Ethnobotanical investigation of *Cistus monspeliensis* (L.) in Northern Morocco: Traditional uses and future prospects

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Research

Abstract

Background: *Cistus monspeliensis* (L.), a medicinal plant from the Rif region, has long been recognized for its therapeutic properties. However, limited ethnobotanical research exists on its traditional uses. This study aims to document the knowledge and practices surrounding *C. monspeliensis* among local populations, highlighting its medicinal and cultural significance.

Methods: Conducted from November 2023 to February 2024, the study surveyed 102 participants across four municipalities and twelve villages in the Al Hoceima province. A structured questionnaire collected data on demographic factors such as origin, age, gender, education, and socioeconomic status. Statistical analyses, including Pearson's chi-square test, were performed using IBM SPSS (version 29).

Results: The survey revealed that knowledge and use of *C. monspeliensis* are limited in both rural and urban areas. Villagers exhibited a stronger familiarity with the plant, while higher education levels correlated with greater awareness. Gender differences were notable, with men possessing broader knowledge due to wider exposure, but women showing deeper understanding of its practical uses. Socioeconomic status also influenced usage, with lower and middle classes using the plant more frequently. Medicinal use was primarily limited to treating digestive, skin, and dental issues, with leaves being the most used part, often prepared as a decoction.

Conclusions: This study emphasizes the high cultural and economic value of *C. monspeliensis* in the Rif region, which is based on the intensive use of this plant in various applications such as traditional medicine, agriculture, beekeeping and even dentistry.

Keywords: Ethnobotanical, Medicinal plants, *Cistus monspeliensis* (L.), Rif region, Morocco

Background

The Mediterranean region is exceptionally rich in medicinal plants that have been widely used in traditional medicine. It also serves as a valuable source of diverse practices across various fields related to these plants, offering significant potential for scientific and clinical studies to validate these traditional methods.

Cistus plants are the predominant shrubs in the Mediterranean region. While most species are widely distributed, a few are narrowly endemic within the Cistaceae L. family, commonly referred to as rockrose (Fernández-Mazuecos & Vargas 2010). This family consists of several perennial medicinal plants (Kalli *et al.* 2018), spanning eight genera, including the Cistus genus (Viapiana *et al.* 2017).

All the Cistus species are frequently used in many traditional medicines for their antimicrobial (Chinou *et al.* 1994, Demetzos *et al.* 1999), antitumor (Dimas *et al.* 2000, Polunin 1969), antiviral (Dimas *et al.* 2000) and anti-inflammatory properties (Demetzos *et al.* 2001, Singh *et al.* 1998, Yesilada *et al.* 1997).

Over the last years, Cistus species have attracted considerable interest due to their wide variety of bioactive compounds and pharmacological properties. This growing focus is highlighted in several key reviews. One of the most recent reviews conducted a comprehensive analysis of the traditional uses, phytochemistry, and pharmacological attributes of the Cistus genus, encompassing studies published since 2014 (Tomou *et al.* 2022). Similarly, another review focused on the scientific literature concerning Cistus species, emphasizing their phytochemical compositions and extensive range of pharmacological activities (Zalagh *et al.* 2021). Additionally, a further review examined the biological properties of various Cistus species through a synthesis of relevant scientific (Stępień *et al.* 2018).

Interest in Cistus species has been demonstrated through various studies across mediterranean countries. In Tunisia, their antioxidant and antimicrobial properties have been confirmed (Nefzi *et al.* 2024), along with their antiproliferative activity (Ben Jemia *et al.* 2013). In Algeria, research has focused on their chemical composition and antibacterial effects (Bechlaghem *et al.* 2019, Gadouche *et al.* 2023). In Turkey, studies have explored their antioxidant capacity, as well as cytotoxic, antimicrobial, and anti-biofilm activities (Nur Onal *et al.* 2023). Italy has investigated their chemical composition (Santagati *et al.* 2008), while Greece examined their antileishmanial activity (Fokialakis *et al.* 2006). In Croatia, research has highlighted their phytochemical composition and antimicrobial properties (Politeo *et al.* 2018), and in Sardinia, studies compared the chemical profiles of various local Cistus species (Mastino *et al.* 2016).

Cistus monspeliensis (L.), commonly known as the Montpellier rockrose, is one of the species that remains a focus of contemporary studies. Previous pharmacological research conducted in various Mediterranean countries has highlighted the potential of *Cistus monspeliensis* (L.) for its antimicrobial (Stępień *et al.* 2018), antioxidant (Nicoletti *et al.* 2014), and antidiabetic properties (İnan *et al.* 2021). In Morocco, specific populations of Montpellier rockrose from different regions have also been studied. For instance, the variety from Maaziz-Khémisset was shown to have hypoglycemic activity (Sayah *et al.* 2017), while the population from Ourika-Marrakesh was investigated for its antimicrobial effects (Bouamama *et al.* 2006).

Despite the abundance of *Cistus monspeliensis* (L.) in the Al Hoceima province, there have been no significant chemical studies on this population, except for a recent pioneering study that began exploring its chemical profile and antioxidant activity (Haida *et al.* 2021). This highlights a gap in research and opens up opportunities for further investigations into the phytochemical and pharmacological potential of this species in the region.

Thus, all the previous results indicate that despite the well-established studies on Cistus species, the Moroccan Montpellier rockrose, particularly in the Rif region, is still under investigation. This presents an opportunity to uncover potential new findings that have not yet been clinically or scientifically validated. Consequently, we conducted an ethnobotanical study in the Rif to explore the traditional uses of *C. monspeliensis*, which has been abundant in this region for generations.

An ethnobotanical study was conducted in the Rif region to evaluate the cultural and practical significance of *Cistus monspeliensis* (L.) among the local population. The primary objective was to assess the community's knowledge and usage of this plant, revealing its various medicinal and diverse applications. Through data analysis, we identified traditional preparation methods and the specific parts of the plant that are commonly used.

The study also aimed to uncover new traditional uses that have not been previously documented in other ethnobotanical studies. Additionally, it sets the stage for further research to examine the plant's potential applications in various fields, such as pharmacology, medicine, agriculture and environmental conservation.

By documenting and analyzing the indigenous knowledge related to plant use, this study not only preserves cultural heritage but also provides valuable insights that could lead to the discovery of new sustainable practices.

