Ethnobotanical survey of the endemic *Retama dasycarpa* Cross. in the Rabat-Salé-Kénitra region, Morocco

Siham El Bassami, Hanane Boutaj, Fatima Zahra Benkhouili, Khairo El Baria Metni, Bouchra Sillahi, Salima Elasraoui, Youssra Iglili, Anass Doukkali, Hanane Benzeid

Correspondence

Siham El Bassami[1], Hanane Boutaj[2*], Fatima Zahra Benkhouili[3], Khairo El Baria Metni[1], Bouchra Sillahi[1], Salima Elasraoui[1], Youssra Iglili[1], Anass Doukkali[1], Hanane Benzeid[1*]

[1]Laboratory of Analytical Chemistry, Faculty of Medicine and Pharmacy, Mohammed V University, Rabat 10100, Morocco.
[2]Laboratory of Life and Health Sciences, Faculty of Medicine and Pharmacy of Tangier, Abdelmalek Essaadi University, Tetouan 93000, Morocco
[3]Laboratory of Medicinal Chemistry, Department of Drug Sciences, Faculty of Medicine and Pharmacy, Mohammed V University in Rabat, Morocco

*Corresponding Author: h.boutaj@uae.ac.ma, benzeid_hanane@yahoo.fr

Ethnobotany Research and Applications 35:10 (2026) - http://dx.doi.org/10.32859/era.35.10.1-15
Manuscript received: 10/05/2026 - Revised manuscript received: 25/06/2026 - Published: 01/07/2026

Research

Abstract

Background: *Retama dasycarpa*, an endemic Moroccan Fabaceae species, plays a significant role in the traditional medicine practices of local communities and herbalists. The present work aims to document the ethnobotanical knowledge related to this species, including its therapeutic uses, the specific plant parts used, as well as preparation methods, and routes of administration. Additionally, it explores herbalists' perceptions regarding the efficacy and safety of this plant's use.

Methods: An ethnobotanical survey was conducted using a structured questionnaire administered to herbalists in the Rabat-Salé-Kénitra region. The data collected included the sociodemographic characteristics of the informants, the local vernacular names of this plant, harvesting areas, the parts used, preparation methods, routes of administration, and the diseases treated. Additionally, the study assessed user satisfaction and the potential occurrence of adverse effects associated with the plant's use.

Results: *R. dasycarpa*, commonly known as "**rtem**," is mainly harvested from the wild and used to address various health issues, including diabetes, digestive disorders, and skin diseases. The most commonly used parts are the whole plant, cladodes, and roots, which are typically prepared as decoctions or infusions.

Conclusions: This study highlights the significance of preserving and promoting traditional ethnobotanical knowledge associated with this species. It also highlights the necessity for additional phytochemical and pharmacological research to scientifically validate its therapeutic properties and evaluate its safety profile.

Keywords: *Retama dasycarpa*, Ethnobotany survey, Traditional medicine, Herbalists, Rabat-Salé-Kénitra, Therapeutic uses.

Background

Medicinal plants have been integral to human healthcare for millennia. Today, traditional medicine remains a cornerstone of healthcare delivery in developing nations. The World Health Organization recognizes that a substantial proportion of the global population relies on herbal remedies for their primary healthcare needs (Tilburt et *al.* 2008). In Africa, nearly 80% of the population depends on medicinal plants, leveraging the continent's rich biodiversity for therapeutic purposes. This makes the systematic study of ethnobotanical knowledge a global scientific priority. Morocco situated at the biogeographic crossroads of the Mediterranean basin, the Atlantic coast, and the Saharan desert, possesses one of the richest and most diverse floras in North Africa (El Baakili et *al.* 2024). Its flora comprises approximately 7,000 plant species, of which 951 are national endemics (representing over 20%) (Plantlife International 2023). Among the botanical genera employed in Moroccan traditional medicine, the genus *Retama* (Fabaceae, subfamily Papilionoideae, tribe Genisteae) holds a distinctive position (Greuter et *al.* 1986). Species of this genus are characterized by great ecological adaptability, being able to grow in steppe, coastal, and desert habitats, as well as in poor, arid, and low-quality soils (Muñoz Vallés et *al.* 2013, Barakat et *al.* 2013).

The genus *Retama* has recently received considerable attention from the scientific community as an excellent source of bioactive phytochemicals with antioxidant, antimicrobial, anti-inflammatory, and antitumor properties (León-González et al., 2018). Congeneric species such as *R. monosperma, R. raetam,* and *R. sphaerocarpa* have demonstrated various pharmacological activities, including hypoglycemic, antidiabetic, antibacterial, and anticancer effects (Benkhouili et al. 2022; El Yadini et al. 2023; Algandaby et al. 2010; Touati et al. 2017; Boussahel et *al.* 2018). *Retama dasycarpa* (Coss.), an endemic Moroccan shrubby leguminous plant known locally as "**r'tem**", "**retam**" or "**aglu**", grows naturally in its habitat without being cultivated or imported (Benkhouili et *al.* 2022*,* El Baakili et *al.* 2024). Unlike the well-studied congeneric species, it has not been extensively investigated from either a phytochemical or an ethnopharmacological perspective. An ethnobotanical survey has shown that the Ishelhin people (an Amazigh group in southern Morocco) have traditionally used *R. dasycarpa* to treat certain urological and nephrological problems, using seeds in some traditional preparations (Teixidor-Toneu et *al.* 2016). El Baakili et *al.* (2024) recently published the first phytochemical analysis of *R. dasycarpa* stems, finding high amounts of total phenolics, flavonoids, and tannins, as well as strong antioxidant and antibacterial effects, analgesic properties, and a good acute toxicity profile in mice.

Despite these recent pharmacological advances, no comprehensive ethnobotanical study of *R. dasycarpa* has been conducted in the Rabat-Salé-Kénitra region. This gap is especially concerning because traditional botanical knowledge is highly localized and transmitted orally, making it more vulnerable to erosion due to modernization and urbanization (Hseini & Kahouadji 2007, Belhaj et *al.* 2021*,* Chaachouay et *al.* 2022). Notably, the Rabat-Salé-Kénitra region does not serve as a harvesting site for *R. dasycarpa* but rather as a central consumption hub where medicinal plants from southern and southwestern Morocco (e.g., Marrakech-Safi, Chiadma, Doukkala-Abda, Essaouira) are commercially traded and used by herbalists. In this context, the present study was designed to fill this gap through a comprehensive ethnobotanical investigation of *R. dasycarpa* in the Rabat-Salé-Kénitra region. This study provides the first comprehensive ethnobotanical documentation of *R. dasycarpa* in this region. The specific objectives of this work were to:

- Document the sociodemographic profile of herbalists using *R. dasycarpa;*
- Identify geographical sources, plant parts used, methods of preparation and routes of administration;
- Catalog the full range of therapeutic indications for which the plant is traditionally used;
- Evaluate treatment patterns, user satisfaction and safety profiles;
- Analyze knowledge transmission patterns and assess conservation implications.

By documenting and preserving this traditional knowledge, the present research contributes to Morocco's intangible biocultural heritage while establishing an ethnobotanical foundation to guide further phytochemical and clinical investigations of this endemic medicinal species.

Materials and Methods

Study area

The ethnobotanical survey was carried out in the region of Rabat-Salé-Kénitra region, located in the northwest of the Kingdom of Morocco (Fig. 1). According to data from the High Commission for Planning (HCP) based on the General Population and Housing Census (HCP 2024), this region covers an area of approximately 17,570 km² and has a population of

approximately 5.1 million. It is characterized by the presence of urban and peri-urban areas in which the commercialization of medicinal plants is a common activity.

