Ethnobotanical study on the traditional uses of *Rosmarinus officinalis* L. in the Nâama Region (South-Western Algeria)

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Research

Abstract

Background: Rosmarinus officinalis L. (rosemary) is extensively used by indigenous communities in Algeria for a wide range of therapeutic purposes. Although rosemary holds important cultural and medicinal value, the Nâama region remains insufficiently documented in ethnobotanical literature.

Methods: This study aims to document, analyse and evaluate local ethnobotanical knowledge regarding the traditional uses of *R. officinalis* within indigenous pharmacopeia. An ethnobotanical survey was conducted among 300 purposively selected informants using semi-structured questionnaires. Quantitative indices, including Use Value (UVs), informant Consensus Factor (ICF), Fidelity Level (FL) and Plant Part Value (PPV) were calculated. Advanced statistical analyses (Chi-square, ANOVA) were performed to assess the influence of socio-demographic factors on knowledge distribution.

Results: The species demonstrated high ethnopharmacological relevance (UV = 3.46). Digestive (FL= 86 %, ICF = 0.992) and respiratory disorders (FL= 69.33%, ICF= 0.978%) were the ailments most frequently treated using rosemary. Leaves were the most commonly used plant part (PPV= 0.623). Infusion (62.33%) and decoction (36.33%) were the dominant preparation methods. Statistical comparisons revealed significant differences in knowledge transmission patterns between age groups and localities.

Conclusions: These findings confirm the therapeutic and cultural significance of *Rosmarinus officinalis* L. and underscore the importance of further targeted phytochemical and pharmacological studies to support its safe integration into complementary and traditional medicine systems. The study provides a robust baseline for conservation efforts and public health policy recommendations.

Keywords: Rosmarinus officinalis L., Nâama region, indigenous knowledge, traditional medicine, ethnobotanical survey.

Background

Medicinal plants have historically served as primary therapeutic resources across many societies (Adli *et al.* 2021). Algeria, with its vast territory (over 2.3 million km²), hosts exceptionally rich flora diversity with more than 4,300 species and subspecies of vascular plants (Al-Sereiti *et al.* 1999; Andrade *et al.* 2018). The popular use of aromatic and medicinal plants, based on ancestral knowledge and expertise, constitutes a valuable cultural heritage (Attaoui *et al.* 2024).

Previous ethnobotanical studies in southern Algeria indicate that the Lamiaceae botanical family is widely represented in traditional pharmacopeia, with *Rosmarinus officinalis* L. often emerging as one of the most valued species (Becer *et al.* 2023; Begum *et al.* 2013; Bekhechi *et al.* 2024). Specifically, a study by Hadjadj *et al.* (2019) in Djebel Aissa National Park (Naâma, south-western Algeria) on 200 informants showed the predominance of Lamiaceae (9 species, or 21.95%) among the 41 recorded plant species. The most popular species was identified as *Rosmarinus officinalis* L., with a citation frequency of around 61% (Fiume *et al.* 2018). Similar results were reported by Benarba (2016) in the Bechar and Adrar region, an area that shares climatic, demographic, and geographical characteristics with the study area (Benarba, 2016).

Rosemary, commonly known among rural Algerian populations as “Iklil” or “Yazir”, has been used in folk medicine for a wide range of applications, including as an antispasmodic, diuretic, carminative, and to relieve respiratory and digestive disorders (Borges *et al.* 2019; Bouafia *et al.* 2021).

The Nâama region, an Algerian typical highland area with its diverse ecosystems, pastoral traditions and long-standing cultural heritage, preserves extensive indigenous knowledge related to aromatic and medicinal plants. While the phytochemical composition of rosemary is well documented in the scientific literature (Boudjelal *et al.* 2013; De Oliveira *et al.* 2019; Diniz do Nascimento *et al.* 2020), no recent comprehensive ethnobotanical study has focused exclusively on rosemary in the Nâama region.

This study therefore aims to fill this gap by documenting local knowledge, identifying medicinal uses, analyzing cultural significance, and evaluating quantitative ethnobotanical indicators associated with *Rosmarinus officinalis* L.

Materials and Methods

Study area

The study area is represented by the province of Nâama (south-western Algeria), a pastoral region covering an area of 29,819.30 km² (latitude: 33° 16' 0.01 North, longitude: 0° 19' 00 West). It is bordered to the north by the Tellian Atlas and to the south by the Saharan Atlas Mountain range. The territory of Nâama is characterised by 03 main geographical zones: A northern steppe plain, a mountainous area and a southern pre-Saharan (Bensaïd. 2006). The province of Nâama is divided into 07 departments and 12 municipalities (Figure 1).

