

An ethnobotanical study on traditional medicinal uses of *Euphorbia resinifera* by local communities in Beni Mellal-Khenifra, Morocco

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Abstract. *Abd-dada H, Bouda S, Dani S, Bouchari MEH, Adiba A, Haddioui A. 2025. An ethnobotanical study on traditional medicinal uses of Euphorbia resinifera by local communities in Beni Mellal-Khenifra, Morocco. Asian J Ethnobiol 8: 230-244. Euphorbia resinifera* O.Berg, endemic to the Beni Mellal-Khenifra region of Morocco, is a culturally and medicinally significant plant now threatened by overexploitation and habitat degradation. This study documented local knowledge, uses, and conservation perceptions through surveys with 515 respondents across five provinces. Socio-demographic data (age, gender, education, residence) and traditional knowledge were analyzed using descriptive statistics, principal component analysis (PCA), and Pearson correlations. Results revealed that knowledge is concentrated among older, rural, and less formally educated populations, while younger and urban respondents showed limited awareness. The latex and stems were the most cited parts, primarily used in treating digestive disorders, skin infections, and diabetes. PCA highlighted strong associations between education level, age, and knowledge distribution. Respondents also reported declining availability of *E. resinifera*, attributing it to unsustainable harvesting and habitat loss. This study demonstrates the erosion of ethnobotanical knowledge alongside ecological threats to *E. resinifera*. Safeguarding this heritage requires integrated strategies, including awareness campaigns, sustainable harvesting practices, and in situ and ex situ conservation. Documenting traditional uses not only supports biodiversity management but also provides a basis for future pharmacological validation.

Keywords: Beni Mellal-Khenifra, ethnobotanical survey, *Euphorbia resinifera*, medicinal plant, Morocco

INTRODUCTION

For millennia, humans have relied on plants not only as nourishment but as vital healing tools. From ancient civilizations to modern societies, plants have alleviated pain, treated illnesses, and promoted well-being, with medicinal knowledge transmitted across generations (Reid et al. 2018; Matole et al. 2021). Even in the 21st century, despite pharmacological advancements, plant-based traditional medicine remains integral to healthcare in many regions, especially in developing nations with limited access to modern medical systems (Nargawe et al. 2023; Khoja et al. 2024; Dalamagka 2024). Morocco, with its diverse Mediterranean landscapes and unique bioclimates, is a biodiversity hotspot hosting thousands of plant species, many endemic or rare (Ghanmi et al. 2011). Of North Africa's 7,000 documented plant species, 4,200 occur in Morocco, including approximately 537 endemics and 1,625 classified as rare or threatened (Benabid 2000; Attouiti 2002). Among these botanical treasures, aromatic and medicinal plants (AMPs) hold profound cultural, ecological, and socio-economic significance. They serve as cornerstones of traditional medicine and potential drivers of sustainable development in rural communities.

One such species, *Euphorbia resinifera* O.Berg, exemplifies the intersection of ecological importance, traditional knowledge, and modern scientific interest. A

succulent member of the Euphorbiaceae family, *E. resinifera* is native and endemic to Morocco's Atlas Mountains, thriving predominantly in the Beni Mellal-Khenifra region (Benabid 2000; Fennane et al. 2007). Characterized by its spiny, cactus-like stems that form dense shrubs up to 2 meters in diameter, the plant produces vibrant yellow flowers in late spring, which sustain local bee populations and yield high-quality therapeutic honey (Figure 1) (Abd-dada et al. 2023). Beyond its ecological role as a keystone species in pre-forest ecosystems (Benabid 2000), *E. resinifera* has been revered for centuries for its medicinal latex, known historically as "euphorbium." Ancient texts describe its use as a potent laxative, blistering agent, and antidote for snakebites (Agrawal and Konno 2009), while Moroccan traditional healers have long employed it to manage diabetes, treat severe skin conditions, and address ailments ranging from cancer to parasitic infections (Errajaji et al. 2010; Farah et al. 2014; El Alami et al. 2016). Modern research has begun to validate these uses, identifying diterpenes within the latex with analgesic, antioxidant, antibacterial, and anticancer properties (Talbaoui et al. 2020; El Idrissi et al. 2021).

Despite its cultural and therapeutic value, *E. resinifera* faces mounting threats that jeopardize its survival. Anthropogenic pressures, including overharvesting, habitat fragmentation from agriculture and urbanization, wildfires,

and fungal diseases, have led to alarming population declines (Taha et al. 2024). Compounding these challenges is the gradual erosion of traditional knowledge, as younger generations drift away from ancestral practices and environmental degradation accelerates. The loss of this species would not only disrupt ecosystems but also sever a living link to Morocco's ethnobotanical heritage, underscoring the urgent need for conservation strategies that balance ecological preservation with community needs.

This study concentrates on the Beni Mellal-Khenifra region, a hub of biodiversity and traditional medicine, to document the ethnobotanical uses of *E. resinifera* by local communities. By engaging with indigenous knowledge holders, the research aims to catalog the plant's applications in treating ailments, its preparation methods, and its socio-cultural importance. Such an approach not only respects the expertise of local populations but also offers essential insights for sustainable management. The findings are intended to guide conservation policies that protect *E. resinifera* while supporting rural livelihoods through ethical harvesting and value-added products like medicinal honey. Moreover, this work underscores the plant's potential as a model for integrating traditional wisdom into modern healthcare and biodiversity conservation frameworks.

In a world increasingly struggling with biodiversity loss and the marginalization of indigenous knowledge, the case of *E. resinifera* serves as a microcosm of broader challenges and opportunities. Preserving this species requires a holistic approach—one that recognizes the interdependence of ecological health, cultural heritage, and economic resilience. By combining scientific research with community-driven stewardship, this study aspires to contribute to a future where Morocco's medicinal plants continue to thrive as symbols of natural wealth and human innovation.

MATERIALS AND METHODS

Presentation of the studied region

Located in the center of the kingdom of Morocco, the Beni Mellal-Khenifra Region was established following the 2015 territorial reorganization. This new entity comprises five provinces: Azilal, Beni Mellal, Fquih Ben Salah, Khenifra, and Khouribga (Figure 2). It includes 19 circles, 16 urban communes, and 119 rural communes, covering 28,374 km² (4% of the nation's territory). Four dominant landscapes characterize the region: plains, mountains, foothills, and the phosphate plateau (HCP 2019).

The region's geographical position creates climatic diversity, ranging from humid mountainous zones to semi-arid plains. Overall, it experiences a continental climate, with very cold winters and very hot summers. Landscape variability influences temperature and precipitation, with an average temperature of 18°C (ranging from 0°C to over 40°C) and annual precipitation between 100 mm (arid areas) and 600 mm (humid areas). Mountainous areas above 1,000 meters receive seasonal snowfall (HCP 2017).

According to the 2024 General Population and Housing Census (RGPH), the region's population is 2,525,801, with 50.8% urban residency (below the national average of 62.8%). Its population density is 58.8 inhabitants/km², below the national average of 83.64 (HCP 2024).

Ethnobotanical surveys

Date, location, and duration of the survey

The study was conducted from 1 February 2024 to 9 April 2024 across all five provinces of the Beni Mellal-Khenifra region. Interviews with participants typically lasted between 20 and 40 minutes.