The Rabat-Salé-Kénitra region was selected for three reasons: (i) it is the second most populous region in Morocco (approximately 5.1 million inhabitants), representing a major consumption hub for medicinal plants; (ii) it encompasses both urban centers (Rabat, Salé) and peri-urban/rural areas (Ain Aouda, Skhirat), allowing for comparison of traditional knowledge across different socioeconomic contexts; (iii) previous ethnobotanical studies in this region (Hseini & Kahouadji, 2007; El Hachlafi et al., 2020; Sekkat et al., 2023) have established a baseline for medicinal plant use, enabling historical comparison of knowledge transmission and change over time.

The study was conducted among traditional herbalists practicing in the main cities and towns of the region, particularly in Rabat and its surroundings, where the use of medicinal plants constitutes an important source of ethnobotanical knowledge passed down from generation to generation.

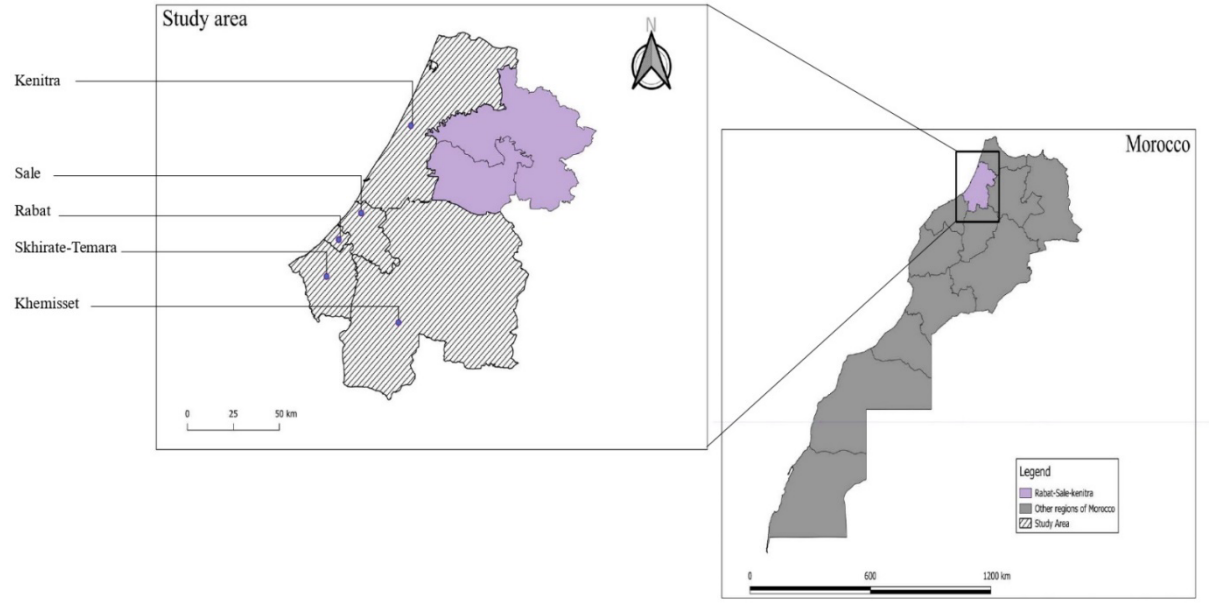

Figure 1. Map of Rabat-Salé-Kénitra region, Morocco, showing the study area.

Data collection

An ethnobotanical survey was conducted between December 15, 2024 and August 10, 2025, in target areas to document traditional knowledge regarding *R. dasycarpa*. The study was conducted following the ethical principles for research involving traditional knowledge. The study protocol was reviewed and approved by the Ethics Committee of the Faculty of Medicine and Pharmacy, Mohammed V University of Rabat from which a written approval letter was obtained. Participation was voluntary, anonymous and unpaid and all participants gave their informed consent to participate for academic purposes only.

Data were collected using semi-structured face-to-face interviews conducted in the Moroccan Arabic dialect (Darija). Interviews were mainly conducted in souks and traditional herbalist shops, as well as in some integrated urban and rural settings.

The questionnaire was constructed based on standardized ethnobotanical protocols and consisted of two main sections:

1. Sociodemographic data: age, gender, level of education, and sources of knowledge transmission.
2. Ethnobotanical data: vernacular name of the plant, parts used, methods of preparation, routes of administration, dosage, frequency of use, perceived efficacy, and reported adverse effects.

A total of 100 traditional herbalists (94 male, 6 female), aged over 30 years and from different socioeconomic backgrounds, were interviewed using a sequential non-probabilistic sampling method until the designated quota was fulfilled. This method

was chosen because no comprehensive registry of herbalists exists in the Rabat-Salé-Kénitra region, making probabilistic sampling unfeasible. The sample size (n=100) was determined based on three practical criteria:

- The availability of herbalists willing to participate during the survey period ;
- The principle of data saturation, whereby no new information emerged after approximately 80 interviews;
- Field constraints including accessibility of herbalist shops and souks, as well as the time required for each interview.

The average duration of each interview was 30 minutes per participant. The information collected was validated by cross-checking quotes from different informants and comparing them to existing ethnobotanical literature.

Harvesting and botanical identification

The taxonomic identification of *R. dasycarpa* species was conducted using the principal reference floras and pharmacopoeias in Morocco, specifically the Traditional Moroccan Pharmacopoeia documented by Bellakhdar (1997), the Practical Flora of Morocco by Fennane (1999), and the Vascular Flora of Morocco: Inventory and Chorology by Fennane & Ibn Tattou (2005). Professor Hamid Khamar, a botanist at the Scientific Institute of Rabat's Department of Botany and Plant Ecology, confirmed this identification. A reference specimen was placed in the herbarium of the same institute under the number RAB 113707, thus ensuring its traceability and future availability. Species names were also verified using online botanical databases including the World Flora Online (https://www.worldfloraonline.org/) and Plants of the World Online (https://powo.science.kew.org/).

Data Analysis

Ethnobotanical data were analyzed using a combination of descriptive statistics and quantitative ethnobotanical indices to assess the cultural importance and therapeutic relevance of *R. dasycarpa*.

Software and statistical analyses

Data entry and preliminary analysis were carried out using Microsoft Excel 2019. Ethnobotanical information was analyzed based on questionnaire responses, taking into account the plant parts used, methods of preparation, routes of administration, dosage and frequency of use, as well as perceived efficacy and reported adverse effects. The data were cross-checked with existing local literature and validated by concordance of citations among several informants. Quantitative analyses were performed using SPSS (Version 20) for Chi-square tests, Jamovi for descriptive statistics (frequencies, percentages, means), and Sphinx v5 for questionnaire processing and analysis. To assess the relationship between plant parts used, sociodemographic variables and ethnobotanical knowledge, the Pearson Chi-square test (Pearson, 1900) was applied. A p-value < 0.05 was considered statistically significant.

The chi-square assumptions (independence, mutually exclusive categories, and expected frequencies ≥5 in at least 80% of cells) were verified, and variables were selected based on theoretical relevance to plant part selection.

Ethnobotanical indices

To assess the relative cultural and therapeutic importance of *R. dasycarpa*, several quantitative ethnobotanical indices were calculated.

Relative frequency of citation (RFC)

The relative frequency of citation (RFC) measures the proportion of informants who mentioned a given plant species and is calculated using the following formula:

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

Where, FC: the frequency of citation (number of informants who cited the species studied); N: the total number of informants interviewed (Tardío & Pardo-de-Santayana 2008).