Materials and Methods

Study area

Al Hoceima is a province in the region of Tanger-Tetouan-Al Hoceima, Morocco. Its capital city is Al Hoceima, it is also the cultural capital of the Rif and it is a city in the north of Morocco, on the northern edge of the Rif Mountains and on the Mediterranean coast. The major cities and towns of Al Hoceima procinve are: Ait Kamra, Ajdir, Al Hoceima, Bni Bouayach, Bni Hadifa, Imzouren, Issaguen, Tamassint, Targuist.

Al Hoceima enjoys a Mediterranean climate, which is a type of temperate climate. The average maximum temperature reaches 29°C, while the average minimum temperature drops to 9°C. According to Emberger's quotient, the area is classified as semi-arid. The annual average precipitation is 420 mm (Table 1) with varying rainfall amounts across different stations (Table 2).

Table 1. Climatic data of Al Hoceima.

Reference station	Al Hoceima
Lambert coordinates	X = 631573
	Y = 515859
Average annual precipitation	420 mm
Average maximum temperature	29 °C
Average minimum temperature	09 °C
Emberger's quotient	Semi-arid
Bioclimatic variant	Temperate

(The information for the study region was sourced from the National Water and Forestry Agency of Al Hoceima)

Table 2. Monthly Rainfall Averages Monitored at Key Weather measurement stations.

Station Name	**Rainfall Quantities Recorded (mm)**							**Total (mm)**
	2019 Data Records				**2020 Data Records**			
	Sept	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	
Dar Chaoui	3.3	29.6	70	169.6	176.5	98.4	34	**581.4**
Bge Nakhla	156.3	42.5	35.9	74.7	163.7	88.7	132.6	**694.4**
Bge Rouze	3.8	32.1	72	121.8	202.7	96	192	**720.4**
Bge Moulay Bouchta	15	63.5	54.5	82	194	85.5	20.7	**515.2**
Sania Ramel	9.6	34.2	33.3	66	182.1	82.1	139.1	**546.4**

(The information for the study region was sourced from the National Water and Forestry Agency of Al Hoceima)

The participants in this study are from Al Hoceima province representing 4 municipalities (Al Hoceima, Imzouren, Bni Bouayach, and Targuist), 8 rural communes (Ait karma, Bni Abdallah, Chakrane, Moulay ahmed Cherif, Nekkour, Tifarouine, Imrabten, and Ait Youssef w Ali) and 11 villages (Tifarouine, Issoufiyene, Ait taa, Aghzar Imziren, Ijarwano, Tamassint, Bouzdour, Izafzafen, Rabda, Amnoud, and Bekkiwa) (Fig. 1).

The ethnobotanical study was conducted from November 1, 2023, to February 15, 2024, using a closed-ended questionnaire. The questionnaire was divided into two sections:

- Participant Information: This section collected personal details, including gender, age, origin, educational background, and socio-economic status.
- Ethnobotanical Characteristics of *Cistus monspeliensis* (L.)*:* This section explored participants' knowledge of the plant, its various uses, consumption patterns, harvest period, preparation and administration methods, and any observed side effects.

The survey was conducted randomly, with respondents participating voluntarily and anonymously.

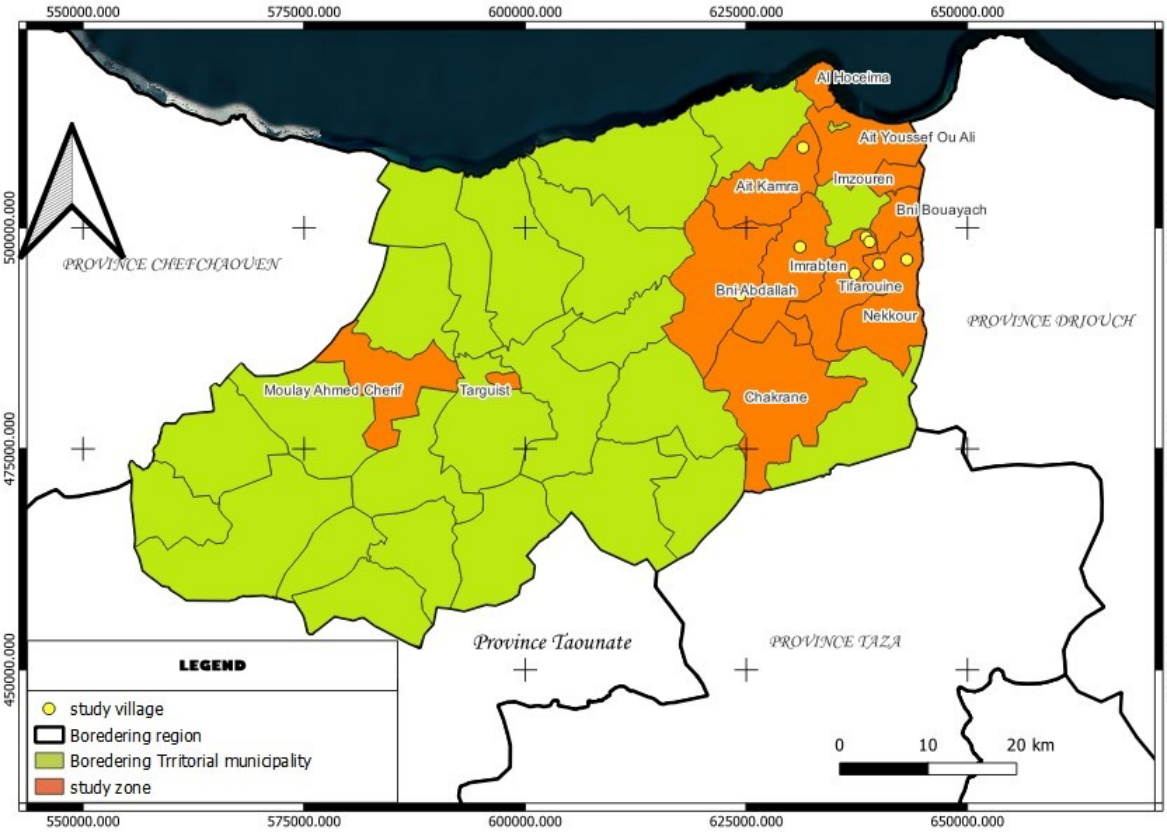

Figure 1. Al Hoceima Province Location Map (QGIS), Generated with Version 3.26.3 of QGIS Software.

