Ethnobotany of *Cistus ladanifer* L.: An important traditional medicinal plant in Northern Morocco

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Research

Abstract

Background: *Cistus ladanifer* L. (Cistaceae) is a widespread Mediterranean shrub that is abundant in Morocco's Rif Mountains and embedded in local practices. While its phytochemistry and bioactivity are well documented, its ethnobotanical roles in Morocco remain insufficiently described. This study documents traditional knowledge, uses, and preparation methods of *C. ladanifer* in Al Hoceima Province and examines how this knowledge varies in relation to socio-demographic factors.

Methods: From December 2024 to February 2025, we administered semi-structured questionnaires to 100 residents across two municipalities and four rural communes. We analyzed associations between knowledge/use and demographic variables using Pearson's chi-square test and visualized patterns with Multiple Correspondence Analysis (MCA). Cultural salience was quantified with Relative Frequency of Citation (RFC) and Fidelity Level (FL).

Results: Knowledge of *C. ladanifer* was significantly associated with origin (rural vs. municipal) and education level, and plant use was associated with age. Seeds (66%) and leaves (29%) were the most used parts. A distinctive food practice—roasted seed powder blended with barley (locally called zembou)—was the dominant use among plant users (RFC = 0.63). Reported therapeutic uses targeted digestive, dermatological, and, less frequently, respiratory conditions. Additional applications included cosmetics, beekeeping, livestock feeding, and oven cleaning.

Conclusions: *C. ladanifer* is culturally and nutritionally important in the Rif region. Documenting these practices supports their transmission and encourages sustainable use, and it identifies community-led opportunities for future nutritional, pharmacological, and agro-pastoral studies.

Keywords: *Cistus ladanifer* L., Ethnobotanical indexes, Ethnobotany, Food uses, Morocco, Rif mountains, Traditional knowledge

Background

Cistus ladanifer L. (Cistaceae) is a long-lived shrub native to the Mediterranean basin, with occurrences in Spain, Portugal, France, Greece, Cyprus, Algeria, and Morocco (Demoly *et al.* 1993, Godinho-Ferreira *et al.* 2005, Heywood 1985, Morales-soto *et al.* 2015). In Morocco, it is primarily found in mountainous regions, including the Rif, the central ranges, and the Beni-Znassen. The species has a long history of traditional use, with its seeds consumed raw as a snack or ground into flour for making cakes and breads, practices well documented in Spain (Blanco & Cuadrado 2000, Facciola 2001). Beyond its cultural significance, *C. ladanifer* has attracted considerable scientific interest due to its rich phytochemical composition and diverse biological activities, which vary according to plant organ and extract type.

A comprehensive review by Zalegh *et al.* 2021 synthesized the extensive pharmacological investigations into aqueous extracts of *C. ladanifer*. The leaves exhibit significant metabolic and cardiovascular potential, including antidiabetic, hypolipidemic, and antihypertensive effects, alongside anti-aggregant activity via thrombin inhibition. Furthermore, the extracts demonstrate antispasmodic properties that validate their traditional use for intestinal ailments. Beyond these systemic effects, the review highlights strong antimicrobial, antioxidant, anti-inflammatory, and analgesic activities, as well as cytotoxicity against pancreatic and breast cancer cells. These diverse bioactivities are primarily attributed to the leaves' abundance of polyphenolic compounds, specifically ellagitannins.

Similarly, the essential oil of *C. ladanifer* is characterized by a richness in oxygenated sesquiterpenes and monoterpenes, such as α-pinene and 1,3,8-p-menthatriene (Jerónimo *et al.* 2020). It exhibits potent antifungal effects (El Karkouri *et al.* 2021, Karim *et al.* 2016, Karim *et al.* 2017, Mrabet *et al.* 1999, Upadhyay *et al.* 2018) and antibacterial properties, particularly against Gram-positive bacteria like Staphylococcus aureus and Listeria monocytogenes (Guinoiseau *et al.* 2015, Nait Irahal *et al.* 2020, Vieira *et al.* 2017). Additionally, the oil demonstrates significant antioxidant activity linked to its high phenolic and terpenoid content (Benali *et al.* 2020, Nait Irahal *et al.* 2021). These findings highlight the oil's potential as a natural preservative and therapeutic agent in both pharmacology and food systems.