Although RFC is commonly used in multi-species studies, it is also applicable to single-species studies to quantify the relative frequency of different therapeutic uses cited by informants. In this study, RFC values indicate which diseases or uses are most commonly associated with *R. dasycarpa* by the interviewed herbalists.

Value of plant parts assessment

The preference value of plant parts (PPV) assesses the relative importance of each plant organ in therapeutic uses. It is calculated using the following formula:

$$PPV = RU_{part}/RU$$

Where $RU_{(part)}$: the number of reported uses for a specific part of the plant and RU : the total number of reported uses for the entire plant (Chaachouay et *al.* 2019).

Level of fidelity (FL)

The level of fidelity (FL) indicates the effectiveness of a plant species in treating a specific disease. It corresponds to the percentage of respondents citing the use of this species for a particular condition in the study area. FL is calculated according to the methods of Alexiades & Sheldon (1996), and Sreekeesoon & Mahomoodally (2014):

$$FL = I_P / L_u \times 100$$

Where: Ip: the number of citations of the species used to treat a particular disease; Lu: the total number of citations of the species used for all diseases.

Results and Discussion

Socio-demographic Profile of Herbalists

The present study revealed a predominant male representation among herbalists (94%, $p < 0.01$) (Table 1). This finding indicates that traditional herbal knowledge in the Rabat-Salé-Kénitra region is primarily transmitted and practiced by men. In comparison with previous studies, this aligns with ethnobotanical research conducted in Morocco (El Haouari 2018). A study carried out in the northeastern region of Morocco revealed that the surveyed general population showed a female predominance (57%) in the use of traditional plants, whereas herbalists represented only 6% of the total respondents, confirming that professional herbalism remains a male-dominated occupation (Kachmar et *al.* 2021). Similarly, a recent ethnobotanical survey carried out in Taza Province with 186 participants revealed that most medicinal plant users were males (70%), providing additional evidence for the pattern of male participation in formal herbal knowledge systems in Morocco (El Aarage et *al.* 2026).

Regarding age distribution, the majority of respondents were over 50 years old (55%). This observation raises important considerations for knowledge conservation. Specifically, the high number of elder practitioners, while indicative of accumulated knowledge, also suggests an urgent need for documentation and transmission strategies to prevent the potential loss of traditional botanical expertise (Belhaj et *al.* 2021*,* Chaachouay et *al.* 2022). This age-related pattern is consistent with findings from Taza Province, where 65.59% of respondents reported knowledge transmission from parents, emphasizing the importance of intergenerational learning for the preservation of ethnomedicinal heritage (El Aarage et *al.* 2026).

Table 1. Socio-demographic characteristics of herbalists included in the study area.

Variable	Category	Number	Proportion of Respondents (%)	P-value	χ^2	df
Gender	Female	6	6	< 0.01	77.4	1
	Male	94	94			
Age	Under 30 years	6	6	< 0.01	60.1	3
	30 - 40 years	10	10			
	40 - 50 years	29	29			
	Over 50 years	55	55			
Education Level	None	21	21	< 0.01	30.2	3
	Primary	44	44			
	Secondary	29	29			
	University	6	6			
Source of Knowledge	Literary research	9	9	< 0.01	48.6	3
	Experience	55	55			
	General knowledge	46	46			
	Cultural heritage	74	74			

Number: absolute number of respondents (out of N=100); Proportion: percentage of total respondents.

Regarding education, 44% of herbalists had only primary education, and only 6% held university degrees. This finding is consistent with other ethnobotanical surveys where illiteracy or primary education was most common among traditional practitioners (Belhaj et *al.* 2021*,* Chaachouay et *al.* 2022*,* El Haouari 2018*,* Ez zoubi et *al.* 2022). Similar findings were reported by Kachmar et *al.* (2021) in northeastern Morocco, where 61% of respondents were illiterate and only 12% had a university education. An interesting paradox emerges, however, within the broader health landscape of the Rabat-Salé-Kénitra region. Although the primary knowledge holders possessed minimal formal education, the prevalent use of plants among patients indicates that traditional remedies remain widely accepted. This pattern suggests that most of Morocco's traditional medicinal knowledge is not taught in schools but rather passed down through oral traditions and hands-on experience.

Regarding professional experience, 55% of herbalists in our study reported having significant experience in herbalism. This proportion is lower than the 79% reported by Doukkali et *al.* (2015) in their national study of Moroccan herbalists, where practitioners had over a decade of experience. Despite these differences, both studies confirm that substantial practical experience characterizes the herbalist profession in Morocco. This discrepancy may reflect several factors. First, the national scope of Doukkali et *al.* (2015) study may have captured more established practitioners. Second, our study's 'experience' variable was self-defined by herbalists rather than measured as a specific number of years. Third, the Rabat-Salé-Kénitra region, being more urbanized than other Moroccan regions, may have a higher proportion of newer herbalists entering the profession.

Geographic Sourcing of *Retama dasycarpa*

R. dasycarpa belongs to the Fabaceae family, subfamily Papilionoideae, and tribe Genisteae (Greuter et *al.* 1986). Herbalists mainly identified this plant by its vernacular name **"r'tem", "retam" or "aglu**". The results showed that all herbalists interviewed indicated that *R. dasycarpa* is a wild plant that grows naturally in its environment without being cultivated or imported. This local perception is consistent with the scientific literature (Benkhouili et *al.* 2022*,* El Baakili et *al.* 2024). As reported in previous studies, the *Retama* genus has a high capacity for ecological adaptation and occupies a wide variety of habitats. These species grow mainly in coastal, steppe, and desert areas, where they are adapted to harsh environmental conditions. They can withstand low winter temperatures as well as high summer temperatures. In addition, species of the genus *Retama* can grow in poor, dry, and infertile soils, which explains their wide distribution in arid and semi-arid regions (Barakat et *al.* 2013*,* Muñoz Vallés et *al.* 2013*,* Benkhouili et *al.* 2022). The results further revealed that all herbalists obtained the plant from regions located in the south and southwest. No informants reported local collection within the Rabat-Salé-Kénitra region itself. The highest proportion of collection sites was reported from Marrakech-Safi region as the main harvesting area (37%), followed by Chiadma (25%), Doukkala-Abda (24 %), and Essaouira (14%) (Fig. 2).

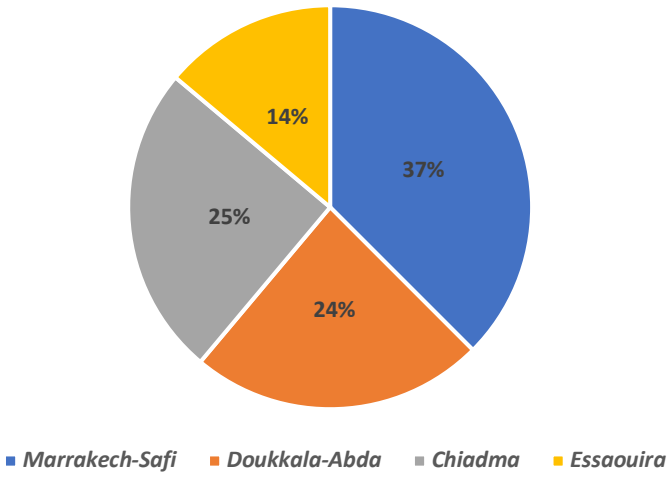

Figure 2. Geographic origins of *Retama dasycarpa* plant material as reported by herbalists.