Data Analysis

In this study, the Chi-Square test (Plackett 1983) was used to assess the association between two nominal variables, X and Y. Additional measures such as Cramér's V and the phi coefficient (Akoglu 2018) were employed to evaluate the strength of the relationship. SPSS software was utilized for the analysis.

Results and Discussion

Survey study population

A total of 102 participants from various rural and urban communities within Al Hoceima Province took part in the study.

Demographics of study participants

Age group

In the study region, the largest proportion of respondents (53.9%) was between 20 and 40 years old. This was followed by those aged 41 to 60 years, who made up 24.5% of the participants, and those aged 61 to 80 years, who comprised 17.6%. The smallest groups were participants under 20 and over 80 years of age, each representing just 2% of the total (Table 3).

Gender

The survey's gender distribution was nearly equal, with men accounting for 51% of the interviews and women for 49% (Table 3).

Origin

Participants originating from villages constituted 52.9% of the sample, while those from municipalities accounted for 47.1% (Table 3).

Education level

In the survey area, participants were targeted from various education levels (Table 3): the majority had a university education (50%), followed by primary school (19.6%) and illiterate participants (14.7%). High school and middle school graduates each accounted for 2.9% of the sample, while participants with a mosque school education were the least represented (1%).

NB: Nine participants did not answer the question, representing 8.8% of the sample.

Socio-economic level

The majority of participants were categorized as having a medium socio-economic level, accounting for 77.5% of the total. In contrast, 19.6% of participants were in the low socio-economic level, while only 2.9% were categorized as high socio-economic level (Table 3).

Table 3. Demographic and Socioeconomic Overview of Al Hoceima Province.

	Group	Count	Percentage (%)
Gender	**Men**	52	51
	Women	50	49
Age	**>80**	2	2
	[61-80]	18	17.6
	[41-60]	25	24.5
	[20-40]	55	53.9
	<20	2	2
Origin	**Village**	54	52.9
	Municipality	48	47.1
Educational level	**Illiterate**	15	14.7
	Mosque school	1	1
	Primary school	20	19.6
	Middle school	3	2.9
	High school	3	2.9
	University	51	50
	Missing	9	8.8
Socio-economic level	**Highest**	3	2.9
	Medium	79	77.5
	Lowest	20	19.6

Knowledge of *C. monspeliensis*

The survey results revealed that 55 of participants were acquainted with the *C. monspeliensis* plant, while 47 were not familiar with it.

Relationship and correlation between knowledge of *C. monspeliensis and variables*

Knowledge of *C. monspeliensis* by age group in Al Hoceima province

The survey results revealed that in the Rif region, younger individuals aged 20-40 years (45.5%) have the highest level of knowledge about *Cistus monspeliensis* (L.) compared to other age groups. The knowledge distribution among other age groups is as follows:

- 41-60 years: 30.9%
- 61-80 years: 18.2%
- Under 20 years: 3.6%
- Over 80 years: 1.8%

According to the results of the chi-square statistical test, the P-value of 0.256 exceeds the significance level of 0.05, suggesting that knowledge of *C. monspeliensis* is independent of age.

Knowledge of *C. monspeliensis* by gender in Al Hoceima province

Knowledge of *Cistus monspeliensis* (L.) varies by gender, with men being more familiar with the plant at 60%, compared to 40% among women.

The results of the chi-square statistical test revealed a P-value of 0.049 (which is below the significance level of 0.05), indicating a significant relationship between knowledge of *C. monspeliensis* and gender.

This conclusion is supported by contrasting the values of Pearson's chi-square statistic. With a calculated Pearson's X^2 value of 3.886 surpassing the theoretical value of 3.841, the analysis affirms a significant relationship between gender and knowledge of *Cistus monspeliensis* (L.).

Having established a correlation between knowledge of *C. monspeliensis* and gender, we calculated Cramer's V coefficient to assess the strength of this relationship. The computed Cramer's V value of 0.195 suggests a strong association between the two variables (Annex 2).

The survey results demonstrate that men possess greater knowledge of the *C. monspeliensis* plant compared to women. This can be justified by the culture of the Rif region, where women traditionally stayed at home, leading to more isolation, while men were more likely to go out and have contact with the outside world.

On the other hand, The predominance of men among herbalists in Morocco is supported by numerous national ethnobotanical studies conducted in regions such as Fez, Casablanca, Marrakech, Beni Mellal-Khenifra, Rabat-Salé-Kenitra, and Taza (Benkhaira *et al.* 2021, Bourhia *et al.* 2019, El Alami *et al.* 2020, El Hachlafi *et al.* 2020, Haouari *et al.* 2018). This trend is also observed in international ethnopharmacological surveys conducted in Algeria, Palestine, and Seymour (Boudjelal *et al.* 2013, Jaradat *et al.* 2017, Buwa-Komoreng *et al.* 2019).

Knowledge of *C. monspeliensis* by origin in Al Hoceima province

The results revealed that participants from villages in the Rif region have significantly greater knowledge of the plant *Cistus monspeliensis* (L.) compared to participants from the municipalities. Specifically, 74.5% of village residents are familiar with the plant, while only 25.5% of municipal residents possess such knowledge.

The chi-square statistical test results, with a P-value of 0.001 (which is less than the significance level of 0.05), lead us to confirm a significant link between participants' origins and their knowledge of *C. monspeliensis*.

This conclusion is supported by contrasting the values of Pearson's chi-square statistic. The calculated Pearson's X^2 value of 22.362 substantially exceeds the theoretical Pearson's X^2 value of 3.841, with 1 degree of freedom (Annex 1). This significant disparity confirms a robust relationship between knowledge of *C. monspeliensis* and the participant's origin.

Having identified a correlation between the two variables, we calculated coefficient of Cramer V, which measures the strength of this relationship. The resulting Cramer's V value of 0.468 indicates a very strong association between knowledge of *Cistus monspeliensis* (L.) and the participant's origin (Annex 2).