Beyond liquid extracts, the plant yields labdanum, a resin exuded from leaves and stems composed primarily of labdane-type diterpenes and methylated flavonoids (Valares Masa *et al.* 2016). Traditionally used for wound healing and fragrance (González *et al.* 2018), labdanum absolute has demonstrated UV-protective, anti-inflammatory, and selective antimicrobial properties (Frazão *et al.* 2022). These attributes emphasize its relevance as a sustainable component in skincare and cosmetic applications, extending its utility from perfumery to therapeutic dermatological contexts.

Recent studies have expanded this scientific perspective even further, framing *C. ladanifer* as a versatile resource for biorefineries, where extraction residues can be converted into biofuels or biomaterials (Alves-Ferreira *et al.* 2023). Its resilience on poor and even contaminated soils suggests potential cultivation on marginal land, aligning ecological restoration with rural livelihoods (Raimundo *et al.* 2018).

However, while the phytochemical and industrial potential of the plant is well-documented, the cultural framework that originally identified these utilities remains underexplored. Specifically, there is no systematic documentation of *C. ladanifer*'s traditional uses in Morocco. This disconnect between extensive laboratory validation and the scarcity of field data presents a critical gap. Addressing this, our objectives are to document local knowledge and applications of *C. ladanifer* in the Rif, to evaluate how usage differs by sociodemographic factors, and to identify traditional practices not yet investigated scientifically.

Materials and Methods

Presentation of the study area

Al Hoceima Province has a Mediterranean climate with mild-to-hot summers and cool winters. Emberger's quotient classifies it as semi-arid, with mean annual precipitation near 420 mm, though rainfall varies by station. Administratively, the province

contains 37 communes (10 urban and 27 rural) grouped into five circles and a population of 371,527 inhabitants. Key socio-demographic indicators are summarized in Table 1. (Direction Regionale de Tanger-Tetouan-Al Hoceima 2024).

Table 1. Socio-demographic profile and administrative organization of Al Hoceima Province.

Territorial organization	Number of administrative communes	Total	37
		Urban	10
		Rural	27
	Number of circles		5
Population distribution		Total	371 527
		Urban	138 977
		Rural	232 550
Sex ratio	Female	Total	49.4%
		Urban	50.5%
		Rural	48.8%
	Male	Total	50.6%
		Urban	49.5%
		Rural	51.2%
Human capital	Illiteracy rate (15+)	Total	36.5%
		Urban	26.3%
		Rural	42.7%
Economic challenges	Unemployment rate	Total	24.6%
		Urban	21.4%
		Rural	26.8%
Living conditions	Households	Total	89 181
		Average size	4.1
	Urban households	Number	36 783
		Average size	3.7
	Rural households	Number	52 398
		Average size	4.4

Plant identification

Specimens of *Cistus ladanifer* L. were collected from the Ikkaouen region, Morocco (34°44’02.4”N, 4°42’12.5”W) in April 2024 during the flowering stage. Species identity was determined based on morphological characteristics using standard taxonomic keys and verified at the Scientific Institute of Rabat (herbarium acronym RAB). The accepted species name and taxonomic status were confirmed using *Plants of the World Online* (POWO). The voucher specimen is deposited under reference RAB 115052.