The Naâma region is inhabited by communities (289,045 inhabitants according to the latest census on 31 December 2019) with a long-standing pastoral tradition which shapes their dependence on medicinal plants.

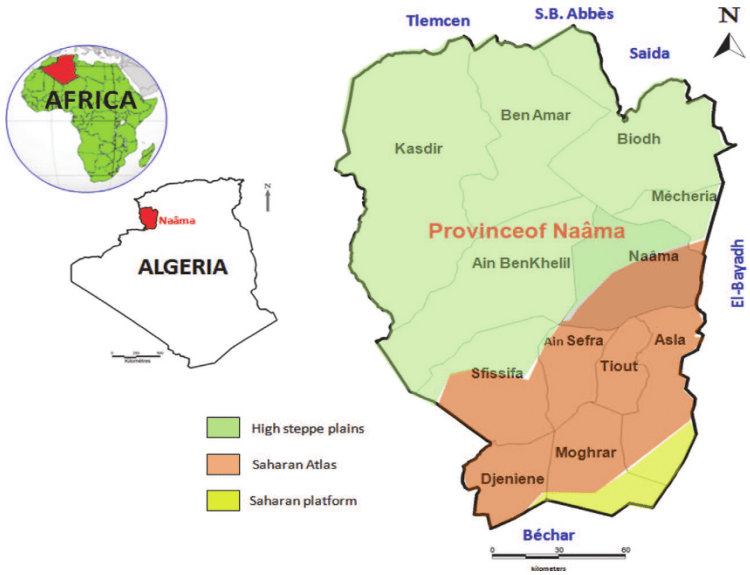

Figure 1. Location of the study area (Nâama, South-West Algeria) (after Benaradj et al. 2021, with permission).

Data Collection

The ethnobotanical survey was conducted during 2024-2025. Semi-structured questionnaires were prepared for interviews with informants, in accordance with the methodology adopted by Martin (2004).

Sampling Procedure

The sample selection was designed to ensure representativeness across the main geographical zones and socio-economic groups of the province. A total of 300 informants were selected using a purposive sampling method. This non-probability technique was chosen to maximize the likelihood of interviewing individuals with deep, specialized ethnobotanical knowledge, thereby ensuring the richness and relevance of the collected data.

Inclusion and Exclusion Criteria

Inclusion criteria

- Residence within the Nâama province for at least 10 years to ensure familiarity with local flora and traditional practices.
- Belonging to one of the following key groups: health professionals (pharmacists, doctors, etc.), traditional herbalists, traditional healers, or elderly people (aged 60 and over), as these groups are considered inexhaustible sources of knowledge on the rational use of plant resources in traditional pharmacopoeia.

Exclusion criteria

- Individuals residing outside the study area or those who refused to provide informed consent.

Questionnaire Structure and Data Validation

The questionnaire was structured into two main sections:

- Socio-demographic data (gender, age, educational level, profession, locality).
- Ethnobotanical and ethno-pharmacological data specific to *Rosmarinus officinalis* L. (vernacular name, plant parts used, preparation methods and administration routes, ailments treated, etc.).

To ensure data quality and mitigate potential biases (e.g., recall bias), a preliminary pilot survey was conducted with 15 non-included informants to refine the clarity and comprehensibility of the questions. Furthermore, the information collected was cross-validated by comparing the uses reported by different informants for the same ailment, a process integral to the calculation of the Informant Consensus Factor (ICF).

Botanical identification

Botanical identification and authentication of plant material was conducted by taxonomists at the University of Sidi bel Abbes, Faculty of Natural and Life Sciences. Voucher specimens were collected, labelled, authenticated and deposited in the institutional herbarium.

Data Analysis

At the end of the study, the socio-demographic characteristics of the participants recorded were analysed using descriptive and quantitative statistical methods. Data processing and analysis were performed using Microsoft Excel 20 and Statistical Package for Social Science (SPSS) version 27.

Quantitative ethnobotanical indices were calculated following established methods:

Medical Use value (UVs): to determines the relative medical importance of a species within a community.

$$UV_s = \Sigma U_{is} / n_s$$ (Phillips & Gentry 1993)

Fidelity level (FL)**:** to quantifies the therapeutic potential of the plant for a specific ailment.

$$FL (\%) = Ip / Iu \times 100$$ (Heinrich *et al.* 1998)

Where:

Ip = The number of informants reporting of the species used in a specific disease treatment.

Iu = The number of informants who cited the same plant as useful.

Informant Consensus Factor (ICF): to measure consensus among informants on the medicinal uses of a species.

$$ICF = (Nur - Nt) / (Nur - 1)$$ (Heinrich *et al.* 1998)

Where:
Nur: Number of use citations for the species within category of ailment.
Nt: Total number of specific uses, refers to the total number of categories treated

Plant part value (PPV): to analyse the frequency of use of different plant parts.

$$PPV = \sum RU_{(plantpart)} / \sum RU$$ (Phillips & Gentry. 1993).