The survey indicates that people residing in rural areas have a better knowledge of *Cistus monspeliensis* (L.) compared to those living in urban areas. This can be attributed to the fact that the plant is naturally found in rural settings, and villagers are more likely to be familiar with local flora. This observation is consistent with another study conducted in Morocco, which also found that residents of Douars or villages have a stronger connection to nature (Jeddi *et al.* 2024).

Knowledge of *C. monspeliensis* by socio-Economic level in Al Hoceima province

The results show that 70.9% of the middle-class population surveyed is familiar with *C. monspeliensis,* whereas only 27.3% of those from lower socio-economic backgrounds reported knowing the plant (Fig. 2).

These findings suggest that knowledge of the plant is independent of socio-economic level. This conclusion is supported by the chi-square test results, where the p-value was 0.093, exceeding the significance level of 0.05.

Knowledge of *C. monspeliensis* by educational level in Al Hoceima province

In Al Hoceima province, it was noted that participants who have a university level (40.4%) know the plant more than those who have a primary level (34.1%) and those who are illiterate (21.3%). While people with a high school (2.1%) or mosque school (2.1%) know little about the plant and people with a college level do not know the plant (Fig. 3).

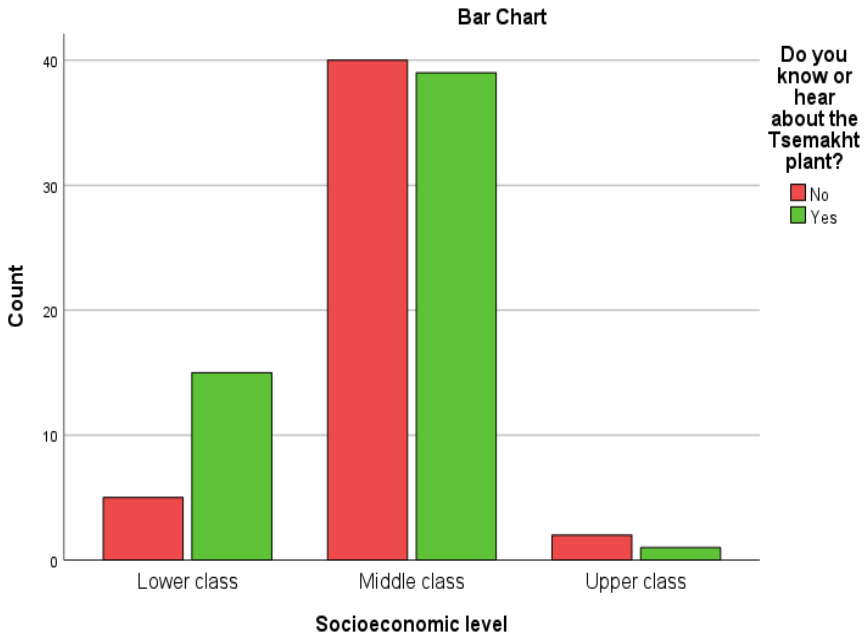

Figure 2. Bar chart: SocioEconomic Status and Plan Knowledge

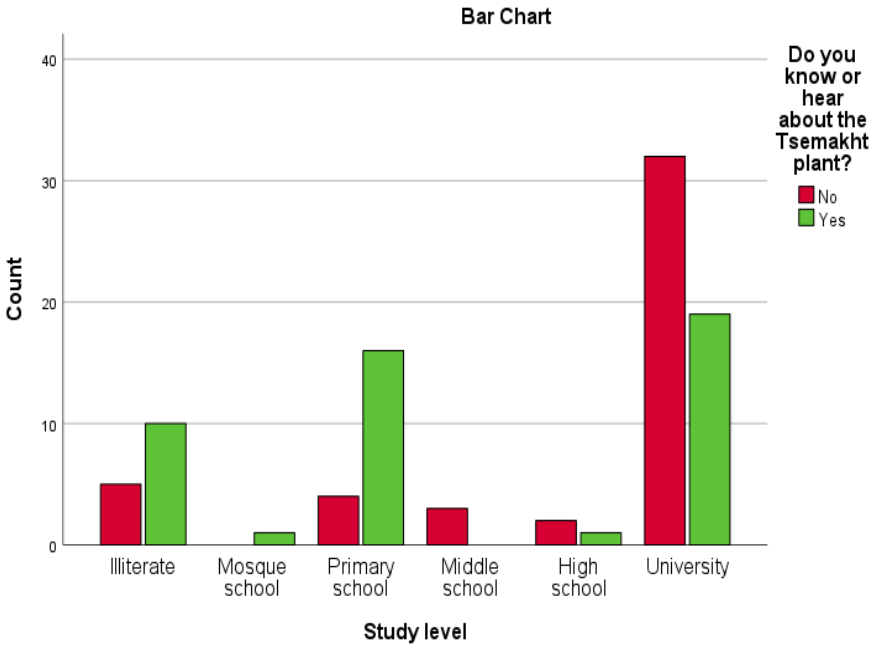

Figure 3. Bar chart: Educational level and Plant Knowledge

The chi-square test results show a p-value of 0.006, which is below the significance level of 0.05. Consequently, we conclude that there is a statistically significant association between educational attainment and plant knowledge.

This finding is further supported through comparison of the calculated value of chi-square (16.505) to the theoretical value (11.071), with 5 degrees of freedom (Annex 1). The calculated value exceeds the theoretical value (16.505 > 11.071), confirming the significant relationship between educational level and plant knowledge.

After identifying a correlation between educational level and knowledge of *Cistus monspeliensis* (L.), we used SPSS software to calculate Cramer's V coefficient which measures the strength of this relationship. The resulting Cramer's V value of 0.421 indicates a very strong association between educational level and knowledge of the plant (Annex 2).

The majority of participants familiar with the plant have either a university education, a primary education, or no formal education at all. This pattern can be attributed to several factors. Those with a university education may have studied or worked in fields related to plants, such as botany or environmental science. In contrast, individuals with only a primary education or no formal education often include farmers or herbalists. In our culture, herbalists typically acquire their knowledge of plants' therapeutic properties through experience or the transfer of knowledge from one generation to the next, rather than through formal study.