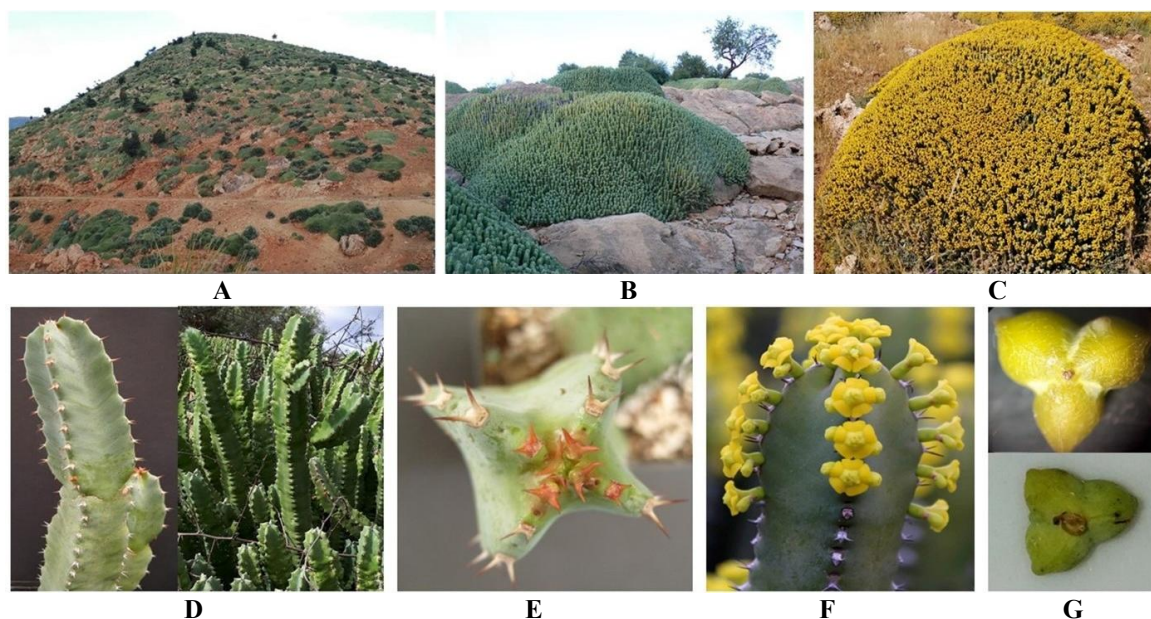


Figure 1. Constituents of the studied medicinal plant. A. *Euphorbia resinifera* population; B. Bush without flowers; C. Bush with flowers; D. Stems; E. Spines; F. Flowers; G. Fruit (Abd-dada et al. 2023)

Tools and procedures for data collection

Before conducting fieldwork, investigation sites within the study area were mapped. Data were collected through face-to-face interviews and discussion groups using semi-structured questionnaires and direct questioning. The questionnaire consisted of two parts: the first focused on participant details (age, sex, marital status, educational level, province of residence, language, and income), while the second gathered information on the medicinal plant (*E. resinifera*) used by respondents to treat or cure diseases.

Sampling and data processing

The sample was prepared using a non-proportional stratified probability (random) sampling method (Godron 1971), divided into zones, covering cities, villages,

agglomerations (Douar), and weekly markets in the study region. Sampling was based on ecological factors (climate, soil, altitude), the presence of the study plant, and population distribution. Within the study area, 53 urban and rural zones were selected as the most representative. This selection prioritized populations that use medicinal plants, particularly those who utilize *E. resinifera* (herbalists, traditional practitioners, plant gatherers, healers, and others). Interviewees were first informed of the study's purpose to secure their consent. They were interviewed in Amazigh or Arabic dialects, depending on their language, to document local knowledge on the plant's use for treating various diseases (Table 1).

Table 1. Distribution of survey areas in the study region

Provinces of Beni Mellal - Khenifra region				
Beni Mellal	Azilal	Khenifra	Fquih Ben Salah	Khouribga
Beni Mellal (Municipal)	Azilal (Municipal)	Khenifra (Municipal)	Fquih Ben Salah (Municipal)	Khouribga (Municipal)
El Ksiba (Municipal)	Demnate (Municipal)	M'rirt	Ouled Zmam	Bejaad
Kasba Tadla (Municipal)	Imi n'Ifri	Elkhab	Souk Sebt	Tachraft
Zaouiat cheikh (Municipal)	Ait Abbas	Ouaoumana	Ouled Ayad	Oued Zem
Taghzirt	Ait M'Hamed	Tighassaline	Khalfia	Oulad Abdoune
Dir El Ksiba	Ouaouizeght	Aguelmam Azegza	Béni Oukil	Lagfaf
Ait Oum El Bekht	Tanant	Kahf Nssour	Elbradia	
Ighram Laalam	Ouaoula	Oum Rabiaa	Dar Ould Zidouh	
Naour	Ait Atab		Had Boumoussa	
Aghbala	Foum Jemaa			
Sidi Jaber	Bine Elouidane			
Ouled Yaich	Bzou			
Moudj	Ouzoud			
Ouled M'Barek	Afourar			
	Timoulilt			
	Isseksi			

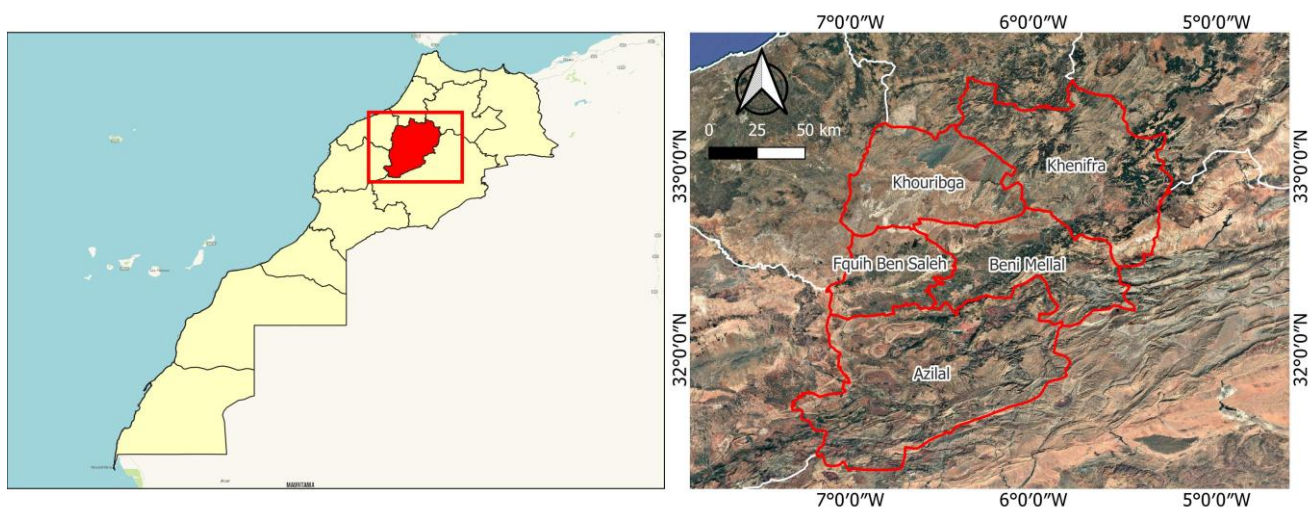


Figure 2. Geographical location and municipal division of Moroccan Beni Mellal-Khenifra Region (HCP 2017)

Using stratified random sampling (Kahouadji 1986), samples were formed in each of the 53 zones and combined to constitute the overall sample of 515 individuals. The number of surveyed individuals varied across zones depending on the use of the medicinal plant *E. resinifera*. Participation in the study is unique, with each person agreeing to complete the questionnaire only once. The process was anonymous and prevented individual identification. Those who had never used this plant for therapeutic or other purposes, as well as transients from regions outside Beni Mellal-Khenifra, were excluded from the survey. The questionnaire was administered to all indigenous persons who agreed to participate and committed to answering honestly.

The collected data were entered and analyzed using Microsoft Excel 2016. Data analysis employed simple descriptive statistical methods: quantitative variables are described using the means, and qualitative variables were described using frequencies and percentages.

To explore the relationships between diseases treated with *E. resinifera* and the socio-demographic characteristics of the informants, we used two statistical methods: Principal Component Analysis (PCA) and Pearson correlation. We also examined how much each variable contributed to the main components in the PCA. Pearson's correlation coefficient (r) was used to measure the strength and direction of the relationships between variables. Only moderate to strong correlations ($r > 0.5$ or $r < -0.5$) were considered in the interpretation. Both analyses were conducted using the statistical software OriginPro 2023 (OriginLab Corporation, Northampton, MA, USA).

RESULTS AND DISCUSSION

The ethnobotanical study made it possible to collect several information related to the interviewee and the uses of the studied plant.

Use of the studied medicinal plant according to the characteristics of the interviewees

According to age

The use of the studied plant (*E. resinifera*) was widespread among all respondents, with the highest prevalence (33.2%) observed in individuals aged 50-60 years. However, lower rates were recorded for the 40-50 age group (26.6%) and those over 60 (13.8%). Use was minimal (1%) among the youngest informants (<20 years old) (Table 2). A cumulative 47% of users over 50 years old indicated a significantly higher reliance on this plant. These results indicate that, in the Beni Mellal-Khenifra region, knowledge of the plant's properties and uses depended on long-term experience and trust in traditional medicine, as respondents retained ancestral knowledge transmitted orally. Knowledge of medicinal plants is typically acquired through long accumulated experience and generational transmission. However, this transmission is increasingly precarious (Anyinam 1995). Therefore, there is a marked lack of interest in phytotherapy and a loss of knowledge about medicinal plants. This can be

attributed to a general sense of mistrust, particularly among youth, who favor modernization over traditional practices. These findings align with prior studies on Moroccan medicinal plant use (Benkhnigue et al. 2010; Salhi et al. 2010; Benlamdini et al. 2014; El Hafian et al. 2014).