Traditional Uses and Therapeutic Applications of *Retama dasycarpa*

The ethnopharmacological data presented in Tables 2, 3, and 4 demonstrate that *R. dasycarpa* is used for an extensive range of therapeutic purposes (100%, $p < 0.01$), with cosmetic (21%) and culinary (10%) applications being less frequent (Table 2). According to the literature, the *Retama* genus is widely used by local populations to treat several diseases (Bellakhdar 1997). In addition, some *Retama* species are also used in pastures, where they provide shade and shelter for animals, especially during hot, dry days (Barakat et *al.* 2013*,* Obo´n et *al.* 2011). Other ethnobotanical investigations indicate that seeds of *R.*

dasycarpa may also be used in certain traditional preparations (Teixidor-Toneu et *al.* 2016). The importance attributed to cladodes and roots further suggests empirical recognition of their therapeutic potential in local traditional medicine (León-González et *al.* 2018).

Table 2. Reported uses, processing methods, and associated substances of *Retama dasycarpa*.

Variable	Category	Proportion of Respondents (%)	P-value	χ^2	df
Primary use of the plant	Therapeutic use	100	< 0.01	190.9	3
	Cosmetic use	21			
	Culinary use	10			
Post-harvest plant treatment	Fresh plant	35	< 0.01	30.6	1
	Dried plant	99			
Substance used	Water	96	< 0.01	174.6	3
	Oil	27			
	Honey	8			

Table 3. Traditional uses of *Retama dasycarpa* by herbalists in the study area.

Kind of use	Parts used	Method of use	Recommended uses among study participants
Therapeutics	Whole plants, Cladodes, Roots	Oral, Dermal, Inhalation	Diabetes, cancer, cicatrisant activity, vermifuge, rheumatism, hypertension, fever, purgative, dermatological infections and wounds, influenza and allergies, stomach disorders, joint pain, headaches, skin wounds, menstrual cycle regulation, ovarian cysts, regulation of heart rhythm, glycemic regulation and digestive disorders, infections in humans and animals, allergies, thyroid disorders, rabid dog bites, antiseptic and sedative effects in the treatment of skin wounds and ulcers, and arthritis.
Cosmetics	Whole plants, Roots, Cladodes	Dermal	Scalp care, Hair care, Skin care, Skin protection, Skin regeneration / wound healing
Culinary	Cladodes	Inhalation	Burned to produce smoke, facilitating cooking of dishes in mountainous regions

The most frequently cited therapeutic indication for *R. dasycarpa* was diabetes (RFC = 0.32), followed by cancer (RFC = 0.23), skin diseases (RFC = 0.18), wound healing (RFC = 0.16), rheumatism (RFC = 0.15), and hypertension (RFC = 0.15) (Tables 3, 4). Diabetes showed the highest RFC value, which is 1.4 times higher than cancer (RFC = 0.23) and 1.8 times higher than skin diseases (RFC = 0.18). The Fidelity Level (FL) analysis revealed that diabetes had the highest FL value (32%), indicating that 32% of herbalists who cited *R. dasycarpa* specifically recommended it for diabetes. This finding is consistent with regional epidemiological and ethnobotanical studies showing that diabetes is commonly managed with medicinal plants in the Rabat-Salé-Kénitra region (Sekkat et *al.* 2023, El Hachlafi et *al.* 2020). It is noteworthy that El Baakili et *al.* (2024) reported significant antioxidant activity in *R. dasycarpa* extracts, which is relevant to complications of diabetes mediated by oxidative stress. However, it must be emphasized that this pharmacological finding does not constitute clinical evidence of antidiabetic efficacy. The traditional use of *Retama* species for diabetes is also documented for congeners such as *R. monosperma*, which has shown hypoglycemic effects in experimental models (Benkhouili et *al.* 2022, El Yadini et *al.* 2023). Similarly, *R. raetam* has been reported for antidiabetic and antibacterial uses in North African traditional medicine (Algandaby et al., 2010; Edziri et al., 2012).

Cancer was the second most reported indication (RFC = 0.23) (Table 4). This finding is notable because cancer is less frequently reported in general ethnobotanical surveys than digestive or respiratory conditions. For example, El Hachlafi et *al.* (2020) reported chronic diseases in the same area but did not mention cancer among the most cited indications. The predominance of cancer in our study could be due to either specific traditional knowledge of *R. dasycarpa* for this condition or increased cancer awareness in the surveyed population. Et-tahir (2020) noted that some plants were exclusively reserved for severe conditions such as cancer, suggesting specific knowledge for these diseases. Anticancer activity has been documented for the congeneric species *R. monosperma* (Benkhouili et *al.* 2022), suggesting that *R. dasycarpa* may contain similar bioactive compounds worthy of investigation. Nevertheless, direct evidence for *R. dasycarpa* remains lacking, and this traditional use should not be interpreted as clinical proof of anticancer efficacy.

When comparing therapeutic categories, diabetes (RFC = 0.32) was the most cited indication, followed by cancer (RFC = 0.23). Together, these two conditions accounted for 55% of all therapeutic citations, indicating that *R. dasycarpa* is primarily used for chronic and severe diseases. In contrast, conditions such as arthritis (RFC = 0.01) and treatment of rabid dog bites (RFC = 0.01) were rarely cited, suggesting that these are less common or more specialized uses. The predominance of diabetes and cancer as the top two indications may reflect the high prevalence of these diseases in the Moroccan population and the perceived efficacy of *R. dasycarpa* for these conditions based on traditional knowledge.

Table 4. Reported diseases treated with *Retama dasycarpa* and their citation indices (FC, RFC and FL).

Disease / Therapeutic use	FC	RFC	FL (%)
Diabetes	32	0.32	32
Cancer	23	0.23	23
Skin diseases	18	0.18	18
Wound healing (Cicatrization)	16	0.16	16
Rheumatism	15	0.15	15
Hypertension	15	0.15	15
Anthelmintic (Vermifuge)	15	0.15	15
Fever	13	0.13	13
Purgative	9	0.09	9
Scalp disorders	9	0.09	9
Eczema	8	0.08	8
Allergies	7	0.07	7
Dermatological infections and wounds	6	0.06	6
Influenza	5	0.05	5
Stomach disorders	5	0.05	5
Joint pain	5	0.05	5
Cutaneous wounds	4	0.04	4
Headache	4	0.04	4
Menstrual cycle regulation	3	0.03	3
Glycemic regulation and digestive disorders	2	0.02	2
Human and animal infections	2	0.02	2
Ovarian cyst	2	0.02	2
Heart rhythm regulation	2	0.02	2
Antiseptic and sedative for skin ulcers and wounds	1	0.01	1
Arthritis	1	0.01	1
Treatment of wounds from rabid dog bites	1	0.01	1

FC: Frequency of citation; RFC: Relative frequency of citation; FL: Level of fidelity.

In addition to its therapeutic uses, *R. dasycarpa* is also used for cosmetic purposes (Table 3). The herbalists interviewed mentioned the dermal application of different plant parts for scalp, hair, and skin care, contributing to skin protection and regeneration. Occasional culinary use was also reported. In some mountainous regions, the plant is burned to produce smoke that facilitates cooking (Table 3). As noted by Tahraoui et *al.* (2007), the richness of the traditional Moroccan pharmacopoeia stems largely from cultural heritage and exchanges between different populations, including Arabs from the Middle East, Andalusians from Spain, and Jewish communities from Europe. When comparing our results with published literature, the traditional uses documented in this study are broadly consistent with data reported for *Retama* species in different regions of North Africa and the Middle East. For example, *R. dasycarpa*, which is endemic to the High Atlas Mountains, is used by the Ishelhin people (an Amazigh group in southern Morocco) to treat certain urological and nephrological conditions (Teixidor-Toneu et *al.* 2016).