Data collection

The ethnobotanical survey covered two municipalities (Al Hoceima and Targuist) and four rural communes (Ikkaouen, Ketama, Issaguen and Taghzout) (Fig. 1). From 1 December 2024 to 15 February 2025, we conducted semi-structured interviews using a questionnaire with two sections: the first addressed participant information, including gender, age, origin, education level and socio-economic status, while the second focused on ethnobotanical descriptors such as vernacular names, harvest periods, uses, preparation and administration methods, consumption patterns and perceived side effects.
A total of 100 respondents were randomly selected using a stratified sampling approach across the six regions. Verbal informed consent was obtained from all participants, and participation was voluntary and anonymous.

Data interpretation

Data were compiled and analyzed in Microsoft Excel 2019 and SPSS version 25. Associations between demographics and knowledge/use were tested with **Pearson’s chi-square** (Plackett 1983), effect sizes were summarized with **Cramer’s V** coefficient (Akoglu 2018). **Multiple Correspondence Analysis (MCA)** was used to visualize relationships among categorical variables.

Cultural salience was quantified with two **Relative citation frequency (RFC)** variants (Tardío *et al.* 2008) and with **Fidelity level (FL)** for sub-uses within broader categories (Friedman *et al.* 1986). The formulas are as follows

1. RFC relative to all informants:

$$RFC\ all = \frac{FC\ category}{N\ total} \times 100$$

Where (FC) category is the number of informants citing a specific use category (e.g., therapeutic use), and (N) total is the total number of participants in the study.

2. RFC relative to informants using the plant:

$$RFC\ users = \frac{FC\ category}{N\ users} \times 100$$

Where (N) users represents the total number of informants who actively use *C. ladanifer*.
This calculation focuses on the prominence of each use category among those who actually utilize the plant, providing a more specific measure of its practical significance.

3. FL:

$$FL\ (\%) = \frac{Np}{N\ category} \times 100$$

Where (Np) represents the number of informants who reported a particular sub-use and (N) category is the total number of informants who cited the broader use category.

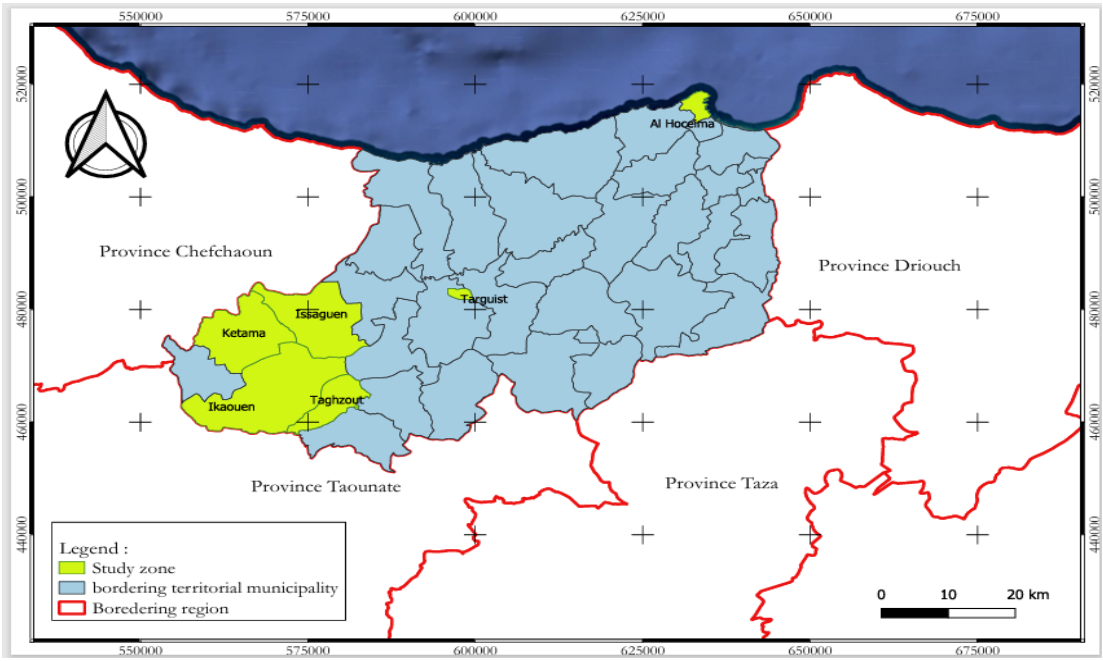

Figure 1. Geographical location of the study site in Al Hoceima Province - Generated with Version 3.26.3 of QGIS Software