According to sex

The investigation of the local population (515 individuals) showed that both men and women were engaged in traditional medicine. However, sex-based distribution showed a slight predominance of women overall (266 users of *E. resinifera*, representing 51.7% of the study population) compared to men (249 respondents, 48.3%) (Table 2). This disparity may stem from women's proactive role in maintaining familial health, their multifaceted use of plants, household responsibilities, and adherence to traditional practices. Specifically, women primarily ensure family well-being and healthcare during illnesses. These findings align with prior ethnobotanical studies at the national level, including those by Benkhnigue et al. (2010) in Mechraâ Bel Ksiri, El Hafian et al. (2014) in Agadir-Ida-Outanane prefecture, and others (Salhi et al. 2010; Mandal et al. 2021; Mantuan and Sannomiya 2024), which consistently highlight women's greater familiarity with and reliance on traditional phytotherapeutic knowledge.

According to the family situation

In the study area, *E. resinifera* is used significantly more by married individuals (68.5%) than by single individuals (22.7%), while the remaining categories (divorced, widowed) account for 8.7% (Table 2). These results align with findings from prior studies (Benkhnigue et al. 2010; Hafsé et al. 2015; Chraïbi et al. 2018). This trend may reflect married individuals' reliance on the plant to reduce material expenses associated with purchasing synthetic drugs. The same finding was reported by Fatima et al. (2015) in their study of medicinal plants used to treat respiratory infections in Morocco's Middle Atlas.

According to the school level

The analysis of the collected data showed that the majority of *E. resinifera* users are illiterate (32%). However, the proportion of plant users with primary education is relatively higher (31.8%) than those with secondary education (20.8%), while individuals with university-level education use this endemic plant significantly less (15.3%) (Table 2). These results are comparable to those obtained by Lahsissene et al. (2009) and Fatima et al. (2015). This suggests that the use of *E. resinifera* as a medicinal plant declines as educational attainment increases.

According to locality and language

The results showed that most users of this endemic Moroccan plant in the study area reside in Azilal Province (37.3%), while 11.5% belong to Khenifra Province, and 14% to Khouribga Province. In contrast, Fquih Ben Salah and Beni Mellal Provinces exhibited similar proportions (19 and 18.3%, respectively). Consequently, 54% of the

population are Amazigh speakers, compared to 46% Arabic speakers (Table 2).

Regarding living environment, the majority of respondents using *E. resinifera* reside in villages and Douars (43.9 and 35.5%, respectively), whereas only 20.6% of the surveyed population lives in urban areas (Table 2). Factors such as limited informational, geographical, and economic access to modern healthcare; inadequate distribution of healthcare staff in isolated localities; mistrust of synthetic products; the preference for "bio" alternatives and socio-cultural habits collectively explain the widespread reliance on medicinal plants like *E. resinifera* for treatment in the Beni Mellal-Khenifra region.

According to income/month (MAD: Moroccan Dirham)

In our study, 59.8% of the population using the studied plant earn less than 1,500 MAD/month, while 31.8% of respondents have incomes ranging between 1,500 and 5,000 MAD, and only 7.8% earn between 5,000 and 10,000 MAD (Table 2). Indeed, medications are expensive, whereas medicinal plants can be freely harvested from nature, explaining why income significantly shapes perceptions of plant use in traditional medicine. These results align with those of Benlamdini et al. (2014), who documented medicinal plants used in traditional phytotherapy by the Eastern Moroccan High Atlas population. The findings indicate that reliance on the studied plant increases as informants' monthly income decreases.

Therapeutic practices

The choice between traditional medicine and modern medicine is firstly

Among the 515 interviewed individuals who use both herbal and modern medicine, the data indicate a higher prevalence of modern medicine users. Specifically, 80.8% (416 individuals) in this region prefer modern medicine as their first choice, while only 19.2% (99 individuals) primarily rely on traditional medicine. Of the latter group, 8% chose traditional medicine primarily for its effectiveness, 50% due to lower costs, 35% for reasons of acquisition, and only 7% due to perceived inefficacy of modern drugs. Among modern medicine users, 41% adopted it for its precision, 12% for its effectiveness, and 47% due to concerns about plant toxicity, such as that of *E. resinifera* (Figures 3.A and 3.B). The toxicity of certain plants, particularly *E. resinifera*, has made residents of the Beni Mellal-Khenifra region cautious, aligning with this study's findings. The reported values here are lower than those from Chraïbi et al. (2018) for *Mentha pulegium*, *Mentha piperita*, and *Pelargonium graveolens* in the Taounate region and from Chaachouay (2020) for medicinal plants used in phytotherapy in the Rif (northern Morocco).

Vernacular name of E. resinifera in the studied region

The plant classification system employed in this study is based on responses provided by the interviewees. A

single medicinal plant may have multiple Arabic and Amazigh vernacular names, depending on the region (Bellakhdar et al. 1997). In this survey, three vernacular names for the plant *E. resinifera* were identified: zeggoum, daghmouss, and tikiwt. Among the respondents, 43% referred to the plant as zeggoum, 20% as daghmouss, and the remaining 37% used the term tikiwt. These names align with those documented by Bellakhdar et al. (1997).

Therapeutic and cosmetic uses of the plant

The information gathered on the local therapeutic and traditional uses of *E. resinifera* revealed that 94.6% of its applications are therapeutic (487 respondents), 13.8% corresponds to cosmetic use (71 respondents), and 6.2% to other purposes (32 respondents). These overlapping responses indicate that the plant is utilized by respondents for both therapeutic and cosmetic applications.

Table 2. Summary of interviewees' socio-demographic data

Characteristics	Number (Total=515)	Percentage (%)
Age		
<20	5	1.0
20-30	82	15.9
30-40	49	9.5
40-50	137	26.6
50-60	171	33.2
>60	71	13.8
Sex		
Male	266	51.7
Female	249	48.3
Family situation		
Single	117	22.7
Married	353	68.5
Others (Divorced, widowed)	45	8.7
School level		
None	165	32.0
Primary	164	31.8
Secondary	107	20.8
University	79	15.3
Province of residence		
Khenifra	59	11.5
Beni Mellal	94	18.3
Azilal	192	37.3
Fquih Ben Salah	98	19.0
Khouribga	72	14.0
Locality		
City	106	20.6
Village	226	43.9
Douar	183	35.5
Language		
Arabic	237	46.0
Amazigh	278	54.0
Income / Month (MAD)		
<250	154	29.9
250-1,500	154	29.9
1,500-5,000	164	31.8
5,000-10,000	40	7.8
>10,000	3	0.6

Parts used of the plant

According to the ethnobotanical survey, the latex was identified as the dominant part used in the preparation of remedies derived from *E. resinifera* in the study area (75.5%; 389 respondents), followed by the stem (33.6%), flower and seeds (17.7%), fruit (15.1%), and underground part (6.8%), respectively. In contrast, the spines were reported as the least frequently used component (1.4%; 7 respondents). These results are comparable to those reported nationally by Benkhniue et al. (2010) (Figure 4).

The preference for latex and stem was attributed to their easy availability, ease of harvesting, and simplicity in remedy preparation. Additionally, these parts contain the majority of secondary metabolites (Appendino et al. 2010). Notably, they have been reported to possess anti-inflammatory, antibacterial, antifungal, and anticancer activities (Farah et al. 2014; Talbaoui et al. 2020).

Techniques and the moment of harvest of the plant studied for traditional uses

The results of the survey conducted with our informants show that 42.3% of the population employs mechanical harvesting techniques, while only 40.8% purchase the

plant, and 16.9% use manual methods. These findings indicate significant exploitation pressure on the region's flora, which could lead to undesirable ecological consequences. Regarding the timing of harvest in the study region, the ethnobotanical survey revealed that 94.56% of respondents (447 individuals) reported year-round harvesting of the plant. However, a small minority (5.44%) stated that harvesting occurs seasonally. This result indicates that the plant is perennially available in traditional remedies used in the Beni Mellal-Khenifra region.

State of the plants used

According to the ethnobotanical survey, fresh plant is predominantly used (53%) compared to dried plants (31%) (Figure 5). In contrast, the use of treated plant material (combined with other medicinal ingredients such as honey, maceration in water or olive oil) is the least common, accounting for 16%. The study conducted by Abdurhman (2010) shows that 86% of preparations utilize fresh plant material. These results may reflect the plant's availability in the study region and the perceived efficacy of fresh medicinal plants in traditional treatments.

