *Althaea officinalis*. This reflects a sophisticated understanding of the distribution of phytochemicals within plant organs (Nasrallah *et al.* 2020, Olarewaju *et al.* 2021). Lamiaceae leaves concentrate antimicrobial terpenoids and flavonoids, justifying their specific harvest for use in skin and respiratory decoctions (Belhouala & Benarba 2021). Root-based mucilage in *Althaea officinalis* and seed compounds in *Capsicum annuum* have distinct therapeutic effects. Similarly, *Plantago ciliata* (Plantaginaceae) is harvested specifically for its polysaccharide-rich leaves in other Algerian regions, demonstrating tailored strategies to maximize healing benefits (Addoun *et al.* 2021).

The prevalence of powdering and decoction methods reflects the interplay between practicality and the efficiency of phytochemical extraction. Powdering extends shelf life, whereas decoction isolates water-soluble compounds that are crucial for infection control (Mukherjee 2019, Yassine *et al.* 2022). In El Bayadh, orally administered herbal teas are predominant for gastrointestinal and respiratory conditions (Touckia *et al.* 2014, Hosseinkhani *et al.* 2016). Essential oil extraction, particularly from *Artemisia herba-alba* and *Rosmarinus officinalis*, demonstrates specialized expertise in capturing volatile antimicrobial compounds (Amel *et al.* 2022, Dif *et al.* 2023). This intergenerational knowledge transmission underscores both the scientific rationale and cultural significance. Comparable methods in other Algerian contexts, such as Propolis ointments for wound closure, illustrate how community-developed techniques can rival standardized preparations (Abubakar & Haque 2020). The ethnopharmacological depth of local communities exists alongside pressing conservation challenges. The increasing demand for high-value medicinal plants in El Bayadh threatens biodiversity and the continuity of

traditional healthcare (Nasrallah *et al.* 2020, Belhouala & Benarba 2021). These attributes make these species valuable for wound care— ease of extraction, potent compounds, and recognized efficacy—may accelerate their depletion without responsible management. Integrative conservation approaches, public education, and scientific collaboration are essential to ensure that semi-arid ecosystems can sustainably provide medicinal resources (Kefifa *et al.* 2019). Similar concerns affect other Algerian regions, such as *Urtica dioica* and *Pistacia vera*, which face ecological pressure from harvesting practices (Degola *et al.* 2019, Nesrine *et al.* 2022). Balancing therapeutic benefits with conservation imperatives represents both a challenge and an opportunity for communities and researchers committed to preserving Algeria's medicinal plant heritage. Documenting El Bayadh's wound-healing plants has valuable applications in healthcare, conservation, and economic development. These findings can inform integrative medicine approaches in remote areas, guide training programs, and develop sustainable harvesting protocols that generate income while preserving the biodiversity of the species.

The methodological limitations include non-random participant selection, potentially causing selection bias; reliance on self-reported information, introducing recall bias; and six-month data collection, possibly missing seasonal patterns. Although we employed mitigating strategies such as botanical verification, data triangulation, and ethical protocols, social desirability bias remains. While the findings may not be generalizable beyond El Bayadh's cultural context, they provide valuable insights into local wound-healing practices. Future research should include multi-seasonal studies, phytochemical validation, and broader community sampling to enhance the understanding of wound healing ethnopharmacology while contributing to sustainability and health care discourse.

## Conclusions

In conclusion, this ethnobotanical study of the steppe flora in North Africa offers important insights into the traditional uses and medicinal potential of local plant species in an arid environment. Despite the limited species richness, these plants hold significant therapeutic value, particularly in wound healing and infection control. Specifically, this survey provides an in-depth account of the flora in El Bayadh, highlighting a strong reliance on Lamiaceae, Asteraceae, and selected high-RFC species (*Lagenaria siceraria* and *Capsicum annuum*), whose bioactive profiles address the region's wound-care needs. By synthesizing cultural knowledge with quantitative measures such as RFC, this study reveals both the adaptability of semi-arid communities in harnessing local biodiversity and the pharmacological potential of the plants. This perspective contributes to the growing discourse on sustainable healthcare strategies, especially in the face of increasing antibiotic resistance and environmental pressures. Moreover, the documentation of traditional practices enriches the broader theoretical frameworks of ethnopharmacology, underscoring how ecological context, cultural heritage, and phytochemical diversity converge to meet local health challenges. Ultimately, the careful documentation and validation of indigenous knowledge presented here form a crucial basis for future investigations. Continued research integrating these ethnobotanical data with modern scientific methods will enhance the discovery of bioactive compounds and support the development of novel natural remedies, reinforcing the importance of preserving biodiversity and cultural heritage for the next generation of therapeutic innovations.