Skin diseases (FC = 18, RFC = 0.18, FL = 18%), wound healing (FC = 16, RFC = 0.16, FL = 16%), rheumatism (FC = 15, RFC = 0.15, FL = 15%), and hypertension (FC = 15, RFC = 0.15, FL = 15%) were among the highly cited therapeutic uses in our study (Tables 3, 4). These findings are consistent with traditional applications documented for *R. monosperma* in the Mediterranean basin, where the species is used to treat skin diseases, rheumatism, and hypertension (Benkhouili et *al.* 2022). Similarly, in the province of Tata (southeastern Morocco), this plant is commonly used to treat scorpion stings, certain skin conditions, promote wound healing, and relieve rheumatism (Abouri et *al.* 2012). The convergence of traditional knowledge across different *Retama* species suggests a common ethnopharmacological heritage and potentially shared bioactive constituents.

Plant Part Utilization and Preparation Methods

This analysis aimed to study the relationship between the different used parts of *R. dasycarpa* (whole plant, cladodes, and roots), sociodemographic and ethnobotanical variables (Table 5). The chi-square test showed no statistically significant association between the parts used and the studied variables ($p > 0.05$). Even without statistical significance, a few trends are worth noting. The whole plant was mostly used by people over 50 years (47.0%), while people under 30 years used the whole plant (66.7%) and cladodes (33.3%). For therapeutic purposes, the whole plant (44.4%) was the most commonly used, while roots (40.0%) were preferred for culinary use.

Table 5. Factors associated with the plant parts of *Retama dasycarpa* used by herbalists.

	Part used					
	Cladodes %	**Whole plant** %	**Roots** %	***P* value**	**χ^2**	**df**
Age				0.146	9.52	6
Under 30	33.33	66.7	0.0			
30-40	16.7	66.7	16.7			
40-50	48.8	29.3	22.0			
Over 50	30.3	47.0	22.7			
Gender				0.549	1.20	2
Female	25.0	62.5	12.5			
Male	35.9	42.7	21.4			
Primary use of the plant				0.257	5.31	4
Therapeutic use	34.9	44.4	20.6			
Cosmetic use	26.9	61.5	11.5			
Culinary use	30.0	30.0	40.0			
Methods of preparation				0.165	16.6	12
Poultice	31.1	53.3	15.6			
Decoction	38.0	37.0	25.0			
Fumigation	45.5	36.4	18.2			
Infusion	39.6	34.0	26.4			
Inhalation	46.2	30.8	23.1			
Maceration	37.5	25.0	37.5			
Powder	15.0	75.0	10.0			
Mode of administration				0.170	6.43	4
Oral	39.8	34.9	25.3			
Dermal	31.7	55.0	13.3			
Inhalation	40.0	40.0	20.0			
Dosage information				0.412	6.10	6
Teaspoon	35.7	50.0	14.3			
Tablespoon	0.0	66.7	33.3			
Pinch	75.0	0.0	25.0			
Hundful	36.0	42.0	22.0			

The Plant Part Value (PPV) analysis showed that the whole plant had the highest PPV (0.44), followed by cladodes (0.40) and roots (0.16) (Fig. 3). The PPV for the whole plant was 1.1 times higher than for cladodes and 2.8 times higher than for roots, indicating that herbalists consider the entire plant to have the broadest therapeutic utility. The relatively low PPV for roots (0.16) suggests that roots are used for a narrower range of conditions, primarily culinary purposes (40.0% of culinary uses) rather than therapeutic applications (20.6% of therapeutic uses) (Table 5). The preference for the whole plant may be explained by a traditional belief that therapeutic activity results from synergistic effects of different bioactive compounds throughout the plant. This type of practice is frequently mentioned in ethnobotanical studies from Morocco and the Mediterranean area (Chaachouay et *al.* 2019). This preference differs from the findings of El Hachlafi et *al.* (2020) in the same region, who reported leaves as the most used plant part for chronic diseases (PPV = 0.246). This discrepancy may be explained by three factors. First, alkaloids in the *Retama* genus are concentrated in all aerial parts of the plant. Second, the whole plant is more durable for long-term storage by herbalists. Third, specific ailments such as diabetes and cancer may require different plant parts than those prescribed for chronic diseases.

Cladodes are also an important used part, especially among middle-aged people. This could be related to the relative ease of harvest and access. The low use of roots may be explained by ecological constraints (particularly the danger of destroying the plant during extraction) and by different beliefs about their therapeutic effects. According to León-González et *al.* (2018), the preference for the whole plant and cladodes over roots may also reflect sustainable harvesting practices, since root collection can be more destructive for the perennial shrub.

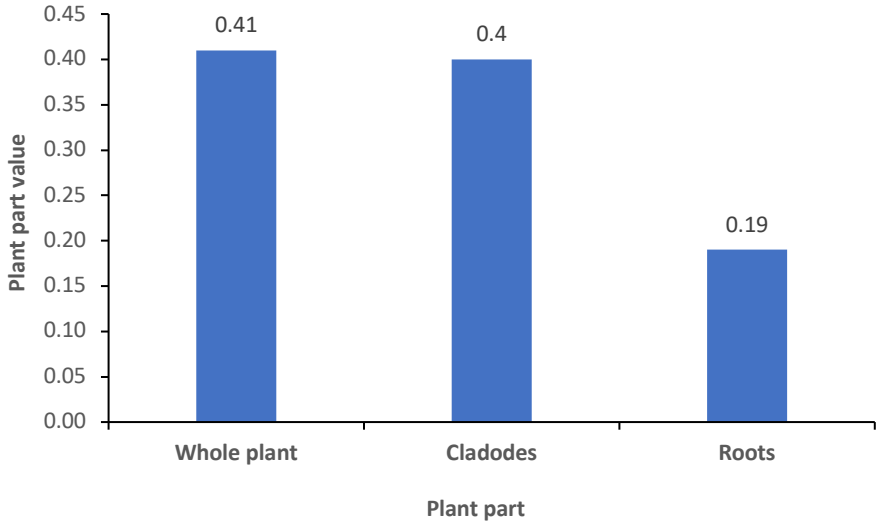

Figure 3. Plant parts of *Retama dasycarpa* used by informants and their corresponding Plant Part Value (PPV).

The integration of RFC, FL, and PPV values provides a comprehensive picture of the therapeutic importance of *R. dasycarpa*. Diabetes and cancer, with high RFC and FL values, are the most consensual indications, and both are primarily treated with the whole plant. In contrast, skin diseases and wound healing, while having moderate RFC values (0.18 and 0.16), are specifically associated with cladodes (PPV = 0.40), suggesting that different plant parts are preferentially used for different therapeutic categories. This pattern indicates that herbalists possess differentiated knowledge regarding which plant part to use for which condition.

Regarding post-harvest treatment, the fresh plant was the most commonly used form (35%, $p < 0.01$), while the dried plant was used by 99% of herbalists (Table 2). Preparation methods influenced part selection. For example, powder preparation exclusively involved the whole plant (75%), whereas maceration used cladodes and roots equally. Dosage forms such as a pinch were associated solely with cladodes (75%) (Table 5).

Regarding preparation methods, water was the most commonly used substance (96%), followed by oil (27%) and honey (8%) (Table 2). The most frequently used methods were decoction and infusion. This finding is in accordance with several ethnopharmacological studies in Morocco, where these preparation methods largely prevail in the traditional practices (Kachmar et *al.* 2021). This trend suggests that preparation method is crucial for the effectiveness of medicinal plants and may even be more important than the plant part used.