Advanced Statistical Analysis: To assess the influence of socio-demographic factors on ethnobotanical knowledge, advanced statistical tests were performed:

- Chi-square test was used to compare the frequency of use citations between categorical variables (e.g., gender, locality: urban vs. rural).
- ANOVA Kruskal-Wallis test was applied to compare different age groups and educational levels.
- Confidence Intervals (95% CI) were calculated for the key ethnobotanical indices (UVs, ICF, FL) to provide a measure of precision for the estimates.
- A *p*-value of 0.05 was considered statistically significant.

Results

Socio-Demographic Characteristics

The survey conducted in various departments of the Nâama province revealed that the use of medicinal plants is part of the culture of low-income indigenous peoples, characterised by an ancestral and cyclical rural and agro-pastoral lifestyle (Hadjadj *et al.* 2019). A total of 300 respondents (167 men and 133 women, sex ratio of 1.25), aged 20-87 years, participated in the study. Educational levels varied substantially with 40.33% having received university-level education and approximately half residing in rural areas (Table 1). Use of *Rosmarinus officinalis* L. was reported across all socio-demographic categories indicating its widespread cultural and medicinal relevance.

Table 1. Socio-demographic characteristics of informants (n=300)

Variables	Categories	Total	Percentages (%)	*p*-value
Gender	Male	167	55.7	0.057*
	Female	133	44.3	
Age groups (years)	≥ to 20 and < to 40	160	53.3	<0.001#
	≥ to 40 and < to 60	96	32	
	≥ to 60	44	14.7	
Educational level	None	58	19.33	<0.001#
	Primary	37	12.33	
	Secondary	84	28	
	University	121	40.33	
Profession	Unemployed	137	45.7	<0.001#
	Employed in the public sector	73	24.3	
	Employed in the private sector	63	21	
	Retired	27	9	
Locality	Small rural area	13	4.3	<0.001#
	Rural area	139	46.3	
	Urban area	148	49.3	

(*) One-sample binomial test. (#) Chi-square test. A *p* value of 0.05 is considered significant.

The ethnobotanical survey that nomads represent 36.70% of the population, compared to 63.30% semi-nomads. Rural areas are undergoing profound changes linked to urbanisation. As a result, the lifestyle of the rural population is tending towards a restructuring in favour of a purely sedentary lifestyle.

The average age of participants was 40.34 ± 15.72 years, with 39.59 ± 15.44 years for men and 42.21 ± 16.05 years for women (p = 0.936). People in the 20-40 age group represent 53.3% of the overall sample, followed by adult informants aged 40-60 (32%). Older people represent approximately 14.7%.

In terms of educational attainment, 12.33% of the population studied had primary education and 28% had secondary education. The illiteracy rate is estimated at 19.33%. It is interesting to note that university graduates account for 40.33% of the total population. This finding clearly demonstrates the interest that young intellectuals have in traditional medicine, undoubtedly influenced by the ethno-pharmaceutical heritage.

According to the analysis of the data collected, more than 54.67% of informants are unemployed. 6% of them are retired. Public sector employees are estimated at 24.33%, including administrators, teachers, health executives, labourers, etc. The private sector accounts for only 6%. Pharmacists are estimated to represent 8.33% of respondents, compared to herbalists, who account for 6.67% (Figure 2).

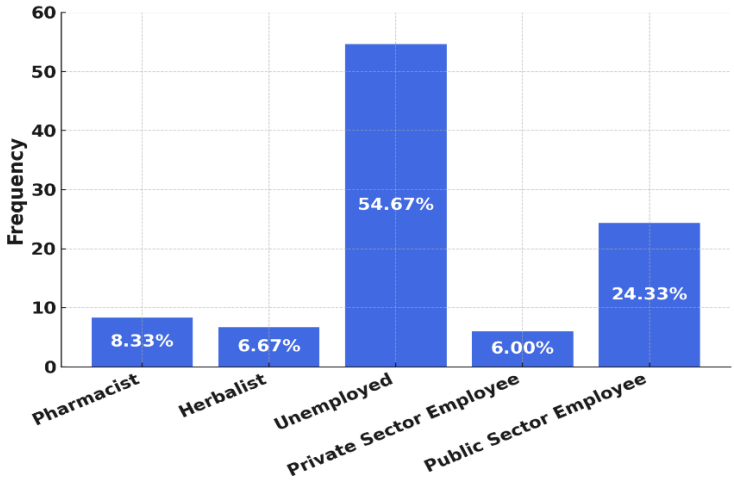

Figure 2. Distribution of participants according to their profession

The survey participants are evenly distributed between rural and urban areas, at 50.6% and 49.3% respectively.