Moreover, our results indicate that individuals with a university education are more familiar with *Cistus monspeliensis* (L.) compared to those who are illiterate. Interestingly, this finding contrasts with typical patterns observed in the region. Similar studies conducted in various parts of Morocco (Aboufaras *et al.* 2022, El Hachlafi *et al.* 2022, Ghanimi *et al.* 2022, Jeddi *et al.* 2024, Jouad *et al.* 2001, Louafi *et al.* 2024) and in other countries, such as Tunisia (Jdaidi & Hasnaoui 2016), have shown that illiterate individuals often have greater knowledge and interest in medicinal plants compared to those with higher educational levels.

Use of *C. monspeliensis* by Al Hoceima province population

According to the survey results, the use of *C. monspeliensis* in the Rif region is relatively limited, with only 20.6% of the local population incorporating it into their practices. Among those who are aware of the plant, just 38.2% actively use it in their daily routines or traditional remedies.

To gain a comprehensive understanding of these results, we analyzed plant usage in relation to various variables—such as gender, age, origin, socioeconomic status and educational level — employing the chi-square test of association in conjunction with SPSS analytical software.

Note: The percentages discussed are based on the 55 participants who are familiar with the plant.

Use of *C. monspeliensis* according to age

The results of the chi-square analysis indicate that the utilization of *C. monspeliensis* is independent of age, as evidenced by the p-value of 0.751.

Use of *C. monspeliensis* by origin

The use of *Cistus monspeliensis* (L.) varies significantly by origin, with 81% of users coming from villages, compared to just 19% from municipalities.

However, the results of the chi-square test (X^2) indicate that there is no significant correlation between origin and the use of the *C. monspeliensis* plant ($p = 0.391 > 0.05$).

Use of *C. monspeliensis* by educational level

The chi-square test results show a p-value of 0.105, which is greater than the significance level of 0.05. Therefore, this suggests that the use of *C. monspeliensis* is independent of educational level.

Use of C. monspeliensis by socio-economic level

The survey results reveal a significant association between the use of *C. monspeliensis* and socio-economic status, with a p-value of 0.001, which is less than the significance level of 0.05. This conclusion is further supported through comparison between the person's chi-square values for 2 degrees of freedom (Annex 1). The calculated value (13.241) exceeds the theoretical value (5.991), confirming a significant relationship between plant usage and socio-economic status.

After establishing a link between the utilization of *C. monspeliensis* and socioeconomic status, we assessed the strength of this relationship by calculating the Phi coefficient using SPSS statistical analysis software. The Phi coefficient of 0.491 indicates a very strong and significant association between the utilization of the plant and socioeconomic status.

Our survey indicates that the majority of *C. monspeliensis* users are from lower (52.4%) and middle (42.9%) socio-economic levels (Fig. 4). This trend can be attributed to the fact that individuals in lower socio-economic groups often utilize all available resources, including plants like *C. monspeliensis,* for purposes such as fodder, food, or phytotherapy. These practices are often part of strategies to generate supplementary income and improve their living conditions.

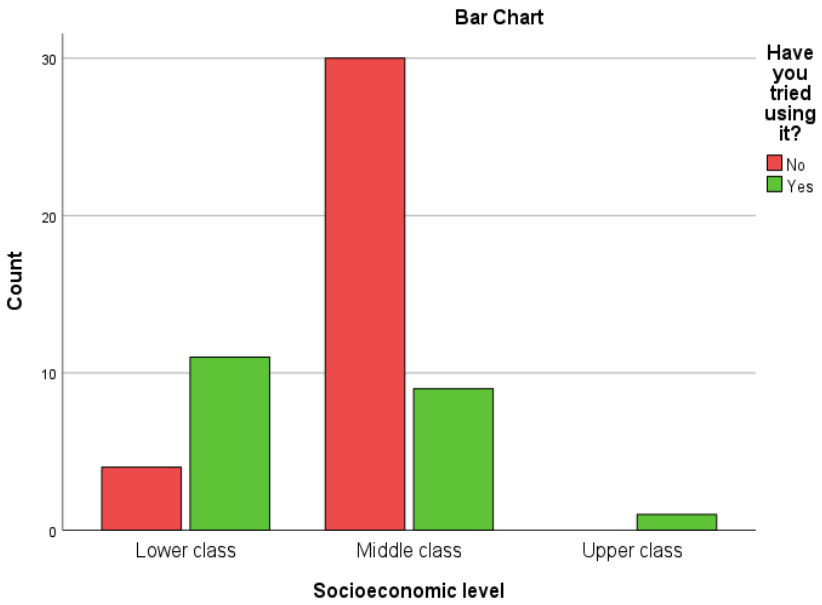

Figure 4. Bar chart: Plant Utilization in Relation to Socio-Economic Status

These results are consistent with findings from surveys in various Moroccan regions (Alami Merrouni *et al.* 2021, El Assri *et al.* 2021, Jeddi *et al.* 2021) and similar research in Algeria (Bouasla & Bouasla 2017), which suggest that individuals with lower socio-economic status are more likely to use aromatic and medicinal plants.

Use of *C. monspeliensis* by gender

Based on the chi-square test (X^2) results obtained using SPSS statistics, we found a significant p-value of 0.041, which is below the 0.05 threshold. This indicates a statistically significant relationship between the use of *Cistus monspeliensis* (L.) and gender.

This finding is further corroborated by contrasting the theoretical and calculated Pearson's chi-square value for 1 degree of freedom (Annex 1). Since the calculated value exceeds the theoretical value (4.160 > 3.841), it reinforces the significant relationship between the use of *C. monspeliensis* and gender.

Since a correlation between gender and the use of *C. monspeliensis* has been established, we quantified the Phi coefficient using IBM SPSS to assess the strength of this relationship. The calculated Phi coefficient is 0.275, indicating a very strong relationship between gender and the use of the plant.

Our survey reveals that the majority of *Cistus monspeliensis* (L.) users are women (57.1%) in the face of 70.6% of men who do not use the plant (Fig. 5). This could be attributed to regional traditions, where women often take on the role of preparing plant-based remedies for family care, this knowledge has been passed down through generations, from mothers to daughters. Our findings are consistent with those of other surveys conducted in the same region (Smaili *et al.* 2023) and those of another national study which shows that women used plants more than men, this is attributed to the ease of information transmission among women and their strong attachment to traditional practices (Jouad *et al.* 2001) and also it is explained by the women are the main keepers of traditional herbal medicine knowledge (Yahyaoui *et al.* 2015). Moreover, the results of different surveys, conducted in other countries, such as Algeria, have showen that women have more knowledge about the use of medicinal plants compared to men (Miara *et al.* 2018).