Results and Discussion

Characteristics of the study population

100 individuals from rural and urban areas were surveyed (Table 2). Age groups were 20 to 40 years old (62%), 41 to 60 (21%), 61 to 80 (14%), and over 80 years (3%). Men comprised 51% and women 49%. Most participants (82%) were villagers and 18% lived in municipalities. Education levels were heterogeneous, university (35%), illiterate (34%), primary (20%), high school (7%) and middle school (4%). Most respondents reported a medium socio-economic status (90%).

Table 2. Socio-demographic Characteristics of Informants.

	Group	Effective	Percentage (%)
Gender	Men	51	51
	Women	49	49
Age	>80	3	3
	[61-80]	14	14
	[41-60]	21	21
	[20-40]	62	62
	<20	0	0
Origin	Village	82	82
	Municipality	18	18
Educational level	Illiterate	34	34
	Primary school	20	20
	Middle school	4	4
	High school	7	7
	University	35	35
Socio-economic level	Highest	4	4
	Medium	90	90
	Lowest	6	6

Local Knowledge of *C. ladanifer* and Its Statistical Correlates

Vernacular name

The species *Cistus ladanifer* L. is locally known as **argile** and/or **touzalt** in the study area (Bellakhdar 1997).

Knowledge of *C. ladanifer*

The survey results revealed that 72 of participants recognized the species while 28% did not.

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

Regarding the correlation between respondents' demographic variables and their knowledge of *C. ladanifer*, origin and educational level were significantly associated with plant knowledge**.** In contrast, age, gender, and socioeconomic status were independent of plant knowledge, since their p-values were higher than the 0.05 significance level (Table 3).

These findings align with previous ethnobotanical studies conducted in northern Morocco (Abou el anouar *et al*. 2024, Louafi *et al*. 2024).

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

The results show that villagers reported higher awareness (98.6%) compared to municipal residents (1.4%).

This difference was supported by the chi-square test (Table 3), which gave a p-value of 0.000—lower than the standard significance level of 0.05—showing a clear link between a person's origin and their knowledge of *C. ladanifer*. The Pearson's chi-square value ($X^2 = 48.071$) was substantially exceeding the critical value of 3.841 at 1 degree of freedom (Annex 1), which strongly supports this result.

To understand how strong this link is, we used Cramer's V test, which gave a value of 0.693. This high number shows a very strong relationship between the participants' origin and their knowledge of *Cistus ladanifer* L. (Annex 2).

The survey indicates that people living in rural areas have a better knowledge of *Cistus ladanifer* L. compared to those residing in urban areas, which may be attributed to the fact that the plant grows naturally in rural environments, where villagers are more frequently in contact with local plant species and traditional practices. This observation is consistent with the findings of Jeddi *et al.* 2024, who carried out an ethnobotanical study in the same region on medicinal plants and reported that rural populations, particularly those living in Douars, have a stronger connection to nature and a deeper knowledge of local flora compared to urban dwellers. Similarly, Abou el anouar *et al.* 2024 conducted a study in the same area on *Cistus monspeliensis* L., a species belonging to the same botanical family (*Cistaceae*), and found that villagers had significantly more knowledge of the plant than those living in municipalities. Moreover, this study revealed a statistically significant correlation

between participants' origin and their knowledge of *C. monspeliensis*, confirming that origin plays a key role in shaping ethnobotanical knowledge in the region.