## Declarations

**List of abbreviations:** RFC: Relative Frequency of Citation.

**Ethics approval and consent to participate:** The research was conducted in accordance with ethical and legal protocols governing studies on traditional knowledge. Verbal informed consent was obtained from each participant before commencing the survey. The collection of data adhered to principles of confidentiality, anonymity, and consent.

**Consent for publication:** Not applicable.

**Availability of data and materials:** The data used to support the findings of this study are available from the corresponding author upon reasonable request.

**Competing interests:** The authors declare that they have no competing interests.

**Funding:** Not applicable.

**Author contributions:** L.F. collected the data, analyzed, conceptualized the methodology, and wrote the text. A.C. participated in the theoretical background, provided supervision and validation, monitored data collection and analysis, helped with discussions, and wrote the final version of the manuscript.

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## Literature cited

- Abubakar AR, Haque M. 2020. Preparation of medicinal plants: Basic extraction and fractionation procedures for experimental purposes. *Journal of Pharmacy & Bioallied Sciences* 12(1):1-10.
- Addoun N, Boual Z, Delattre C, Chouana T, Gardarin C, Dubessay P, Benaoun F, Addaoud S, Ould El Hadj MD, Michaud P, Pierre G. 2021. Beneficial health potential of Algerian polysaccharides extracted from *Plantago ciliata* Desf. (Septentrional Sahara) leaves and seeds. *Applied Sciences* 11(9):4299.
- Agyare C, Boakye Y, Bekoe E, Hensel A, Dapaah S, Appiah T. 2016. Review: African medicinal plants with wound healing properties. *Journal of Ethnopharmacology* 177:85-100.
- Amel BH, Mahmoud DM, Abbassia A, Souhila M. 2022. Valorization of essential oil of *Rosmarinus officinalis* L. from El Bayadh Region-Algeria. *Egyptian Academic Journal of Biological Sciences C: Physiology and Molecular Biology* [Online]. doi: 10.21608/eajbsc.2022.234378.
- Antonio Demetrio R, Cárdenas León D, Delgado C, Correa R, Espinoza RV. 2025. Traditional ecological knowledge on stingless bees in two Ashaninka communities in the central rainforest of Peru. *Ethnobiology and Conservation* 14.
- Baali F, Boudjelal A, Smeriglio A, Righi N, Djemouai N, Deghima A, Bouafia Z, Trombetta D. 2024. *Phlomis crinita* Cav. from Algeria: A source of bioactive compounds possessing antioxidant and wound healing activities. *Journal of Ethnopharmacology* 331:118295.
- Bano A, Saboor A, Ahmad M, Ashraf MA, Sultana S, Zafar M, Khan MPZ, Arshad M, Hadda TB. 2014. Quantitative ethnomedicinal study of plants used in the Skardu Valley at high altitude of Karakoram-Himalayan range, Pakistan. *Journal of Ethnobiology and Ethnomedicine* 10(1):43.
- Belhouala K, Benarba B. 2021. Medicinal plants used by traditional healers in Algeria: A multiregional ethnobotanical study. *Frontiers in Pharmacology* 12:760492.