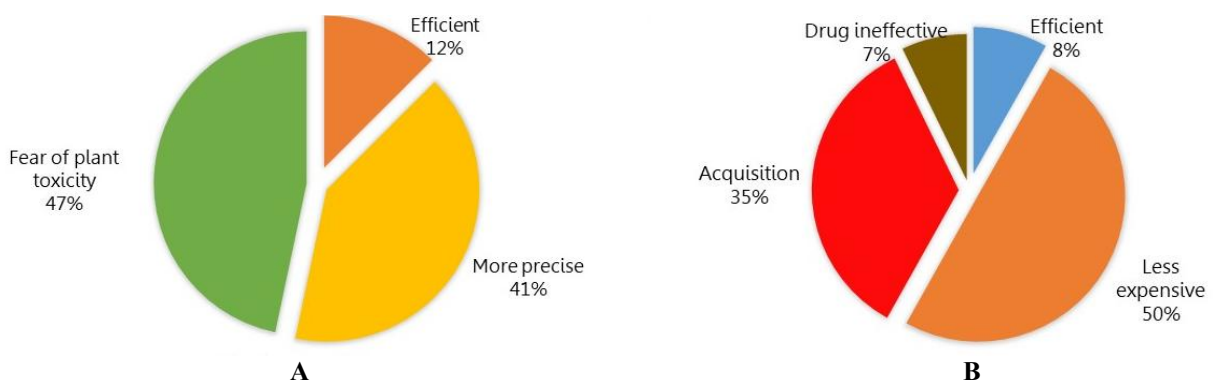


Figure 3. Percentage of different reasons for respondents' medication preferences. A. Modern medicine; B. Traditional medicine

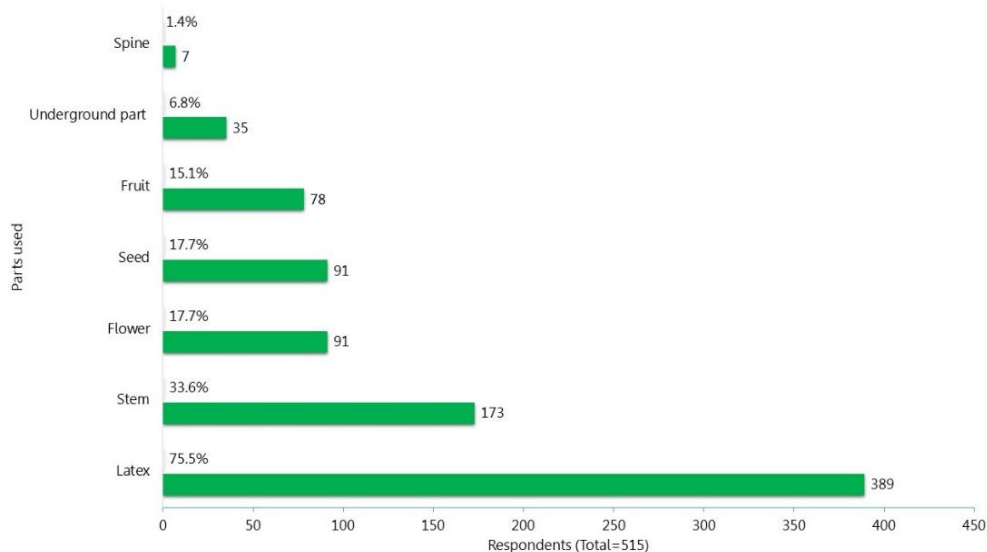


Figure 4. Distribution of *E. resinifera* use according to plant parts

Drug preparation

According to the recorded recipes (Figure 6), the plant is prepared alone (10% of respondents) or combined with other plant species (11%). In contrast, combinations with honey accounted for the highest proportion 43%, while other combinations represented 36%. Notably, recipes incorporating honey were the most prevalent, likely to neutralize the sharp (bitter) taste or mitigate the toxicity of the plant's latex during remedy preparation. These results contrast sharply with those of El Rhaffari and Zaid (2002), who, in a similar survey conducted in southeastern Morocco (Tafilalet), found that 85.3% of recorded recipes utilized the plant alone, with only 14.7% combined with other ingredients.

Preparation methods of the studied plant

Given the plant's toxicity, preparation methods in the study area are highly specific to avoid poisoning (Figure 7). Our study found that latex mixed with warm water and honey is the most common preparation in traditional remedies derived from the plant, accounting for 30% of applications. Other methods, such as decoction in water, tea, or milk, represent 25%. Depending on the treated ailment, interviewees utilize powdered dried plant parts

(cumulative 18%), while stems without latex combined with juice or ground aerial parts mixed with honey also account for 18% cumulatively. The frequent use of honey in Beni Mellal-Khenifra traditions- especially in areas where the plant naturally grows- explains the 9% of remedies incorporating *E. resinifera* honey. This aligns with findings from the Azilal and Beni Mellal Atlas regions by El Alami et al. (2020). Furthermore, ethnobotanical surveys in other Moroccan regions further indicate that most respondents prepare remedies via decoction (Salhi et al. 2010; Fatima et al. 2015; Slimani et al. 2016; Bourhia et al. 2019), underscoring the widespread exchange of knowledge on medicinal plant use among Moroccan communities.

Dose used

In the study region, the surveyed population informed us that remedies based on *E. resinifera* are administered in varying doses: 72% by spoonful, 23 % by pinch, and 5% by handful (Figure 8). This absence of standardized dosing practices among the local population of the Beni Mellal-Khénifra region may pose adverse health risks. These results partially align with findings from Benkhniqie et al. (2010) in the Mechraâ Bel Ksiri region.

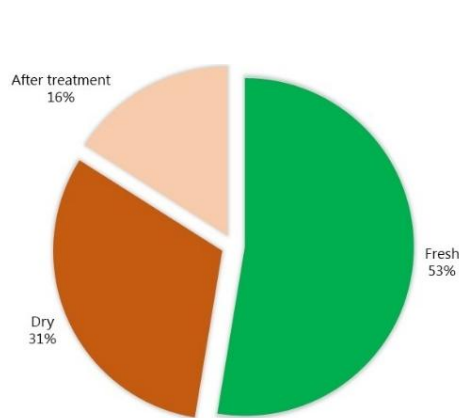


Figure 5. Use of the plant according to its state

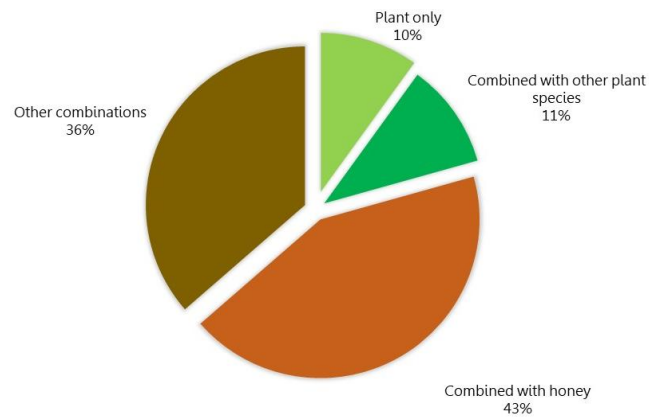


Figure 6. Proportion of species used alone and mixed

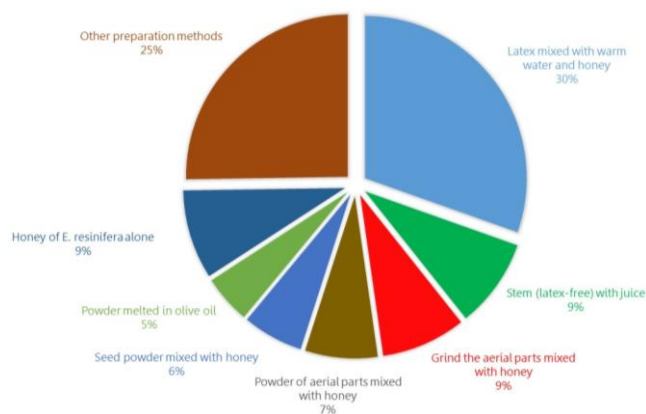


Figure 7. Methods of preparation of plant (%)

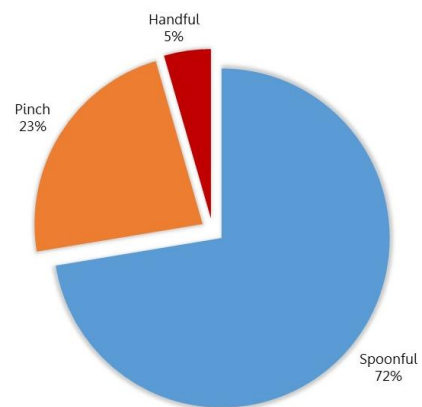


Figure 8. Use of the plant according to dose precision

Method of administration

According to the surveys, the most common form of administration is oral (52%). However, external application (17%) is primarily used for wound healing, wound disinfection, and insect bite treatment. The remaining 31% utilize both administration modes (Figure 9). The predominance of oral administration for remedies based on the studied medicinal plant aligns closely with ethnobotanical studies conducted across North Africa (El Hafian et al. 2014; Chermat and Gharzouli 2015; El Hajli et al. 2024).