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

In Al Hoceima province, illiterate participants constituted the largest proportion of knowledgeable individuals. This group was followed by individuals with either a primary education or a university degree, both contributing equally at 22.2%. Participants with a high school education represented 9.7%, while those with a middle school level had the lowest proportion of knowledge, at just 5.6% (Fig. 2).

The results of the chi-square test (Table 3) revealed a p-value of 0.001, which is lower than the significance level of 0.05. This indicates a statistically significant association between the participants' educational attainment and their knowledge of *C. ladanifer*. This conclusion is further supported by the comparison between the calculated chi-square value (19.889) and the critical value (9.488) with 4 degrees of freedom (Annex 1). Since the calculated value exceeds the critical value (19.889 > 9.488), the relationship is confirmed as statistically significant.

To evaluate the strength of this association, we used SPSS software to calculate Cramer's V coefficient. The resulting value of 0.446 indicates a strong association between educational attainment and knowledge of *C. ladanifer* (Annex 2).

This finding contrasts with our earlier observation regarding *Cistus monspeliensis* L., where individuals with university education showed greater familiarity with the plant (Abou el anouar *et al.* 2024). In the case of *C. ladanifer*, the dominance of illiterate participants in plant knowledge may be explained by their close relationship with nature and their reliance on traditional ecological knowledge. Notably, most of these individuals were either farmers or unemployed, two groups that often engage in daily interactions with the natural environment and local flora. In rural Moroccan communities, especially in the Rif region, plant knowledge is frequently transmitted orally across generations, particularly among those without formal education. These individuals often acquire practical knowledge of medicinal plants through experience, observation, and cultural heritage rather than academic training.

This result aligns with previous ethnobotanical studies in Morocco and neighboring countries, which have shown that illiterate individuals often possess deeper knowledge of medicinal plants because of their close engagement with traditional practices. In the same region as our study, similar observations were reported in previous works (El-Assri *et al.* 2021, Jeddi *et al.* 2024, Louafi *et al.* 2024, Essaih *et al.* 2024), which all emphasized the strong plant knowledge among rural, often illiterate populations.

Studies from other regions of Morocco have also confirmed this trend, including research conducted in the Rabat-Salé-Kénitra region (El Hachlafi *et al.* 2022), the Béni Mellal-Khénifra region (Aboufaras *et al.* 2022), and the Fès-Boulemane region (Jouad *et al.* 2001). Lastly, similar findings were also reported in Tunisia, where illiterate individuals were found to possess greater knowledge of medicinal plants than those with formal education (Jdaidi & Hasnaoui 2016).

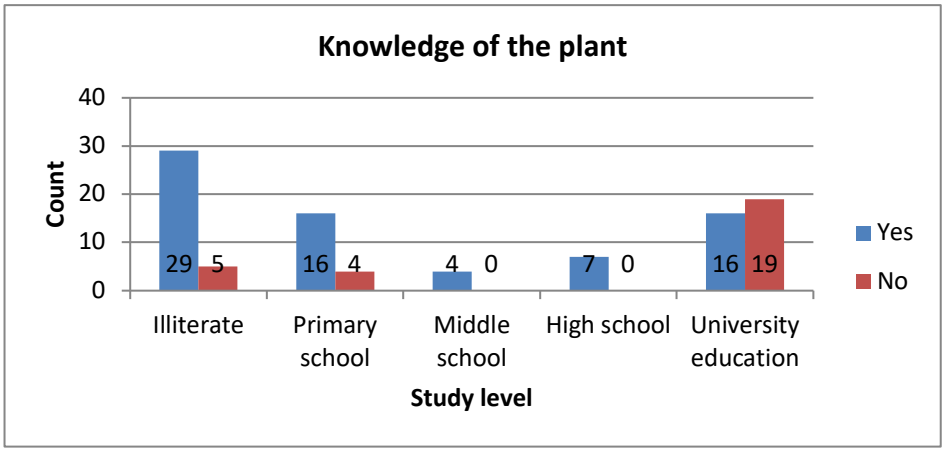

Figure 2. Educational level and plant knowledge

Table 3. Chi-square statistical results.