Patterns of use and plant parts utilized of *Cistus monspeliensis* (L.) by the population of Al Hoceima province

Cistus monspeliensis (L.) commonly found across the rif region, yet its use among the local population remains quite limited. According to our survey results, out of the 102 participants, only 55 are familiar with the plant, and just 21 actually use it.

Part used of the plant

According to the results, the most commonly used part of the plant is the whole plant, with a usage rate of 56.5%. This is followed by the leaves, which are used 34.8% of the time. Lastly, the flowers are the least utilized part, with only 8.7% usage (Fig. 6).

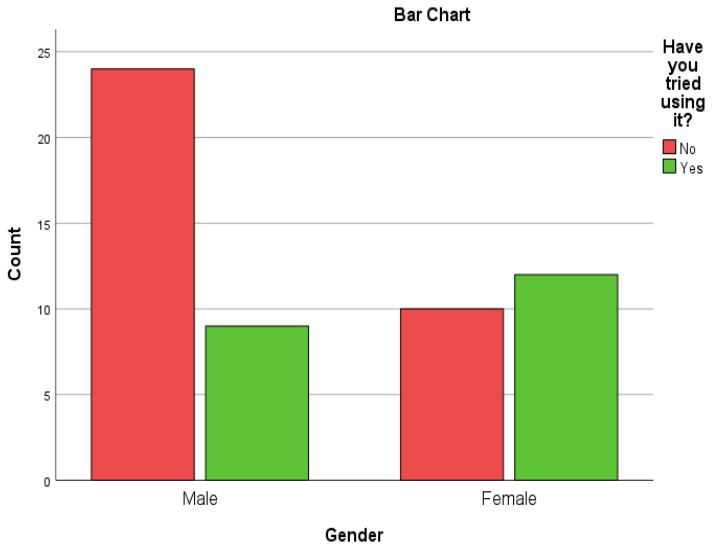

Figure 5. Bar chart: Plant use by gender

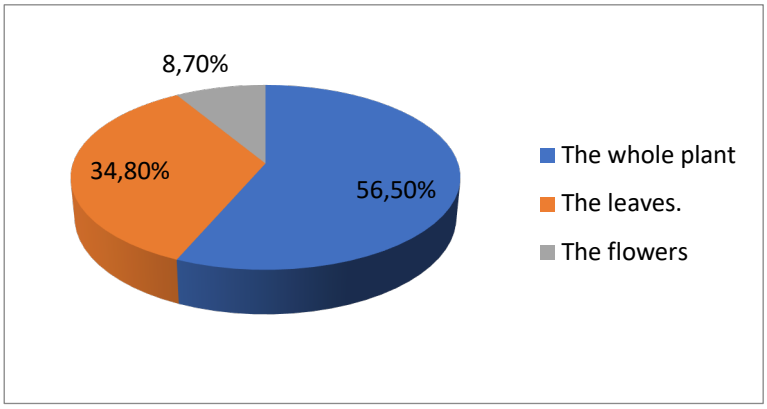

Figure 6. Bar chart: Plant part used of the plant in the Rif region

Regarding the nature of *Cistus monspeliensis* (L.) usage, our survey revealed a variety of responses with differing percentages. The most prevalent use of the plant is for fanning traditional oven fires, comprising 47.8% of the reported uses. This is followed by therapeutic applications, which account for 26.1%. Additionally, beekeeping and its use as fodder and for sweeping each constitute 8.7% of its applications (Fig. 7).

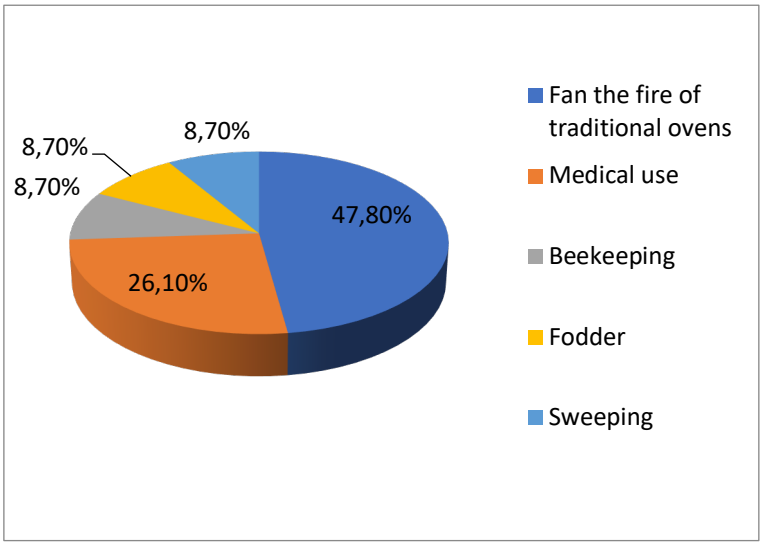

Figure 7. Bar chart: Nature of use of the plant in the Rif region

Nature of use of *C. monspeliensis*

Fan the fire

Users employ the whole plant to fan traditional ovens for baking bread.

Medical use

- Digestive disorders: Participants who use *Cistus monspeliensis* (L.) to address digestive issues describe the preparation process as boiling the leaves in water, then filtering and drinking the resulting liquid. The majority of participants in our survey who use the plant for this purpose report that it has no negative side effects.

- Dermatological conditions: According to users, the leaves of the plant are used to stop bleeding and promote wound healing. The leaves are crushed and either placed directly on the wound and then bandaged, or the water extracted from the crushed leaves is applied to the wound. This process is repeated each time the wound dressing is changed until healing is achieved.

NB: All users have confirmed that this traditional practice is used for both humans and animals, employing the same preparation method and changing the dressing daily until the wound heals.

- Dental issues: For dental problems, the leaves of *C. monspeliensis* are ground and boiled in water. The resulting infusion is used as a mouthwash to alleviate persistent toothaches.

Fodder

The leaves of the plant are commonly used to feed domesticated livestock, particularly goats.

Beekeeping

Beekeepers utilize the plant's flowers as a pollen source during flowering seasons.