Treatment duration

The duration of treatment varies significantly depending on the individual and the treated condition. Analysis of Figure 10 shows that treatment with *E. resinifera* until cure is achieved is most common (77%), followed by one-week duration (15%). Finally, one-month and one-day treatment durations account for 7% and 1%, respectively. These results are in agreement with those of Chaachouay et al. (2020), who reported that treatment with medicinal plants until cure was predominant (46.6%).

Source of information

Regarding the source of information through which respondents learned about the plant's uses, 50% reported relying on advice and experiences from their immediate social circle (family and friends) who use it as a remedy for specific illnesses. This highlights the intergenerational transmission of traditional practices. 35% obtained their information from a herbalist "Achabe", while 15% self-sourced knowledge by consulting traditional medicine texts, watching television programs, or drawing on personal experience due to the plant's prevalence in their environment (Figure 11). These results align with studies by Benkhniqie et al. (2010) in the Mechraâ Bel Ksiri region and El Yahyaoui et al. (2015) in Laayoune Province.

Diagnostic methods

Data analysis resulted in Figure 12, which shows that in the study areas, 39% of indigenous self-diagnosed (201 interviewees), followed by 33% diagnosed by a doctor, and 17% by an herbalist. Finally, diagnoses through other methods accounted for the remaining 11%.

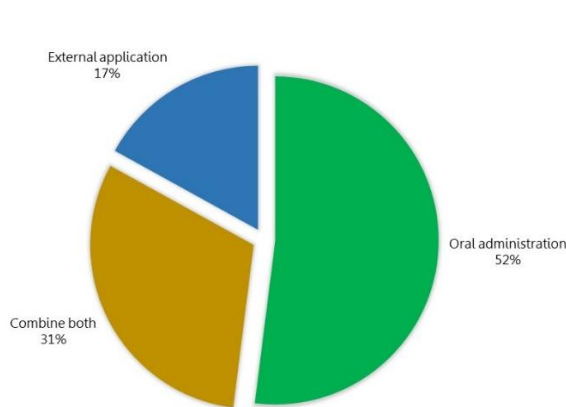


Figure 9. Frequency of different methods of administration of remedies based on the plant *E. resinifera*

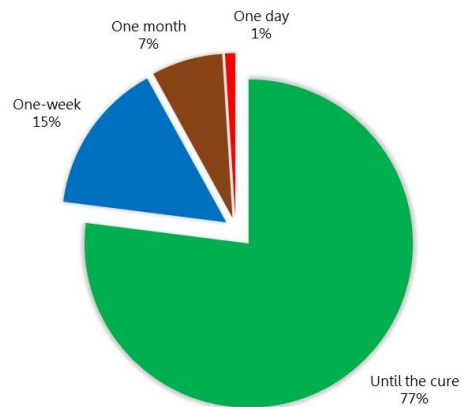


Figure 10. Frequency of different durations of use of remedies based on the plant studied

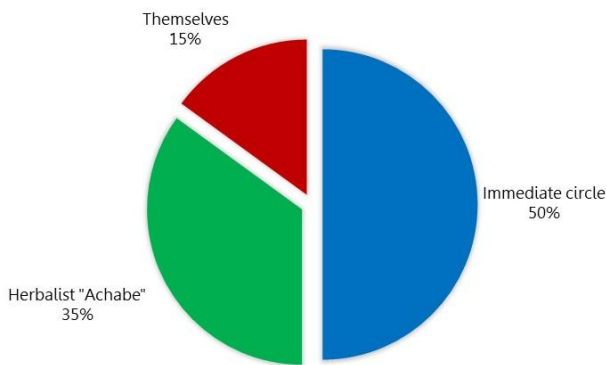


Figure 11. Distribution of *E. resinifera* users according to the origin of information

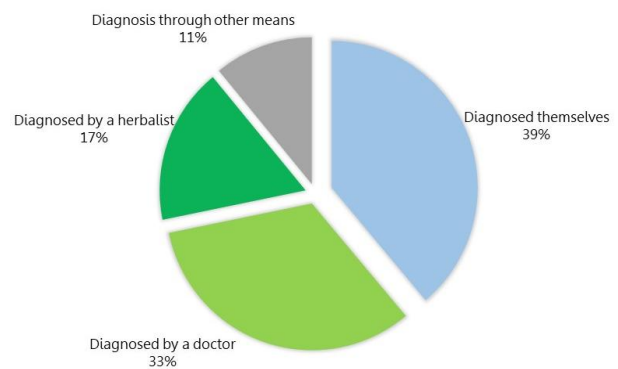


Figure 12. Proportion of actors responsible for disease diagnosis

Diseases treated by *E. resinifera* plant

In humans

The ethnobotanical survey revealed that the plant *E. resinifera* is primarily used in humans to treat type 2 diabetes (58%; 299 respondents) and digestive disorders (54.2%). Its applications for cancer treatment include 19% for female genital cancers, 25.40% for breast cancer, 28.30% for skin cancer, and 34.40% for cancers such as colon, lung, uterine, leukemia, and oral cancers. Local populations also use the plant to treat snake bites and scorpion stings (39.80%), warts (42.5%), female genital tract cysts (28.7%), toothaches (49.10%), and hair care (8.20%). Additional uses are detailed in Table 3. These findings on the therapeutic uses of *E. resinifera* align with phytochemical studies. Research indicates that extracts from various parts of *E. resinifera* exhibit significant therapeutic potential, rivaling synthetic chemicals and antibiotics in treating infectious diseases (Hanane et al. 2014; Samouh et al. 2019; Belhaj et al. 2020; Talbaoui et al. 2020). Among respondents, 51% believe *E. resinifera* effectively cures the treated conditions, 48% consider it improves health outcomes, and 1% distrust its efficacy (Figure 13). These results correlate with studies by Zeggwagh et al. (2013) in Fes, Chraïbi et al. (2018) in Taounate, and Chaachouay (2020) in the Moroccan Rif.

Contrasting with Mediterranean studies by Fortini et al. (2016), Chiocchio et al. (2024), Patti et al. (2025), in Italy, Saïve et al. (2018), Zidane et al. (2020) in French, and Emre et al. (2021) in Turkey, which primarily document generalized applications of multiple plant taxa for digestive, respiratory, and dermatological conditions, our results demonstrate that *Euphorbia resinifera* is distinctively employed against a spectrum of highly specific pathologies. Notably, it is extensively utilized in managing type 2 diabetes (58% of respondents), diverse malignancies (reported in up to 34.4% of applications—including female genital cancers (19%) and genital tract cysts (28.7%), envenomation (39.8%), and oral pathologies (49.1%). These applications, particularly for oncological, toxicological, and dental conditions, remain undocumented in the comparative literature, underscoring the distinctive ethnopharmacological role of this endemic Moroccan species within its regional healing traditions.

In animals (pets)

The results show that *E. resinifera* is also utilized in animals (pets) to treat specific ailments, depending on the animal type. For poultry, goats, cattle, and other animals, 29, 28, 25, and 11% of respondents, respectively, reported using this plant to treat certain diseases. However, 7% of the respondents do not use the plant (Figure 14.A). Among users of *E. resinifera*, perceived treatment efficacy varied: 50% reported complete cure and 41% observed health improvement, dependent on the animal species and disease treated, while 9% deemed it ineffective (Figure 14.B). These findings underscore the need to better understand the true efficacy of this medicinal plant in veterinary applications, as well as potential risks linked to side effects. A more rigorous research approach is required to evaluate its safety and therapeutic potential in veterinary medicine systematically.