- Belwal T, Ezzat SM, Rastrelli L, Bhatt ID, Daglia M, Baldi A, Devkota HP, Orhan IE, Patra JK, Das G, Anandharamkrishnan C, Gomez-Gomez L, Nabavi SF, Nabavi SM, Atanasov AG. 2018. A critical analysis of extraction techniques used for botanicals: Trends, priorities, industrial uses and optimization strategies. *TrAC Trends in Analytical Chemistry* 100:82-102.
- Benarba B, Belabid L, Righi K, Bekkar A, Elouissi M, Khaldi A, Hamimed A. 2015. Ethnobotanical study of medicinal plants used by traditional healers in Mascara (North West of Algeria). *Journal of Ethnopharmacology* 175:626-637.
- Bhaskar A, Nithya V. 2012. Evaluation of the wound-healing activity of *Hibiscus rosa sinensis* L. (Malvaceae) in Wistar albino rats. *Indian Journal of Pharmacology* 44(6):694-698.
- Bouasla A, Bouasla I. 2017. Ethnobotanical survey of medicinal plants in northeastern of Algeria. *Phytomedicine* 36:68-81.
- 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(2):395-402.
- Boukhobza Z, Sekkoum A, Cheriti A. 2021. Traditional phytotherapy of medicinal plants used in Brezina Oasis (El Bayadh district-Algeria). *Phytochemical and Biosubstances Journal* 15(3):341.
- Chaima B, Boutlelis D, Touhami L, Amara D, Atoki A, Zahnit W, Messaoudi M. 2025. Polyphenolic profiling and wound healing potential of *Hammada scoparia* (Pomel) Iljin: preclinical evaluation of a novel topical formula. *Natural Product Communications* 20(1).
- Cheriti AA, Rouissat A, Sekkoum K, Balansard G. 1995. Plantes de la pharmacopée traditionnelle dans la région d'El-Bayadh (Algérie). *Fitoterapia* 66:525-538.
- Choi S, Son B, Son Y, Park Y, Lee S, Chung M. 2001. The wound-healing effect of a glycoprotein fraction isolated from *Aloe vera*. *British Journal of Dermatology* 145(4):535-545.
- Dastyar N, Lysiuk R. 2023. Identification of the most important medicinal plants used for wound healing: An ethnobotanical study of Sistan and Baluchestan Province, Southeastern Iran. *Journal of Biochemistry and Phytomedicine* [Online]. doi: 10.34172/jbp.2023.5.
- Degola F, Marzouk B, Gori A, Brunetti C, Dramis L, Gelati S, Restivo F. 2019. *Aspergillus flavus* as a model system to test the biological activity of botanicals: an example on *Citrullus colocynthis* L. Schrad. organic extracts. *Toxins* 11(5):286.
- Dif M, Alami O, Benchohra A, Allali N. 2023. Ethnobotanical study of antifungal medicinal plant in the region of El Bayadh (Algeria). *Research Journal of Pharmacy and Dosage Forms and Technology* [Online]. doi: 10.52711/0975-4377.2023.00014.
- Fetati A, Lassouani A. 2018. Chemical composition of leaves and fruits of a South Algerian *Pistacia atlantica* Desf. ecotype. In: Kallel A, Ksibi M, Ben Dhia H, Khélifi N. (eds). *Recent advances in environmental science from the Euro-Mediterranean and surrounding regions*. Springer, Cham, Switzerland, Pp. 1415-1417.