Quantitative analysis

Medical Use value (UV_s)

The calculated Use Value (UVs=3.463, 95% CI: 3.35-3.57) indicates a high degree of ethnobotanical relevance, reflecting the broad spectrum of medicinal uses attributed to *Rosmarinus officinalis* L. by the local population. (Table 2).

Table 2. Ethnobotanical indices values (ICF, UVs, and FL) by category for the treatment of the most frequent ailments

Ailments	Sub-categories of disorders	ICF	FL (%)	UVs
1- Digestive disorders	Gastroenteritis, Constipation, Diarrhea, Vomiting, Bloating, Nausea	0 .992	86	3.463
2- Respiratory disorders	Asthma, Cold, Cough, Allergies, Rhinopharyngitis inflammations	0.978	69.333	
3- Parasitic diseases	Intestinal worms, Helminthiasis	0.974	42.666	
4- Osteoarticular disorders	Polyarthritis, Rheumatism, Muscle spasms	0.967	41	
5- Dermatological disorders	Dermatoses	0.960	29	
6- Hepatic & biliary diseases	Cholestasis, Gallstones	0.941	28	
7- Genito-urinary disorders	Urinary tract infections, Cystitis, Prostatitis, Hemorrhoids, Dysmenorrhea	0.909	24.333	

8- Diabetes	Hyperglycemia	0.857	15.333
9- Cancer		0.833	5.666
10- Others	Wounds, Burns, Thyroid disorders	0.750	5

ICF: Informant Consensus Factor. FL: Fidelity Level. UVs: Use Value.

Fidelity Level (FL)

The highest fidelity level (FL=86%) corresponded to digestive system ailments, followed by respiratory disorders (FL=69.33%). Moderate fidelity levels were reported for parasitic, osteoarticular and dermatological conditions indicating broader yet less specific applications of the plant.

Informant Consensus Factor (ICF)

The statistical results were processed to classify the therapeutic categories according to their degree of effectiveness as recognised by the local population:

Category 1: very strong consensus (0.974 ≤ ICF ≤ 0.992)
Digestive disorders, respiratory disorders, parasitic diseases.
Category 2: with strong consensus: (0.967 ≥ ICF ≥ 0.941)
Osteo-articular disorders, dermatological disorders, hepato-biliary disorders.
Category 3: with moderate consensus: (0.909 ≥ ICF ≥ 0.857)
Genitourinary disorders, diabetes.
Category 4: with weak consensus: 0.857 ≥ ICF ≥ 0.833 Cancer.
Category 5: with very weak consensus: ICF ≤0.750 Others.

High informant consensus values were recorded for digestive disorders (ICF=0.992), respiratory disorders (ICF=0.978) and parasitic diseases (ICF=0.974) indicating strong agreement among participants regarding the effectiveness of rosemary-based remedies.

Plant part value (PPV)

Leaves constituted the most frequently used plant part (PPV=0.623), followed by the whole plant (PPV=0.366). This preference aligns with the concentration of bioactive compounds typically found in rosemary foliage (Figure 3).

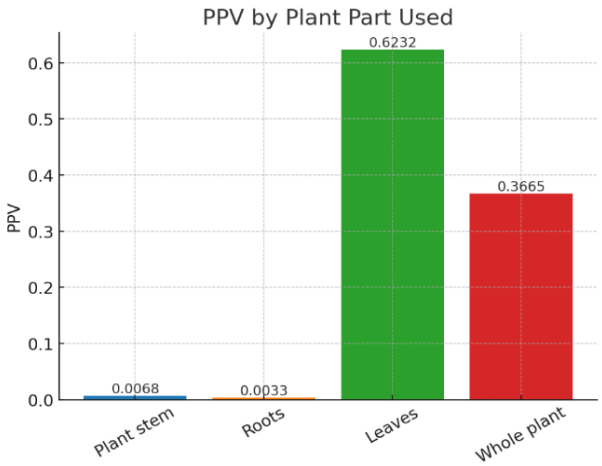

Figure 3. Distribution of plant parts according to (PPV)

Diagnostic and care results

Although herbalists represent 6.67% of the overall sample, they play an important role in diagnosing and prescribing rosemary-based remedies. They are consulted by more than 55.3% of participants. On the other hand, 44.3% of informants

make their own diagnoses, as most of them have acquired sufficient ethnopharmaceutical knowledge from their elders to follow traditional self-medication practices. Only 3% of respondents regularly consult doctors.