Main diseases treated by *E. resinifera* honey in humans

Euphorbia resinifera honey is widely used for therapeutic purposes; analysis of survey results from this study demonstrates its efficacy in treating a broad spectrum of ailments (Table 4). A 69.70% of respondents (359 individuals) use this honey to treat digestive diseases, and 59% to treat cancers. It is also effective against respiratory diseases (57.50%). Local populations further utilize this melliferous plant's honey for reproductive system diseases (34.40%) and intoxications (32.80%). Similarly, *E. resinifera* honey is used to treat throat infections (29%) and skin disorders (24.10%). Additionally, respondents report its use for headaches (20.60%), weakness, and jaundice (8.70%). These findings corroborate studies by Errajraji et al. (2010), Kuehn (2018), Boutoub et al. (2020), and Benjamaa et al. (2020). Also, the honey of this species is utilized for cosmetic purposes as hair and skin care (El Alami et al. 2016).

Table 3. Diseases treated using the medicinal plant *E. resinifera* in the Beni Mellal-Khenifra region

Diseases treated	Number of respondents (Total=515)	Percentage %
Type 2 diabetes	299	58.0
Type 1 diabetes	261	50.7
Digestive disorders	279	54.2
Toothaches	253	49.1
Warts	219	42.5
Snake bites and scorpion stings	205	39.8
Inflammation (general)	203	39.4
Other conditions	204	39.6
Skin inflammation	197	38.3
Cancers (colon, lung, uterus, leukemia, oral)	177	34.4
Goiter	153	29.7
Female genital tract cysts	148	28.7
Skin cancers	146	28.3
Breast cancer	131	25.4
Poisonings	128	24.9
Female genital tract cancer	98	19.0
Respiratory diseases (influenza, asthma, allergies)	61	11.8
Hair care	42	8.2
Abortifacient	17	3.3
Paralysis	14	2.7

Table 4. Main diseases treated by *E. resinifera* honey in humans in the Beni Mellal-Khenifra region

Diseases treated	Number of respondents (Total=515)	Percentage %
Digestive diseases	359	69.7
Cancers	304	59
Respiratory diseases (influenza, asthma, allergies, etc.)	296	57.5
Reproductive system diseases	177	34.4
Intoxications	169	32.8
Throat infections	149	29
Skin disorders	124	24.1
Headaches	106	20.6
Weakness, and jaundice	45	8.7

Side effects and toxicity of the E. resinifera plant

A question was posed to respondents to assess their awareness of potential side effects associated with *E. resinifera*. Results show that 19% reported observing no adverse effects from using this medicinal plant. However, 75% noted mild side effects related to its use (Figure 15.A). Only 6% believed the plant causes toxicity post administration. Additionally, the present study reveals widespread awareness of the plant's toxicity: 81% answered "Yes" to the question, "Is this plant toxic?" while 19% responded "No" (Figure 15.B). This awareness likely explains the low reported toxicity (6%) among users. Respondents who acknowledged toxicity also emphasized the plant's efficacy, asserting it addresses limitations of modern medicine. Collectively, these findings reflect strong confidence in herbal medicine within the studied population.

Statistical analysis: Principal Component Analysis (PCA) and Pearson correlation

Relationships between diseases treated with E. resinifera and the socio-demographic characteristics of the informants

The result of Principal Component Analysis (PCA) showed that the first two principal components accounted

for 72.5% of the total variance. The first component (PC1) explains 51.13% of the total variation, and the second component (PC2) explains 21.37%. PC1 mainly separates long-term and internal diseases, while PC2 helps identify treatments for external and short-term problems (Figure 16).

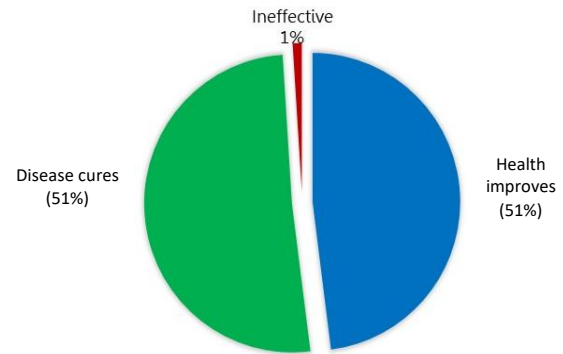


Figure 13. Results of improvement observed after phytotherapy in humans

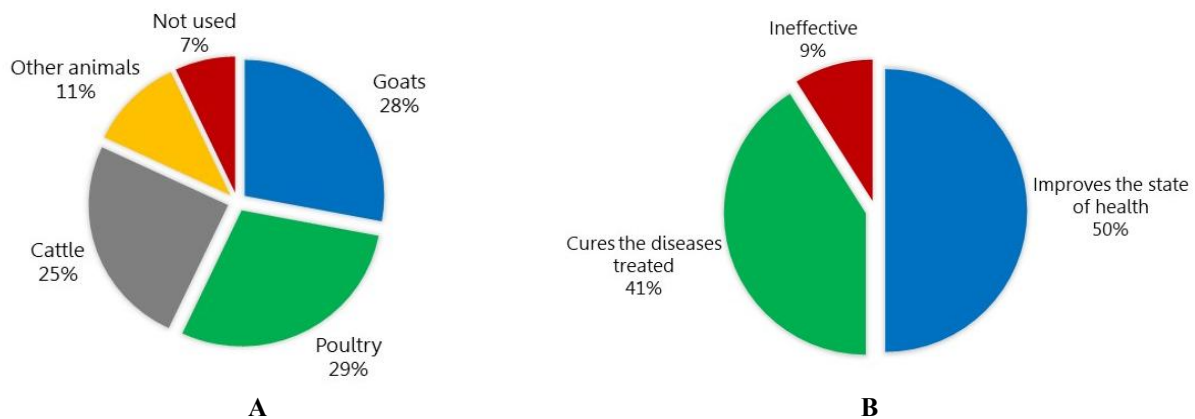


Figure 14. A. Diseases treated in pets; and B. Results after treatment

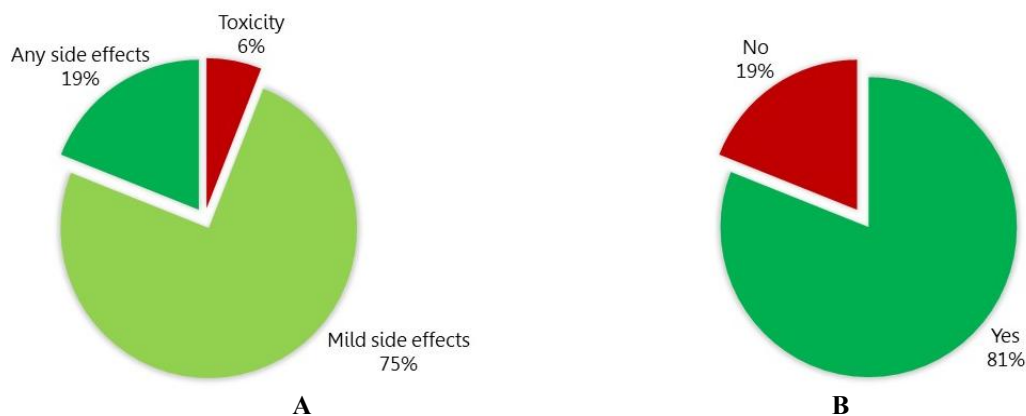


Figure 15. A. Percentage of side effects; and B. Information on the toxicity of the plant studied

The result shown in Figure 16.A demonstrates that diseases like type 2 diabetes, type 1 diabetes, and digestive disorders had high positive values on PC1. This suggests that *E. resinifera* is mostly used to treat these chronic diseases. These conditions are often related to long-term health problems such as blood sugar imbalance and stomach issues, and the plant might be used for its anti-inflammatory or hypoglycemic properties. On the other hand, diseases such as toothaches, warts, and snake bites and scorpion stings had high positive values on PC2. These are more acute or external problems, which may be treated with direct applications of the plant. This shows that *E. resinifera* is also used for fast, traditional treatments in urgent or painful conditions. Moreover, some diseases had low or negative values on both PC1 and PC2, such as breast cancer, female genital tract cancer, paralysis, and abortifacient use. These low values mean that *E. resinifera* is not often used for these types of conditions, or that the use is limited to a few individuals or specific communities.

When we compare this information with the socio-demographic characteristics, we see interesting relationships (Figure 17). People aged under 30 had higher values on PC2, showing that younger people are more likely to use the plant for quick treatments like skin problems or toothaches. In contrast, people aged 40 to 60 had higher values on PC1, meaning they tend to use the plant more for chronic diseases like diabetes or digestive

disorders. In addition, Men were more associated with PC1, suggesting they use the plant more for internal or chronic health issues. Women, on the other hand, had higher values on PC2, meaning they may use the plant more for external conditions or reproductive health. In terms of education, people with primary and secondary school education were more associated with PC2, while those with university education were more associated with PC1.