Sweeping

The whole plant is used to sweep mud houses.

According to our results, 53.9% of the individuals who are familiar with *C. monspeliensis,* but only 20.6% actually employ it. The distribution of its use is as follows: 2.32% for fanning traditional oven fires, 1.26% for medical applications, and 0.42% each for beekeeping, fodder, and sweeping. This highlights, on one hand, a significant lack of awareness and underutilization of the plant in this region. On the other hand, its primary use is to fuel traditional ovens, as it significantly enhances fire ignition. This is supported by a study that conducted over 60 experiments to examine the impact of fuel moisture content on the combustion of *C. monspeliensis* shrubs exposed to low-intensity fires. The findings underscore the critical role of leaf water content in the combustion process of *Cistus* (Luciani *et al.* 2024).

Users have indicated that *Cistus monspeliensis* (L.) presents significant opportunities for beekeeping. Beekeepers in the Rif region bring their bees during the flowering period to collect pollen from the flowers of *C. monspeliensis*. This practice is supported by a study conducted in Spain (Ortiz 1994), which demonstrates that Cistaceae species serve as an important pollen source for bees during their blooming season. Additionally, these plants secrete nectar with high sugar concentrations, further attracting bees and providing a lasting impact on their nourishment outside of flowering periods. Recent research has highlighted the viability and germination of pollen from *Cistus* species (Zampino *et al.* 2020). These limited studies underscore the need for more in-depth research on *C. monspeliensis* and other *Cistus* species in the Rif region concerning their apicultural value.

Furthermore, users have observed that livestock, particularly goats, prefer to feed on *Cistus monspeliensis* (L.). This observation may lead to a new study aimed at verifying whether this plant possesses galactogenic effects. If such effects exist, it would be valuable to explore its potential impact on the physiology of milk production in livestock species. This has been the focus of several studies on other plants, as summarized in a recent review (Posan *et al.* 2022). Consequently, investigating *C. monspeliensis* could uncover a new, readily available, and cost-effective plant that could be incorporated into the diet of dairy animals to enhance milk production.

In terms of its therapeutic use, the plant is primarily employed for three conditions: wound healing, soothing digestive discomfort, and alleviating dental pain. Firstly, wound healing can be explained by the anti-inflammatory properties of *C.*

monspeliensis, as demonstrated in a study where the plant was collected from the Paringianu area, a locality in Italy (Mac Sweeney *et al.* 2024). The effectiveness of the plant in wound healing is supported by a study in Italy where the aerial parts are used in Sardinian traditional medicine for wound healing (Cappadone *et al.* 2020), a condition with an inflammatory basis (Koh & DiPietro 2011). But further in-depth research is necessary to fully understand its therapeutic potential. Secondly, regarding its digestive potential, users claim that this plant can remedy various digestive discomforts (bloating, gas, gastrointestinal pain) without demonstrating any side effects. This aligns with an initial Turkish study that examined the consequences of the in vitro human digestion simulation method on Turkish Cistus species, including Montpellier rockrose, by focusing on their phenolic compounds (İnan *et al.* 2021). Therefore, further in vivo and clinical studies are needed to assess in detail the bioavailability of the phenolic compounds and their contribution to the reported pharmacological effects. Thirdly, to the best of our knowledge, there is no study that has clinically or preclinically examined the ability of Cistus to remedy dental conditions. This exclusively allows this ethnobotanical study to highlight a new traditional use of *Cistus monspeliensis* (L.) that may be beneficial in the pharmacological sector.

The leaves of *C. monspeliensis* are exclusively used for their therapeutic properties. This result can be attributed to the high concentration of bioactive compounds found in the leaves of *C. monspeliensis* (Bouyahya *et al.* 2016, Demetzos *et al.* 2001, Gadouche *et al.* 2023, Haida *et al.* 2021, Loizzo *et al.* 2013, Nicoletti *et al.* 2014, Santagati *et al.* 2008). This concentration of bioactive compounds underpins the plant's therapeutic efficacy and explains why the leaves are the preferred part for medicinal use. However, since decoction or infusion is the common form in traditional medicine, the use of aqueous extracts for activity assessment in experimental studies is particularly important.

This finding can also be attributed to the fact that individuals in this region predominantly use and prefer the leaves of medicinal plants for different treatments. And this has been demonstrated by several ethnobotanical surveys in this region for different diseases, such as, Nervous system diseases (Chaachouay *et al.* 2020), cardiovascular diseases (Chaachouay *et al.* 2022), metabolic diseases (Chaachouay *et al.* 2019), and COVID-19 (Jahjah *et al.* 2024). However, the other parts of the plant should be the focus of further studies to determine their chemical profile and confirm the various traditional uses of the plant mentioned in this study (beekeeping, fan the fire and goat fodder).

According to all users, the plant is effective for all the treatments mentioned. However, some users caution against overconsumption, though they all report using random doses without observing any signs of toxicity. This observation aligns with the findings of a study on the antiproliferative and cytotoxic activity of *C. monspeliensis* extract, which highlights the biologically significant effects of the polyphenolic constituents contained in the plant under study (Vitali *et al.* 2011).

In the final analysis, *Cistus monspeliensis* (L.) has multiple multidisciplinary uses, which may lead to its excessive consumption, highlighting the need for agricultural studies to ensure its long-term preservation. This research could investigate the optimal growth conditions for the plant, including soil types, climate, water availability, and the influence of surrounding flora and fauna. Understanding these factors is essential for developing effective cultivation practices to enhance yields. Additionally, the study could examine the integration of *Cistus monspeliensis* (L.) into local agricultural systems, promoting biodiversity and providing income sources for farmers through the sale of the plant and its derivatives. Preserving this valuable species will safeguard its availability for traditional uses and explore new applications in medicine and veterinary care. Overall, a comprehensive ecological study will support sustainable agricultural development while maintaining the richness of *Cistus monspeliensis* (L.) in the region.

Conclusion and perspectives

The research conducted in the region of Al Hoceima province has provided valuable insights into the knowledge and usage of *Cistus monspeliensis* (L.) among local residents.