Preparation Methods and administration

Remedies based on wild rosemary, highly prized by the local population, are prepared by healers in different ways depending on the diagnosis and type of ailments. The use of dried plants predominates (66.78%) in traditional recipes compared to fresh plants (33.22%). However, infusion (62.33%) and decoction (36.33%) were the primary preparation reported. Most remedies were administered orally (87%) reflecting the predominance of internal ailments treated with rosemary.

The use of the plant in its raw state in powder form remains very low (1%). Other less frequent forms of use (0.33%) have been recorded, such as macerations, poultices, cooked preparations, etc. (Figure 4).

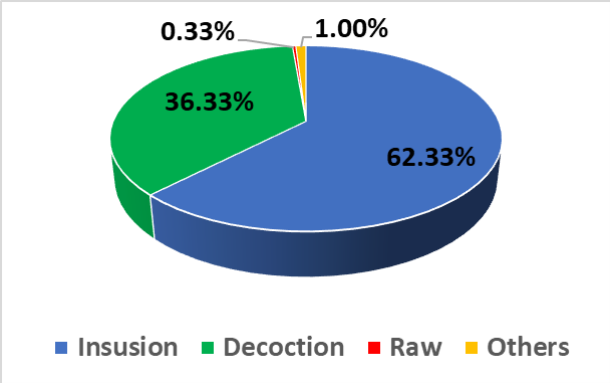

Figure 4. Frequency of various preparation methods

The method of administration depends on the nature of the preparation, the type of condition, and the age and gender of the patient. In general, most prepared remedies are prescribed for oral use (87%), followed by massage (8.33%), bandages (3%) and rinsing (1.7%) (Figure 5).

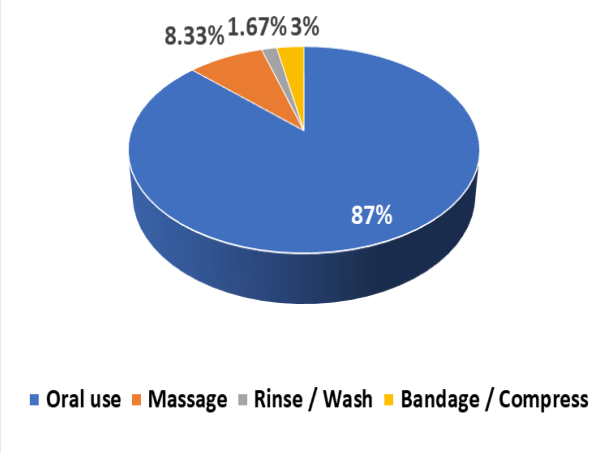

Figure 5. Methods of administration

Dosage and Duration

Dosage was traditionally measured using culturally embedded units such as pinches, spoonfuls and handfuls sometimes according to the part of the plant used (number of leaves, buds, etc.) (Figure 6). 42.95% of respondents use rosemary in pinches, 40.94% in handfuls and 16.11% in spoonfuls (Figure 6).

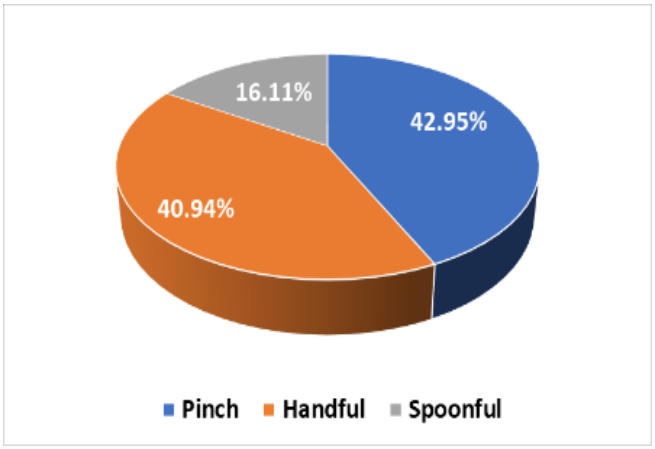

Figure 6. Distribution of medicinal plant users according to dosage

Treatment duration ranged from a single day to several weeks depending on the severity and type of ailment. 1.7% of respondents use the plant for one day, 34.67% for one week, 2.67% for one month, and 61% until complete recovery (Figure7).