This may reflect differences in knowledge or preferences in how the plant is used. Looking at the regions, people from Khenifra and Beni Mellal were more related to PC1, which means that in these areas, the plant is mostly used for long-term diseases. People from rural areas (villages and douars) contributed to both PC1 and PC2, showing that the rich and varied traditional knowledge is rich and varied in these regions. Language also played a role. Both Arabic and Amazigh speakers were associated with PC1, showing that both groups use *E. resinifera* for chronic conditions, and that this traditional knowledge is shared across ethnic groups. Moreover, income had an important effect. People with lower incomes (<250 MAD) contributed more to both components, meaning they rely more on the plant for different treatments. People with higher incomes had lower contributions, which may indicate less dependence on traditional medicine and more access to modern healthcare.

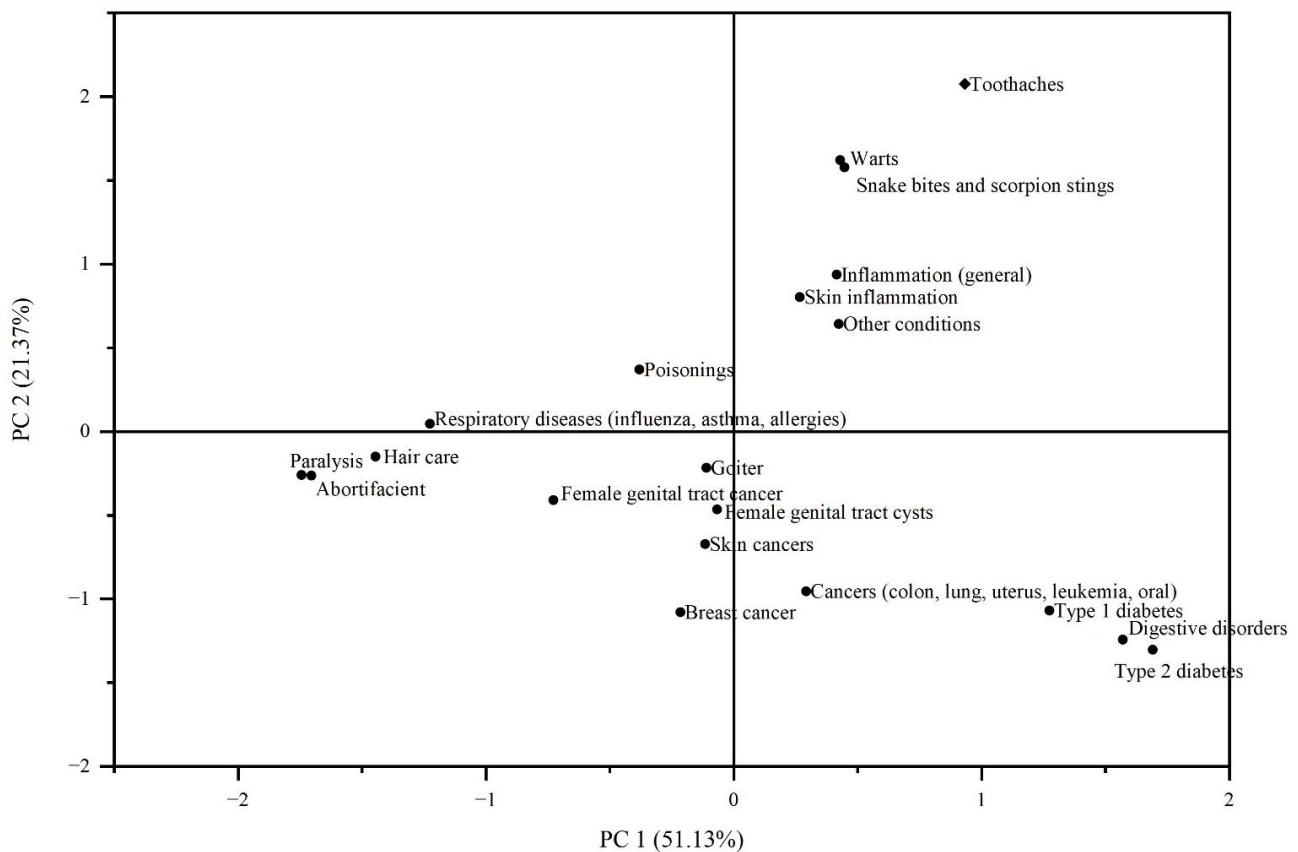


Figure 16. Principal Component Analysis (PCA) score plot of diseases treated by *E. resinifera* in the Beni Mellal Khenifra region

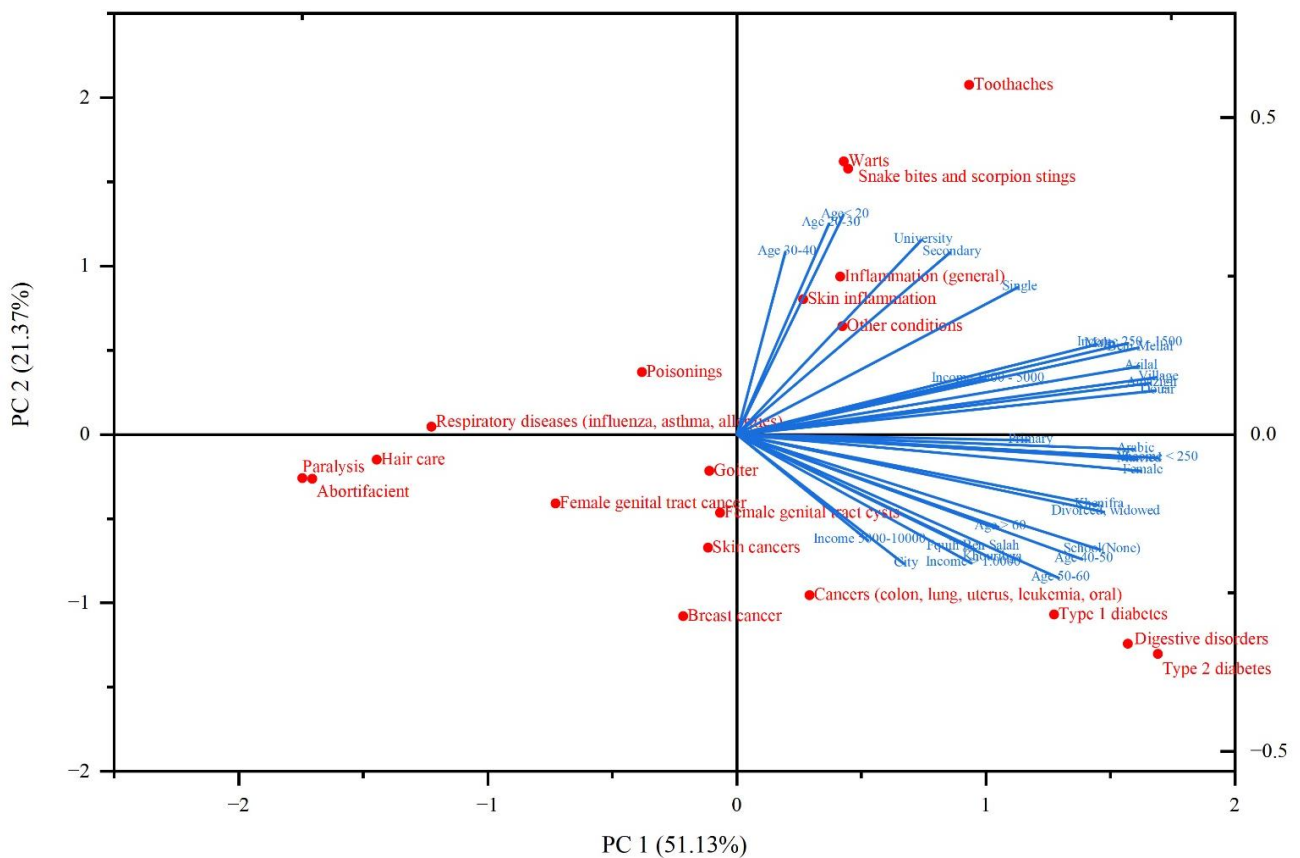


Figure 17. PCA biplot of the relationship between diseases treated with *E. resinifera* and respondents' socio-demographic characteristics

The study revealed that the PCA shows that *E. resinifera* is mostly used for metabolic and digestive diseases, especially by middle-aged women in rural areas. It is also used for acute problems like toothaches and bites, especially by young, educated people. The use of the plant depends on several social factors, such as age, gender, education, place of residence, language, and income. These factors influence how people use and value traditional medicine. Future studies should focus on confirming the plant's effectiveness for the most common diseases, like diabetes and toxicological problems, to connect traditional knowledge with modern science.