The survey revealed that oral administration was the most frequently observed mode of *R. dasycarpa* consumption, generally as a decoction or infusion. This finding agrees with Teixidor-Toneu et *al.* (2016), who confirmed that *R. dasycarpa* is mostly used orally. Dermal use was also frequently reported, especially for skin conditions, whereas inhalation was less common and was mainly used for fever and flu (Tables 3, 5). The frequency of oral and dermal administration suggests versatile use of the plant to manage internal and external pathologies, as widely described in Moroccan ethnobotanical studies (Jamila and Mostafa, 2014). The prevalence of aqueous preparations is attributed to traditional extraction methods intended to enhance the extraction of bioactive compounds extraction. Similarly, poultice application involves local applications for specific therapeutic purposes (Table 5). As reported by León-González et al (2018), the most frequent preparation methods in the genus *Retama* are infusion, decoction and poultice. Together, these findings confirm that aqueous extraction is the preferred method in Rabat-Salé-Kénitra traditional medicine. This preference may be pharmacologically relevant because the aqueous extracts of *R. dasycarpa* were reported to contain high amounts of total phenolic compounds and flavonoids (El Baakili et *al.* 2024).

Additionally, honey as an adjuvant is of special interest because it possesses antimicrobial and wound healing properties that may act synergistically with the plant's therapeutic effects. In some regions, cladodes and leaves crushed with honey are administered orally as an emetic. Leaf decoctions were also used as rectal enemas for their purgative and vermifuge properties (Table 3). In Marrakech, the crushed plant is mixed with milk or butter for similar uses (Bellakhdar 1997). In the Middle East, a decoction of *R. raetam* cladodes and flowers is used in traditional medicine to treat syphilis and female infertility (Yaniv and Dudai 2014). In the province of Errachidia (Morocco), a decoction of *R. sphaerocarpa* roots is used to treat diabetes (Tahraoui et *al.* 2007), while in the Sahara, the roots are traditionally used as a remedy for diphtheria (Mouhajir 2009). Similarly, powdered cladodes of *R. raetam, R. monosperma,* and *R. sphaerocarpa*, mixed with honey, are administered orally as an emetic. In Tissint, the cladodes and dried flowers of *R. raetam* are ground into powder and used for their healing properties, particularly during circumcision, as well as a vulnerary, antiseptic, and sedative in the local treatment of wounds, skin ulcers, and infected lesions. In most cases, doses were mainly administered as a standardized handful (78%) or a teaspoon (24%) (Table 6). These results suggest notable variation in the methods and dosages of *R. dasycarpa* consumption among respondents, which could have implications for their health. Furthermore, the lack of a significant association between the variables studied and the plant parts used may indicate a degree of homogeneity in ethnobotanical knowledge within the population. This homogeneity is likely due to intergenerational transmission of traditional knowledge, a phenomenon widely documented in studies conducted in Morocco (Achour et *al.* 2022).

Treatment Patterns and Safety Profile

The treatment patterns showed that the majority of remedies were administered to humans (80%), with only 3% administered to animals (Table 6). These patterns are also observed in ethnobotanical research, where medicinal plants are primarily used for human health with fewer uses in traditional veterinary medicine (Derso et *al.* 2024). In Marrakech, Bellakhdar (1997) reported that plant decoction is traditionally rubbed to treat pruritus and scabies in humans and animals. These data demonstrate the prominent role of the plant in traditional human medicine, while its veterinary use appears less common among the surveyed herbalists.

Table 6. Treatment patterns and outcomes associated with *Retama dasycarpa* use in traditional practice.

Variable	Category	Number of citations	Proportion of Respondents (%)	P-value	χ^2	df
Recipient	Humans	80	80	< 0.01	95.3	2
	Animals	3	3			
	Both	20	20			
Period of application	Random	46	46	< 0.01	90.7	4
	In the evening	7	7			
	In the morning	40	40			
	On an empty stomach	7	7			
Duration of treatment	One day	4	4	< 0.01	20.5	4
	One week	27	27			
	One month	16	16			
	Until recovery	25	25			
	The duration was not specified	28	28			
User satisfaction	Moderately satisfied	27	27	< 0.01	87.8	3
	Satisfied	62	62			
	Very satisfied	11	11			
Observed results	Healing	38	38	< 0.01	58.6	2
	Improvement	62	62			
Adverse effects	No	81	81	< 0.01	38.4	1
	Yes	19	19			

The most frequent application period was "random" (46%), followed by "in the morning" (40%, $p < 0.01$). Smaller percentages mentioned use "in the evening" (7%) or on "an empty stomach" (7%). Such observations are consistent with ethnobotanical literature where medicinal plants are generally administered once or twice a day, often in the morning or evening depending on traditional practices and the condition being treated (Messaoudi et *al.* 2015). Treatment duration varied widely: 28% of respondents did not specify a duration, 27% reported one week, and 25% treated until recovery. This variability has been

mentioned in other ethnobotanical surveys where the duration of plant use is associated with the disease severity and patient response (Errahmani and Zahir, 2024).

Regarding satisfaction, our results indicated that users have a generally positive perception of *R. dasycarpa* effects. High user satisfaction was found, with 62% satisfied and 11% very satisfied ($p < 0.01$). Observed therapeutic results were improvement (62%) and healing (38%). These results indicate that *R. dasycarpa* is widely recognized and valued by users as having therapeutic value based on traditional experience. Similar observations have been reported in several ethnobotanical studies in Morocco and the Mediterranean region (Chaachouay et *al.* 2022*,* Errahmani and Zahir 2024). It is important to note, however, that user satisfaction and perceived improvement do not constitute clinical evidence of efficacy.

Regarding adverse effects, 81% of herbalists stated that there were no adverse effects associated with the consumption of *R. dasycarpa*, while 19% reported vomiting, diarrhea and drowsiness. The relative safety reported by herbalists is supported by the acute toxicity study performed by El Baakili et *al.* (2024), who administered 2 g/kg of *R. dasycarpa* extract to mice and observed no deaths or visible behavioral changes over 14 days. This preclinical safety profile is consistent with the herbalists' reports, supporting the relative safety of traditional preparations when used appropriately. These observations are consistent with the literature on *Retama* species toxicity. According to Bellakhdar (1997), the flowers and leaves can be used, but their use remains rare because of the known risk of poisoning. Moreover, Touati et *al.* (2015) reported that *R. dasycarpa* fruit is considered the most toxic part of the plant, containing several alkaloids including cytisine, sparteine and retamine, the latter being approximately twice as cytotoxic as sparteine. This chemical composition explains the care required in the use of *Retama* and justifies the negative reactions reported by some users. El Hachlafi et *al.* (2020), in the same region, recorded 18 cases of adverse effects from plant use, particularly from species such as *Aristolochia longa*. Similarly, Et-tahir (2020), studying northern Morocco's pharmacopoeia, identified 11 specific recipes and highlighted risks of misuse and toxicity when plants are improperly prepared.

Knowledge Transmission and Conservation Implications

The prevalence of "general knowledge" (46%) and "cultural heritage" (30%), compared to 9% from literary studies, suggests that botanical knowledge in the region is mainly acquired through oral transmission. These findings are consistent with El Hachlafi et *al.* (2020), who found that herbal knowledge in the studied region was acquired through family inheritance and practical training. A similar pattern was reported in Taza Province, where knowledge about medicinal plants was mainly acquired from parents (65.59%) (El Aarage et *al.* 2026). In northeastern Morocco, 54% of participants relied on herbalists for information, while 23% and 16% referred to popular culture and family heritage respectively (Kachmar et *al.* 2021). In the present study, the finding that 55% of herbalists are over 50 years old further underscores the need for conservation. The low percentage of literary knowledge as a means of transmission suggests limited success of formal documentation of traditional knowledge. This finding corroborates the recommendation by El Hachlafi et *al.* (2020) that knowledge transfer should be an integral part of ethnobotanical documentation.