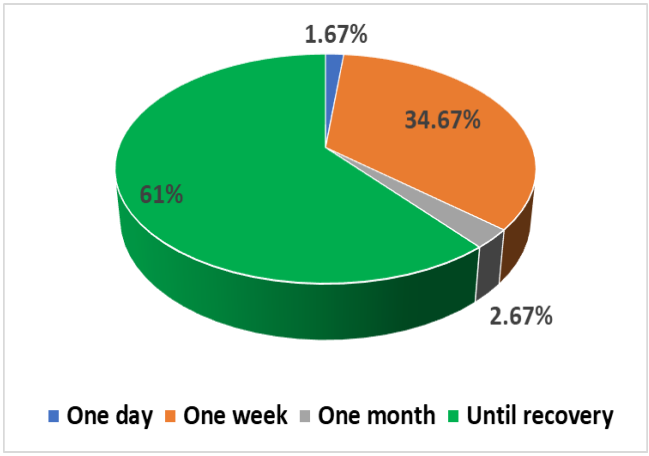

Figure 7. Treatment duration

Safety

It seems very interesting to know that the medicinal use of rosemary does not present any visible toxicity. No adverse health effects were reported by participants. Rosemary is classified as generally recognised as safe (GRAS) by the Food and Drug Administration in the US; however comprehensive toxicological data remain limited (Ghasemzadeh Rahbardar *et al.* 2022).

Discussion

The findings of this study underscore the central role of *Rosmarinus officinalis* L. within the traditional medicinal practices of the Nâama region.

The significant difference in knowledge depth across age groups ($p < 0.001$) is a critical finding, highlighting a potential risk of ethnobotanical knowledge erosion. The elderly (Age 60 years) serve as the primary reservoir of traditional knowledge, while the younger generation reports fewer uses. This trend is often associated with urbanization and the shift away from traditional agro-pastoral lifestyles (Hadjadj *et al.* 2025).

The consistently high UVs, FL and ICF values demonstrate strong community consensus and a well-established collective understanding of the plant's therapeutic potential. Our findings align with ethnobotanical studies conducted across the Maghreb region, which consistently rank *Rosmarinus officinalis* L. among the most frequently cited medicinal plants. For instance, studies in Morocco (El-Ghazouani *et al.* 2024) and Tunisia (Ould El Hadj *et al.* 2003) also report its primary use for digestive and respiratory ailments, confirming a shared traditional knowledge base across North Africa and other Mediterranean regions; where rosemary is widely recognized for its anti-inflammatory, antimicrobial and antioxidant

properties (Gonçalves *et al.* 2022; Becer *et al.* 2023; Gonçalves *et al.* 2019). However, our study provides a unique quantitative perspective for the Nâama region, an area previously underrepresented in the literature. The high UVs value observed here is notably higher than the average UVs reported for *Rosmarinus officinalis* L. in some central Algerian regions (Bouafia *et al.* 2021; Boudjelal *et al.* 2013), suggesting a particularly strong cultural reliance on this species in the pastoral Nâama communities.

The predominance of leaf use corresponds with the phytochemical composition of rosemary as its leaves contain high concentration of essential oils, phenolic compounds and other bioactive constituents responsible for therapeutic effects (Tomi *et al.* 2016; da Rosa *et al.* 2013; Rašković *et al.* 2014; Gonçalves *et al.* 2018; Borges *et al.* 2019). The preference for the leaves is certainly due to the simplicity of preparing remedies. Bioactive principles are naturally present in the plant's organs in varying concentrations. However, the leaves are the main source of these compounds, as they are the site of photosynthesis of secondary metabolites, mainly glycosides, alkaloids and volatile oils responsible for biological properties (El Hadj *et al.* 2003). Similar results have been recorded by most ethnobotanical surveys conducted throughout Algeria (Boudjelal *et al.* 2013, Benarba *et al.* 2016, Bouafia *et al.* 2021, Hadjadj *et al.* 2025).

The preference for infusion as a preparation method aligns with local ethnopharmacological practices aimed at preserving heat-sensitive and volatile compounds, while decoction is preferred in cases requiring stronger extraction of water-soluble components (Elkolli, 2019). Oral administration of wild rosemary is highly recommended for treating various ailments due to the simplicity of preparation and the predominance of internal conditions (digestive disorders, intestinal worms, respiratory disorders, etc.). These results are corroborated by studies by Hadjadj *et al.* (2025) and Benarba (2016).

The findings also highlight the importance of safeguarding traditional knowledge, particularly at a time when socio-economic transitions and rural transformation may contribute to the erosion of indigenous ethnobotanical heritage.

Furthermore, the documented uses of rosemary extend beyond medicinal applications reflecting its cultural, culinary and cosmetic significance within the region. Such multidimensional value reinforces the need for integrated conservation strategies and sustainable management of wild rosemary populations.

Conclusion

This study provides a comprehensive assessment of the ethnobotanical significance of *Rosmarinus officinalis* L. in the Nâama region. The species represents a cornerstone of local traditional medicine used to treat a wide range of ailments and demonstrating strong cultural permanence. The findings further underscore the need for:

- Expanded phytochemical and pharmacological investigations to validate traditional claims;
- Conservation strategies aimed at ensuring the sustainable use of wild rosemary populations;
- Preservation and documentation of indigenous knowledge in line with international regulations and benefit-sharing frameworks.
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Overall, the documented richness of traditional knowledge reinforces the importance of continuing ethnobotanical research in the region, as well as, developing community-centred approaches for protecting local resources.