- Frei B, Sticher O, Heinrich M. 2000. Zapotec and Mixe use of tropical habitats for securing medicinal plants in México. *Economic Botany* 54(1):73-81.
- Frezza C, Venditti A, Serafini M, Cauto F, Bianco A, Serafini M, Celano R, Mastellone C, Foddai S. 2019. Phytochemistry, chemotaxonomy, ethnopharmacology, and nutraceuticals of Lamiaceae. *Studies in Natural Products Chemistry* 62:125-178.
- Hosseinkhani A, Falahatzadeh M, Raoofi E, Zarshenas M. 2016. An evidence-based review on wound healing herbal remedies from reports of traditional Persian medicine. *Journal of Evidence-Based Complementary & Alternative Medicine* 22(2):334-343.
- Huang CJ, Pu CM, Su SY, Lo SL, Lee CH, Yen YH. 2023. Improvement of wound healing by capsaicin through suppression of the inflammatory response and amelioration of the repair process. *Molecular Medicine Reports* 28(2):155.
- Kefifa A, Saidi A, Hachem K, Mehalhal O. 2019. An ethnobotanical survey and quantitative study of indigenous medicinal plants used in the Algerian semi-arid region. *Phytothérapie* [Online]. doi: 10.3166/PHYTO-2018-0077.
- Kowalczyk T, Merecz-Sadowska A, Ghorbanpour M, Szemraj J, Piekarski J, Bijak M, Śliwiński T, Zajdel R, Sitarek P. 2023. Enhanced natural strength: Lamiaceae essential oils and nanotechnology in in vitro and in vivo medical research. *International Journal of Molecular Sciences* 24(20):15279.
- Larit F, León F. 2023. Therapeutics to treat psychiatric and neurological disorders: A promising perspective from Algerian traditional medicine. *Plants* 12(22):3860.
- Meguellati H, Ouafi S, Saad S, Djemouai N. 2019. Evaluation of acute, subacute oral toxicity and wound healing activity of mother plant and callus of *Teucrium polium* L. subsp. *geyrii* Maire from Algeria. *South African Journal of Botany* 127:25-34.
- Mehboob M, Naureen I, Saleem A, Amanat A. 2022. Medicinal and nutritional importance of *Lagenaria siceraria* (lauki). *Saudi Journal of Biomedical Research* 7(2).
- Miara M, Bendif H, Hammou A, Teixidor-Toneu I. 2018. Ethnobotanical survey of medicinal plants used by nomadic peoples in the Algerian steppe. *Journal of Ethnopharmacology* 219:248-256.
- Mukherjee PK. 2019. Antiviral evaluation of herbal drugs. In: Mukherjee PK. (ed). *Quality control and evaluation of herbal drugs*. Elsevier, Amsterdam, Netherlands, Pp. 599-628.
- Nabti B, Kellou M, Boukhalfa D. 2023. Physicochemical characteristics and thin layer chromatography of the essential oil of spearmint: *Mentha spicata* L. from Western Algeria. *International Journal of Biological and Pharmaceutical Sciences Archive* 6(2):156-163.
- Nandhini MS, Ahmadiyahangar R, Lavanya R, Lathika M, Megavarthini KV, Lavanya M, Shanmugapandiyan P. 2024. A review: The therapeutic power of natural extracts in wound recovery. *Future Journal of Pharmaceuticals and Health Sciences* 4(4):94-101.
- Nasrallah Y, Aouadj S, Khatir H. 2020. Impact of the exploitation of medicinal plants on biodiversity conservation in Saida and El Bayadh regions, Algeria. *Biodiversity Research and Conservation* 60:11-22.
- Nesrine H, Khedidja B, Meriem B. 2022. The medicinal plants of the region of El Oued (Southeastern Algeria): Inventory and traditional therapeutic uses. *Plant Archives* 22(2):357-365.
- Olarewaju O, Fajinmi O, Arthur G, Coopoosamy R, Naidoo K. 2021. Food and medicinal relevance of Cucurbitaceae species in Eastern and Southern Africa. *Bulletin of the National Research Centre* 45(1):139.
- Ouelbani R, Bensari S, Mouas T, Khelifi D. 2016. Ethnobotanical investigations on plants used in folk medicine in the regions of Constantine and Mila (Northeast of Algeria). *Journal of Ethnopharmacology* 194:196-218.
- Phumthum M. 2020. How far are we? Information from the three decades of ethnomedicinal studies in Thailand. *Ethnobiology and Conservation* 9.
- Song M, Qiu L, Liu Y, Wang ZY, Zhang QW. 2024. Conventional methods of sample preparation for quality control of Chinese medicines. In: Wang X, Zhang W. (eds). *Quality control of Chinese medicines: Strategies and methods*. Springer Nature Singapore, Singapore, Pp. 251-266.
- Tardío J, Pardo-de-Santayana M. 2008. Cultural importance indices: A comparative analysis based on the useful wild plants of southern Cantabria (northern Spain). *Economic Botany* 62(1):24-39.
- Touckia GI, Kosh-Komba E, Yongo OD. 2014. Plantes alimentaires d'intérêt médicinal utilisées par les Pygmées de la commune de Pissa (République Centrafricaine). *International Journal of Biological and Chemical Sciences* 8(2):517-527.
- Tsitsigianni E, Tomou EM, Almpani C, Rallis MC, Skaltsa H. 2023. Biological activities of Lamiaceae species: Bio-guided isolation of active metabolites from *Salvia officinalis* L. *Agronomy* 13(5):1224.

Yassine D, Mahmoud D, Amel B, Houda D, Asma A, Salima B, Abderezzak B, Miloua S. 2022. Sensitive medicinal plants in El Bayadh Zone (Algeria, W). *Egyptian Academic Journal of Biological Sciences C: Physiology and Molecular Biology* [Online]. doi: 10.21608/eajbsc.2022.260909.

Zitouni-Nourine S, Belyagoubi-Benhammou N, Zitouni-Haouar F, Douahi O, Chenafi F, Fetati H, Sari S, Benmahieddine A, Zaoui C, Mekaouche F, Bekkara A, Kambouche N, Gismondi A, Toumi H. 2022. *Echinops spinosissimus* Turra root methanolic extract: Characterization of the bioactive components and relative wound healing, antimicrobial and antioxidant properties. *Plants* 11(24):3440.