Comparison between the present study and previous work by Hseini and Kahouadji (2007) in the Rabat region provides insight into the historical context of knowledge preservation. Those authors reported a large number of medicinal plants and highlighted that traditional knowledge is well-practiced. Nevertheless, they expressed concerns about losing this heritage due to urbanization and the availability of modern health facilities. Our results, obtained 15-20 years later, show that although traditional knowledge still exists (as reflected in the detailed therapeutic applications in Table 3), the practitioner population is dominated by older individuals (55% > 50 years).

The harvesting of *R. dasycarpa* from wild populations in southern Morocco raises sustainability concerns. Overharvesting without cultivation poses risks of population decline, particularly given the species' restricted distribution. The preference for whole plant collection, especially of roots, may be destructive to individual plants. Conservation management should include: (i) assessment of wild population status; (ii) development of sustainable harvesting guidelines; (iii) exploration of cultivation methods to reduce pressure on wild populations; and (iv) integration of local herbalists into conservation planning.

Limitations of the Study

The present findings should be interpreted in light of certain limitations. First, the use of self-reported data from herbalists may be subject to recall bias. Second, the cross-sectional design provides information on knowledge at a specific point in time and does not capture changes in traditional practices over time. Third, it is important to emphasize that therapeutic claims reported in this study reflect traditional knowledge and user perceptions, not clinical evidence. While pharmacological

studies on congeneric species provide supporting mechanistic data, randomized controlled trials are necessary to establish clinical efficacy and safety in humans. Fourth, the use of non-probabilistic sequential sampling limits the generalizability of our findings. While our sample captured the diversity of practitioners in souks and herbalist shops, selection bias cannot be entirely excluded. Fifth, the investigation was limited to the Rabat-Salé-Kénitra region, and the results may not be generalizable to other regions of Morocco with distinct ecological and cultural contexts. Finally, while multivariate methods such as Multiple Correspondence Analysis (MCA) could provide visual confirmation of knowledge homogeneity, the categorical nature of our data and the sample size would require careful interpretation. Future studies with larger sample sizes may employ MCA to complement bivariate chi-square analyses.

Conclusion

This ethnobotanical survey represents the first comprehensive documentation of the traditional uses of *R. dasycarpa* among herbalists in the Rabat-Salé-Kénitra region. The plant is primarily used for chronic and severe diseases, particularly diabetes and cancer, followed by skin diseases, wound healing, rheumatism, and hypertension. The whole plant demonstrated the highest use value, while aqueous decoctions and infusions were the main preparations. Preclinical studies confirm the species' favorable safety profile. However, the predominance of older practitioners, reliance on oral transmission, and external sourcing of plant material raise legitimate concerns about knowledge preservation and sustainable harvesting. Future research should focus on clinical validation of the most cited therapeutic indications, notably diabetes and cancer, along with conservation assessments of wild populations to ensure the long-term sustainability of this endemic Moroccan species.

Declarations

List of abbreviations: RFC: Relative Citation Frequency, FC: Citation Frequency, N: Total Number of herbalists, PPV: Plant Part Value, RUpart: Number of reported uses for a specific part of the plant, RU: Total number of reported uses for the entire plant, FL: Fidelity Level, Ip: Number of citations of the species used to treat a particular disease, Lu: total number of citations of the species used for all diseases.

Ethics approval and consent to participate: The data were collected in accordance with ethical standards, ensuring confidentiality, anonymity, and informed consent. All participants were fully informed about the purpose of the study prior to data collection.

Consent for publication: Not applicable

Availability of data and materials: The data from this study have not been deposited in public repositories.

Competing interests: The authors declare no conflicts of interest.

Funding: Not applicable

Author contributions: S.E.B. Study design, conduction of ethnobotanical surveys, active participation in structuring the methodology, manuscript writing, data analysis, and interpretation. H.B. Data analysis, interpretation, methodology development, manuscript writing, Review and editing, and interpretation. F.Z.B. Data analysis, contribution to methodology. K.E.B.M. Investigation, writing of the original draft, methodology, and formal analysis. B.S. Investigation, writing of the original draft, methodology, and formal analysis. S.E. Review and editing, methodology, formal analysis, and drafting. Y.I. Review and editing, methodology, formal analysis, and drafting. A.D. Investigation, writing of the original draft, methodology, and formal analysis. H.B. Study design and supervision, contribution to methodology, manuscript refinement, and review editing. All authors read, reviewed, and approved the final version of the manuscript.

Acknowledgements

The authors thank Pr. Hamid Khamar from the Botanical Department of the Scientific Institute of Rabat, Morocco, for the authentication of the plants.

Literature cited

Abouri M, El Mousadik A, Msanda F, Boubaker H, Saadi B, Cherifi K. 2012. An ethnobotanical survey of medicinal plants used in Tata Province, Morocco. International Journal of Medicinal Plant Research 1:99-123.

Achour S, Chebaibi M, Essabouni H, Bourhia M, Ouahmane L, Salamatullah AM, Aboul-Soud MAM, Giesy JP. 2022. Ethnobotanical study of medicinal plants used as therapeutic agents to manage diseases of humans. Evidence-Based Complementary and Alternative Medicine 2022:1-8.

Alexiades MN, Sheldon JW (eds.). 1996. Selected Guidelines for Ethnobotanical Research: A Field Manual. New York Botanical Garden, Bronx, New York, U.S.A.

Algandaby MM, Alghamdi HA, Ashour OM, Abdel-Naim AB, Ghareib SA, Abdel-Sattar EA, Hajar AS. 2010. Mechanisms of the antihyperglycemic activity of *Retama raetam* in streptozotocin-induced diabetic rats. Food and Chemical Toxicology 48:2448-2453.

Barakat NAM, Laudadio V, Cazzato E, Tufarelli V. 2013. Potential contribution of *Retama raetam* (Forssk.) Webb & Berthel as a forage shrub in Sinai, Egypt. Arid Land Research and Management 27:257-271.

Belhaj S, Chaachouay N, Zidane L. 2021. Ethnobotanical and toxicology study of medicinal plants used for the treatment of diabetes in the High Atlas Central of Morocco. Journal of Pharmacy and Pharmacognosy Research 9:619-662.

Bellakhdar J. 1997. La Pharmacopée Marocaine Traditionnelle: Médecine Arabe Ancienne et Savoirs Populaires. Ibis Press, Paris, France.

Benkhouili FZ, Moutawalli A, Benzeid H, Doukkali A, Zahidi A. 2022. *Retama monosperma* (L.) Boiss.: a review of its uses in traditional medicine, chemical constituents, and pharmacologic activities. Phytomedicine Plus 2:100349.

Boussahel S, Cacciola F, Dahamna S, Mondello L, Saija A, Cimino F, Speciale A, Cristani M. 2018. Flavonoid profile, antioxidant and antiglycation properties of *Retama sphaerocarpa* fruits extracts. Natural Product Research 32:1911-1919.

Chaachouay N, Benkhnigue O, Fadli M, El Ibaoui H, Zidane L. 2019. Ethnobotanical and ethnopharmacological studies of medicinal and aromatic plants used in the treatment of metabolic diseases in the Moroccan Rif. Heliyon 5:e02191.

Chaachouay N, Benkhnigue O, Zidane L. 2022. Ethnobotanical and ethnomedicinal study of medicinal and aromatic plants used against dermatological diseases by the people of Rif, Morocco. Journal of Herbal Medicine 32:100542.