Declarations

List of abbreviations: UV: Use value; FL: Fidelity level; ICF: Informant Consensus Factor; PPV: Plant Part Value; SPSS: Statistical Package for the Social Sciences; FDA: Food and Drug Administration; EFSA: European Food Safety Authority; GRAS: Generally Recognized as Safe; *L.*: Linné.

Ethics approval and consent to participate: The study was conducted in accordance with international ethical guidelines for research involving human participants. Ethical approval was granted by the Ethics Committee of the University Hospital of Sidi Bel Abbes (Reference No. 33, September 17th, 2025). All participants provided informed prior informed consent.

Nagoya Protocol Compliance: Access to traditional knowledge was obtained with permission from community members and the study was conducted in accordance with the Nagoya Protocol on Access and Benefit-Sharing.

Availability of data and materials: The datasets generated and analysed during the study are available from the corresponding author upon reasonable request.

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

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Authors' contributions: HA designed the study, conducted the field survey and drafted the manuscript. MB supervised the research, critically revised the manuscript, and approved the final version. MD performed statistical analyses and contributed to methodological. All authors read and approved the final manuscript.

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Literature cited

Adli B, Touati M, Yabrir B, Bezini E, Hachi M, Yousfi I, Dahia M. 2021. Consensus level and knowledge of spontaneous medicinal plants used in the Algerian Central Steppe Region (Djelfa). Agriculturae Conspectus Scientificus 86(2):139-152.

Al-Sereiti MR, Abu-Amer KM, Sen P. 1999. Pharmacology of rosemary (*Rosmarinus officinalis* Linn.) and its therapeutic potentials. Indian Journal of Experimental Biology 37(2):124-130.

Andrade JM, Faustino C, Garcia C, Ladeiras D, Reis CP, Rijo P. 2018. *Rosmarinus officinalis* L.: An updated review of its phytochemistry and biological activity. Future Science OA 4(4):FSO283.

Attaoui W, Benaradj A, Bourahla L. 2024. Floristic characterization of grassy steppe groups in the Naâma region (Algeria). Annals of Valahia University of Târgoviște - Agriculture 16(2):13-18.

Becer E, Altundağ EM, Güran M, Vatansever HS, Ustürk S, Yiğit Hanoğlu D, Başer KHC. 2023. Composition and antibacterial, anti-inflammatory, antioxidant, and anticancer activities of *Rosmarinus officinalis* L. essential oil. South African Journal of Botany 160:437-445.

Benaradj A, Boucherit H, Bouderbala A, Hasnaoui O. 2021. Biophysical Effects of Evapotranspiration on Steppe Areas: A Case Study in Naâma Region (Algeria). In: Tiefernbacher JP (ed) Climate change in Asia and Africa - Examining the biophysical and social consequences, and society's responses. IntechOpen. doi: 10.5772/intechopen.97614

Begum A, Sandhya S, Shaffath Ali S, Vinod KR, Reddy S, Banji D. 2013. An in-depth review on the medicinal flora *Rosmarinus officinalis* (Lamiaceae). Acta Scientiarum Polonorum, Technologia Alimentaria 12(1):61-73.

Bekhechi A, Malti CEW, Babali B, Bouafia M, Bekhechi C, Casanova J, Paoli M, Tomi F. 2024. Chemical variability and anti-inflammatory activity of *Rosmarinus officinalis* L. leaf essential oil from the Algerian Sahara. Chemistry & Biodiversity 21(4):e202302077.

Benarba B. 2016. Medicinal plants used by traditional healers from South-West Algeria: An ethnobotanical study. Journal of Intercultural Ethnopharmacology 5(4):320-330.

Bensaïd A. 2006. SIG et télédétection pour l'étude de l'ensablement dans une zone aride : le cas de la wilaya de Naâma (Algérie). Thèse de doctorat, Université Joseph-Fourier Grenoble I, France.

Borges RS, Ortiz BLS, Pereira ACM, Keita H, Carvalho JCT. 2019. *Rosmarinus officinalis* essential oil: A review of its phytochemistry, anti-inflammatory activity, and mechanisms of action involved. Journal of Ethnopharmacology 229:29-45.

Bouafia M, Amamou F, Gherib M, Benaissa M, Azzi R, Nemmiche S. 2021. Ethnobotanical and ethnomedicinal analysis of wild medicinal plants traditionally used in Naâma, southwest Algeria. Vegetos 34(3):654-662.