Correlation analysis between the different parts of E. resinifera used in traditional medicine and the socio-demographic characteristics of respondents

The correlation matrix shows important relationships between socio-demographic characteristics and the use of specific parts of *E. resinifera* among interviewees in the Beni Mellal-Khenifra region. Strong correlations ($|r| \geq 0.5$; $p < 0.05$) indicate that age, gender, income, location, and education all influence how this plant is used in traditional medicine. These patterns reflect both the preservation of traditional knowledge and the impact of modern social and economic changes on ethnobotanical practices (Figure 18).

Use of plant parts and demographic influences.

Latex shows opposite trends depending on the group. There

is a negative correlation with young people (Age <20: $r = -0.55$), but a positive one with high-income participants (Income >10,000 MAD: $r = 0.55$). This suggests that younger generations are less involved in using latex, while wealthier individuals may use it for more specialized or commercial purposes. Also, the stem is strongly linked to urban residents (City: $r = 0.61$) and Arabic-speaking users ($r = 0.41$), showing how urbanization influences traditional medicine use. Furthermore, flowers are mostly used by poorer people ($r = 0.68$), those in rural areas (Village: $r = 0.67$; Douar: $r = 0.61$), and women ($r = 0.57$). Married and divorced or widowed people also use flowers more ($r = 0.63$ and 0.74), which shows that women play an important role in family health care.

In addition, fruits are mostly used by older people (Age 40-50: $r = 0.75$; Age 50-60: $r = 0.76$) and wealthier users ($r = 0.61$), especially in the Khouribga ($r = 0.55$) and Fquih Ben Salah ($r = 0.50$) Provinces. This could be because older people have more knowledge, and wealthier people can afford the less common parts. Spines are linked to education (Secondary: $r = 0.50$; University: $r = 0.54$), which may mean educated people are more open to new or less traditional uses. On the other hand, seeds and underground parts don't have many strong links, but seeds are closely related to flower use ($r = 0.69$), which suggests they may be used together.

Socio-demographic patterns of variation. Age makes a big difference. Young people use latex and fruit less ($r=-0.55$ and -0.32), while older people still use fruit ($r=0.53$) and stem ($r=0.38$). Gender and marital status also matter: flowers are more commonly used by women and those who are married or divorced, which fits with women's role in family healthcare. Income creates two groups: poorer people use flowers and latex because they are easier to get, while richer people use fruit and latex for more specific treatments. In addition, the place of living and language also affect plant use. Rural people prefer flowers, showing they keep more traditional knowledge. City dwellers use stems more, showing adaptation to modern life. Arabic speakers use stems ($r=0.41$) and fruits ($r=0.58$) more than Amazigh speakers, which may show a mix of cultures. In different provinces, people use the plant in different ways: Beni Mellal and Azilal prefer flowers ($r=0.58$ and 0.60),

while Khouribga uses more fruits ($r=0.55$). Education encourages the use of spines ($r = 0.50-0.54$), but people without schooling use them less ($r=-0.18$). So, education can help people learn new uses but may also cause traditional ways to fade.

This study identified three main points from the analysis. First, traditional knowledge is not being passed down to young people, while older individuals still use the plant in more traditional ways. Second, income influences which plant parts are utilized—poor people use what is easy to find, whereas wealthier individuals use more specialized or commercial parts. Third, the location and culture of people affect how they use the plant—rural residents retain flower-based knowledge, urban residents tend to use stems more, and educated people explore new uses like spines.

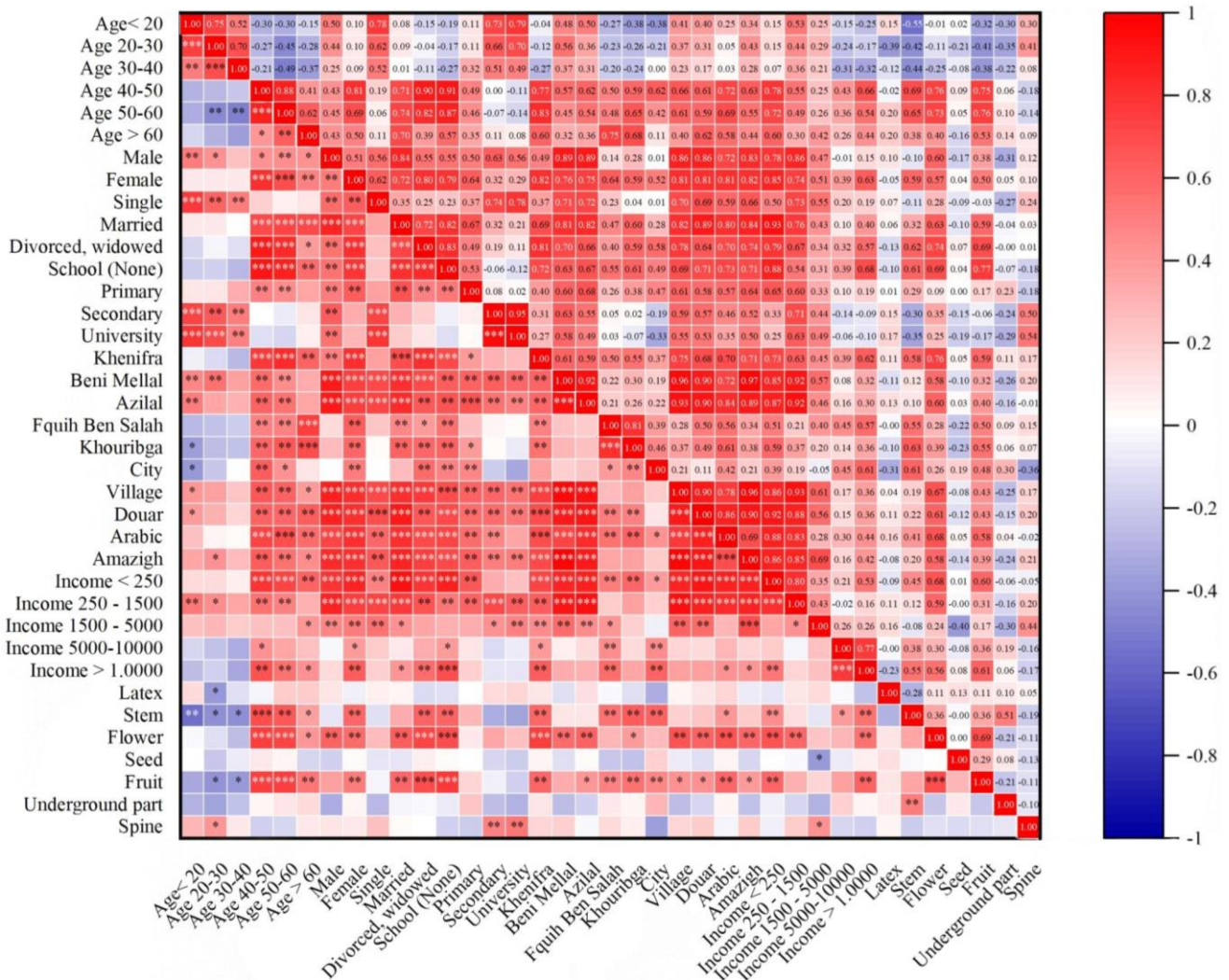


Figure 18. Correlation matrix between respondents' socio-demographic characteristics and parts of *E. resinifera* used in traditional applications

In conclusion, the ethnobotanical survey in the Beni Mellal-Khenifra region underscores the extensive traditional knowledge of local populations regarding the medicinal use of the endemic *E. resinifera*. Notable for its regional prevalence and therapeutic efficacy, the species' documented properties are empirically validated by chemical and pharmacological studies. Utilization frequency correlates with demographics: older individuals exhibit greater familiarity than younger generations, and women hold a slight edge in medicinal knowledge, reflecting intergenerational expertise transmission. Latex and stems are the primary plant parts used, prepared with consideration of dosage and toxicity. The population demonstrates significant awareness of toxicity risks (81%), yet employs the plant widely for treating Type 2 diabetes, digestive disorders, cancers, and diverse ailments via its honey. Preserving this heritage requires safeguarding knowledge transmission to future generations. Rising demand for phytotherapy now threatens both biodiversity and cultural heritage. Safeguarding *E. resinifera* requires urgent in situ and ex situ conservation, regulated harvesting, and measures to ensure ecological sustainability. At the same time, its documented pharmacological potential supports continued bioprospecting for novel therapeutics. Integrating this knowledge into health education and cultural programs will help preserve ancestral traditions while promoting responsible, sustainable use.

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