Our findings highlight the connection between knowledge of the plant and the demographics of the participants. Men, individuals living in rural areas, and those with a university education are the groups most familiar with *C. monspeliensis*. On the other hand, women and those from lower and middle socio-economic backgrounds are more likely to use the plant. The survey also revealed that only a small fraction of users applies *C. monspeliensis* for medicinal purposes. Among those who do, the leaves are the most commonly used part, typically prepared as a decoction. Participants reported using the plant primarily to treat digestive, dermatological, and dental conditions.

This ethnobotanical study confirmed the traditional uses of *Cistus monspeliensis* (L.) for treating mostly skin conditions and digestive disorders. However, our findings suggest that this plant may possess additional properties worthy of investigation, potentially leading to new studies across multiple fields, including veterinary medicine, agricultural economics, sustainable farming, livestock management, beekeeping, agronomy, and even dentistry. It is also imperative to conduct thorough toxicological assessments to determine safe and effective dosages for extracts of *C. monspeliensis*.

Declarations

Ethics approval and consent to participate: Confidentiality, anonymity, and informed approval were rigorously maintained throughout the study. Participants were thoroughly informed about the study's objectives and gave their consent before taking part.

Consent for publication: Not applicable

Availability of data and materials: Requests for the data used in this article are welcome and will be accommodated

Competing interests: No conflicts of interest have been identified or reported

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Author contributions: A.S. Designing the study, conducting the ethnobotanical survey, actively participating in structuring the methodology, analyzing and interpreting data (including statistical processing), writing the original draft, revising and editing the final version. B.M. Data analysis. Manuscript revision and improvement, supervision. L.B. analysis and interpretation (statistical analysis), manuscript revision and improvement. A.N. Ethnobotanical survey. S.A. and B.M. Methodology, conceptualization, plant taxonomy and description, oversight of work and validation.

All authors have reviewed, read and endorsed the final article.

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Annex

Annex 1. Chi-square Distribution table

Chi-Square (χ^2) Distribution

Degrees of Freedom	Area to the Right of Critical Value									
	0.995	0.99	0.975	0.95	0.90	0.10	0.05	0.025	0.01	0.005
1	—	—	0.001	0.004	0.016	2.706	3.841	5.024	6.635	7.879
2	0.010	0.020	0.051	0.103	0.211	4.605	5.991	7.378	9.210	10.597
3	0.072	0.115	0.216	0.352	0.584	6.251	7.815	9.348	11.345	12.838
4	0.207	0.297	0.484	0.711	1.064	7.779	9.488	11.143	13.277	14.860
5	0.412	0.554	0.831	1.145	1.610	9.236	11.071	12.833	15.086	16.750
6	0.676	0.872	1.237	1.635	2.204	10.645	12.592	14.449	16.812	18.548
7	0.989	1.239	1.690	2.167	2.833	12.017	14.067	16.013	18.475	20.278
8	1.344	1.646	2.180	2.733	3.490	13.362	15.507	17.535	20.090	21.955
9	1.735	2.088	2.700	3.325	4.168	14.684	16.919	19.023	21.666	23.589
10	2.156	2.558	3.247	3.940	4.865	15.987	18.307	20.483	23.209	25.188
11	2.603	3.053	3.816	4.575	5.578	17.275	19.675	21.920	24.725	26.757
12	3.074	3.571	4.404	5.226	6.304	18.549	21.026	23.337	26.217	28.299
13	3.565	4.107	5.009	5.892	7.042	19.812	22.362	24.736	27.688	29.819
14	4.075	4.660	5.629	6.571	7.790	21.064	23.685	26.119	29.141	31.319
15	4.601	5.229	6.262	7.261	8.547	22.307	24.996	27.488	30.578	32.801
16	5.142	5.812	6.908	7.962	9.312	23.542	26.296	28.845	32.000	34.267
17	5.697	6.408	7.564	8.672	10.085	24.769	27.587	30.191	33.409	35.718
18	6.265	7.015	8.231	9.390	10.865	25.989	28.869	31.526	34.805	37.156
19	6.844	7.633	8.907	10.117	11.651	27.204	30.144	32.852	36.191	38.582
20	7.434	8.260	9.591	10.851	12.443	28.412	31.410	34.170	37.566	39.997
21	8.034	8.897	10.283	11.591	13.240	29.615	32.671	35.479	38.932	41.401
22	8.643	9.542	10.982	12.338	14.042	30.813	33.924	36.781	40.289	42.796
23	9.260	10.196	11.689	13.091	14.848	32.007	35.172	38.076	41.638	44.181
24	9.886	10.856	12.401	13.848	15.659	33.196	36.415	39.364	42.980	45.559
25	10.520	11.524	13.120	14.611	16.473	34.382	37.652	40.646	44.314	46.928
26	11.160	12.198	13.844	15.379	17.292	35.563	38.885	41.923	45.642	48.290
27	11.808	12.879	14.573	16.151	18.114	36.741	40.113	43.194	46.963	49.645
28	12.461	13.565	15.308	16.928	18.939	37.916	41.337	44.461	48.278	50.993
29	13.121	14.257	16.047	17.708	19.768	39.087	42.557	45.722	49.588	52.336
30	13.787	14.954	16.791	18.493	20.599	40.256	43.773	46.979	50.892	53.672
40	20.707	22.164	24.433	26.509	29.051	51.805	55.758	59.342	63.691	66.766
50	27.991	29.707	32.357	34.764	37.689	63.167	67.505	71.420	76.154	79.490
60	35.534	37.485	40.482	43.188	46.459	74.397	79.082	83.298	88.379	91.952
70	43.275	45.442	48.758	51.739	55.329	85.527	90.531	95.023	100.425	104.215
80	51.172	53.540	57.153	60.391	64.278	96.578	101.879	106.629	112.329	116.321
90	59.196	61.754	65.647	69.126	73.291	107.565	113.145	118.136	124.116	128.299
100	67.328	70.065	74.222	77.929	82.358	118.498	124.342	129.561	135.807	140.169

Source Chi-Square distribution table originally published on https://faculty.elgin.edu/dkernler/statistics/ch09/chi-square-table.pdf

Annex 2.Phi and Cramer's V interpretation

Phi and Cramer's V	Interpretation
> 0.25	Very strong
> 0.15	Strong
> 0.10	Moderate
> 0.05	Weak
> 0	No or very weak

Source. Akoglu 2018.