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 ethnopharmacological survey. Journal of Ethnopharmacology 148(2):395-402.

da Rosa JS, Facchin BM, Bastos J, Siqueira MA, Micke GA, Dalmarco EM, Pizzolatti MG, Fröde TS. 2013. Systemic administration of *Rosmarinus offici*nalis attenuates the inflammatory response induced by carrageenan in the mouse model of pleurisy. Planta medica 79(17), 1605-1614.

De Almeida Gonçalves G, Sá-Nakanishi AB, Comar JF, Bracht L, Dias MI, Barros L, Peralta RM, Ferreira ICFR, Bracht A. 2018. Water-soluble compounds of *Rosmarinus officinalis* L. improve oxidative and inflammatory states. Food & Function 9(4):2328-2340.

De Oliveira JR, Camargo SEA, De Oliveira LD. 2019. *Rosmarinus officinalis* L. (rosemary) as a therapeutic and prophylactic agent. Journal of Biomedical Science 26(1):5.

Diniz do Nascimento L, Moraes AAB, Costa KSD, Galúcio JMP, Taube PS, Costa CML, Cruz JN, Andrade EHA, Faria LJG. 2020. Bioactive natural compounds and antioxidant activity of essential oils from spice plants. Biomolecules 10(7):988.

El Hadj MO, Hadj-Mahammed M, Zabeirou H. 2003. Importance des plantes spontanées médicinales dans la pharmacopée traditionnelle de la région de Ouargla (Sahara Septentrional-Est Algérien). Science Technology 20:73-8.

El-Ghazouani F, Boukhanfer R, Yacoubi B, Zekhnini A. 2024. Ethnobotanical study of medicinal plants used in the rural area of the Western High Atlas (Morocco). Ethnobotany Research and Applications 29:1-26.

Elkolli M. 2019. Are the plants used in Algerian traditional medicine effective? Medical Technologies Journal 3(3):443-452.

Fiume MM, Bergfeld WF, Belsito DV, et al. 2018. Safety assessment of *Rosmarinus officinalis* (rosemary)-derived ingredients as used in cosmetics. International Journal of Toxicology 37(3 Suppl.):12S-50S.

Ghasemzadeh Rahbardar M, Hemadeh B, Razavi BM, Eisvand F, Hosseinzadeh H. 2022. Effect of carnosic acid on acrylamide-induced neurotoxicity. Drug and Chemical Toxicology 45(4):1528-1535.

Gonçalves C, Fernandes D, Silva I, Mateus V. 2022. Potential anti-inflammatory effect of *Rosmarinus officinalis* in preclinical in vivo models. Molecules 27(3):609.

Gonçalves GA, Corrêa RCG, Barros L, Dias MI, Calhelha RC, Correa VG, Bracht A, Peralta RM, Ferreira ICFR. 2019. Effects of gastrointestinal digestion on a rosemary extract rich in rosmarinic acid. Food Chemistry 271:393-400.

Hadjadj K, Benaissa M, Mahammedi M, Ouragh A, Rahmoune A. 2019. Importance des plantes medicinales pour la population rurale du parc national de Djebel Aissa (sud-ouest Algerien). Lejeunia, Revue de Botanique 199 : 1-12.

Hadjadj K, Nichane M, Guerine L, Belhadj S, Soufan W, Hail ZR. 2025. Medicinal plants used by indigenous communities for veterinary practices in Naâma region. Boletín Latinoamericano y del Caribe de Plantas Medicinales y Aromáticas 24(4):536-549.

Heinrich M, Ankli A, Frei B, Weimann C, Sticher O. 1998. Medicinal plants in Mexico: Healers' consensus and cultural importance. Social Science & Medicine 47(11):1859-1871.

Martin GJ. 2004. Ethnobotany: A Methods Manual. London, England: Earthscan.

Ould El Hadj M, Hadj-Mahammed M, Zabeirou H, Chehma A. 2003. Importance des plantes spontanées médicinales dans la pharmacopée traditionnelle de la région d'Ouargla. Sciences & Technologie, Biotechnologies 20:73-78.

Phillips O, Gentry AH. 1993. The useful plants of Tambopata, Peru. Economic Botany 47:15-32.

Rašković A, Milanović I, Pavlović N, Ćebović T, Vukmirović S, & Mikov M. 2014. Antioxidant activity of rosemary (*Rosmarinus officinalis* L.) essential oil and its hepatoprotective potential. BMC complementary and alternative medicine 14, 225.

Tomi K, Kitao M, Konishi N, Murakami H, Matsumura Y, Hayashi T. 2016. Enantioselective GC-MS analysis of volatile components from rosemary (*Rosmarinus officinalis* L.) essential oils and hydrosols. Bioscience, biotechnology, and biochemistry 80(5), 840-847.