Derso YD, Kassaye M, Fassil A, Derebe B, Nigatu A, Ayene F, Tamer M, Van Damme P. 2024. Composition, medicinal values, and threats of plants used in indigenous medicine in Jawi District, Ethiopia: implications for conservation and sustainable use. Scientific Reports 14:23638.

Doukkali Z, Bouidida H, Srifi A, Taghzouti K, Cherrah Y, Alaoui K. 2015. Anxiolytic plants in Morocco: ethnobotanical and ethnopharmacological study. Phytothérapie 13:306-313.

Edziri H, Mastouri M, Mahjoub MA, Mighri Z, Mahjoub A, Verschaeve L. 2012. Antibacterial, antifungal and cytotoxic activities of two flavonoids from *Retama raetam* flowers. Molecules 17:7284-7293.

El Aarage B, Ghabbour I, Khabbach A, Hammani K, Ghabbour N. 2026. Comprehensively expanding ethnobotanical insights into traditional health practices in Taza Province, Morocco. Ethnobotany Research and Applications 33:1-24.

El Baakili A, Fadil M, Guaouguaou FE, El Idrissi MM, Taghzouti K, Jeddi M, Fikri-Benbrahim K, Es-Safi NE. 2024. Unveiling the phytochemical profile, antioxidant and antibacterial activities, acute toxicity insight and analgesic effect of *Retama dasycarpa* stems: an unexplored endemic plant from Morocco. Heliyon 10(18):e37429.

El Hachlafi N, Chebat A, Bencheikh RS, Fikri-Benbrahim K. 2020. Ethnopharmacological study of medicinal plants used for chronic diseases treatment in Rabat-Salé-Kénitra region, Morocco. Ethnobotany Research and Applications 20:1-23.

El Haouari M, El Makaoui S, Jnah M, Haddaouy A. 2018. A survey of medicinal plants used by herbalists in Taza, Northern Morocco to manage various ailments. Journal of Materials and Environmental Science 96:1875-1888.

El Yadini A, Elouafy Y, Amiri-Ardekani E, Shafiee M, Firouzi A, Sasani N, Khalid A, Abdalla AN, Bakrim S, Tan CS, Goh KW, Bouyahya A. 2023. A comprehensive review of the pharmacological properties and bioactive components of *Retama monosperma*. Molecules 28:1708.

Errahmani W, Zahir I. 2024. Ethnobotanical study of medicinal plants with hypocholesterolemic effect in the Beni Mellal Khenifra region of Morocco. Ethnobotany Research and Applications 29:1-36.

Et-tahir A. 2020. Ethnopharmacological survey of aromatic and medicinal plants of the pharmacopoeia of northern Morocco. Ethnobotany Research and Applications.

Ez zoubi Y, Lairini S, El Amrani S, El-Akhal F, Farah A, Bouslamti R, El Ouali Lalami A. 2022. Ethnobotanical survey of herbs used in the preservation of food products in Fez, Morocco. Journal of Ethnic Foods 9:29.

Fennane M, Ibn Tattou M. 2005. Flore vasculaire du Maroc: inventaire et chorologie. Travaux de l'Institut Scientifique, Rabat, série Botanique 37:1-483.

Fennane M, Tattou MI, Mathez J. 1999. Flore pratique du Maroc: manuel de détermination des plantes vasculaires. Pteridophyta, Gymnospermae, Angiospermae (Lauraceae-Neuradaceae). Institut Scientifique, Rabat, Morocco.

Greuter W, Burdet HM, Long G. 1986. Med-Checklist: a critical inventory of vascular plants of the circum-mediterranean countries. Dicotyledones (Convolvulaceae-Labiatae).

Haut-Commissariat au Plan (HCP). 2024. Recensement général de la population et de l'habitat (RGPH 2024), Région de Rabat-Salé-Kénitra: Principaux résultats, Octobre 2025. Available at: https://www.hcp.ma/RGPH-2024-Region-de-Rabat-Salé-Kénitra-Principaux-resultats-Octobre-2025_a4213.html (Accessed on 20 March 2026).

Hseini S, Kahouadji A. 2007. Étude ethnobotanique de la flore médicinale dans la région de Rabat (Maroc occidental). Lazaroa 28:79-93.

Jamila F, Mostafa E. 2014. Ethnobotanical survey of medicinal plants used by people in Oriental Morocco to manage various ailments. Journal of Ethnopharmacology 154:76-87.

Kachmar MR, Naceiri Mrabti H, Bellahmar M, Ouahbi A, Haloui Z, El Badaoui K, Chakir S. 2021. Traditional knowledge of medicinal plants used in the northeastern part of Morocco. Evidence-Based Complementary and Alternative Medicine 2021:6002949.

León-González AJ, Navarro I, Acero N, Muñoz Mingarro D, Martín-Cordero C. 2018. Genus Retama: a review on traditional uses, phytochemistry, and pharmacological activities. Phytochemistry Reviews 17:701-731.

Messaoudi MI, Filali H, Tazi A, Hakkou F. 2015. Ethnobotanical survey of healing medicinal plants traditionally used in the main Moroccan cities. Journal of Pharmacognosy and Phytotherapy 7:164-182.

Mouhajir F. 2009. Medicinal plants used by Berber and Arab peoples of Morocco: ethnopharmacology and phytochemistry.

Muñoz Vallés S, Gallego Fernández JB, Cambrollé J. 2013. The biological flora of coastal dunes and wetlands: *Retama monosperma* (L.) Boiss. Journal of Coastal Research 290:1101-1110.

Obón C, Rivera D, Verde A. 2011. Plantas medicinales en la provincia de Albacete: usos, creencias y leyendas. Zahora 28:1-119.

Pearson K. 1900. On the criterion that a given system of deviations from the probable in the case of a correlated system of variables is such that it can be reasonably supposed to have arisen from random sampling. The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science 50:157-175.

Plantlife International. (2023). Important Plant Areas of Morocco. https://www.plantlife.org.uk/our-work/important-plant-areas-of-morocco/ (Accessed on 30 April 2026)

Sekkat ZL, Hassikou R, Souad S. 2023. Ethnobotanical study on the use of medicinal plants among diabetic patients in the Rabat-Salé-Kénitra region, Morocco. Ethnobotany Research and Applications 26:1-44.

Sreekeesoon DP, Mahomoodally MF. 2014. Ethnopharmacological analysis of medicinal plants and animals used in the treatment and management of pain in Mauritius. Journal of Ethnopharmacology 157:181-200.

Tahraoui A, El-Hilaly J, Israili ZH, Lyoussi B. 2007. Ethnopharmacological survey of plants used in the traditional treatment of hypertension and diabetes in south-eastern Morocco (Errachidia province). Journal of Ethnopharmacology 110:105-117.

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 62:24-39.

Teixidor-Toneu I, Martin GJ, Ouhammou A, Puri RK, Hawkins JA. 2016. An ethnomedicinal survey of a Tashelhit-speaking community in the High Atlas, Morocco. Journal of Ethnopharmacology 188:96-110.

Tilburt JC, Kaptchuk TJ. 2008. Herbal medicine research and global health: an ethical analysis. Bulletin of the World Health Organization 86:594-599.

Touati R, Santos SA, Rocha SM, Belhamel K, Silvestre AJ. 2015. *Retama sphaerocarpa*: an unexploited and rich source of alkaloids, unsaturated fatty acids and other valuable phytochemicals. Industrial Crops and Products 69:238-243.

Touati R, Santos SA, Rocha SM, Belhamel K, Silvestre AJ. 2017. Phenolic composition and biological prospecting of grains and stems of *Retama sphaerocarpa*. Industrial Crops and Products 95:244-255.