Profil		Percentage of knowledge	Pearson's Chi-squared Test				Interpretation
			P-value	calculated Pearson's X^2 value	theoretical Pearson's X^2 value	Cramer's V value	
Age	[20-40]	61.1%	0.312	---	---	---	No Correlation
	[41-60]	25%					
	[61-80]	11.1%					
	>80	2.8%					
Gender	Men	55.6%	0.144	---	---	---	No Correlation
	Women	44.4%					
Socio-economic level	Medium	91.6%	0.464	---	---	---	No Correlation
	Low	4.2%					
	High	4.2%					
Origin	Village	98.6%	0.000	48.071	3.841	0.693	Very strong correlation
	Municipality	1.4%					
Educational level	Illiterate	40.3%	0.001	19.889	9.488	0.446	Very strong Correlation
	Primary school	22.2%					
	University level	22.2%					
	High school	9.7%					
	Middle school	5.6%					

Multiple Correspondence Analysis (MCA) of socio-demographic factors and knowledge of *C. ladanifer*

Graphical results from the MCA emphasize the relationships between socio-demographic variables and knowledge of *C. ladanifer*. A clear association was observed between illiterate and rural respondents and traditional knowledge of the plant, confirming the statistically significant relationship identified through the chi-square test. This reflects the persistence of such knowledge in village communities. In contrast, individuals with university education and urban origin were positioned closer to the 'no' category, suggesting that formal education and urbanization reduce familiarity with this species. Interestingly, older participants and those with low socio-economic status tended to report less knowledge, whereas younger men with a medium socio-economic level were positioned nearer to 'yes,' suggesting that they are more likely to maintain inherited knowledge, as illustrated in Fig. 3.

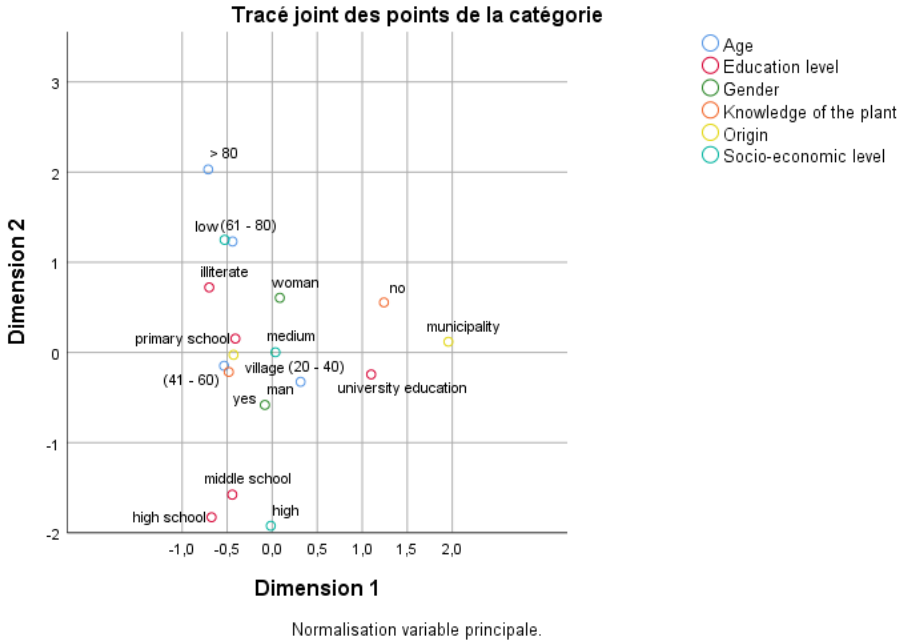

Figure 3. Graphic representation of the MCA showing the association between socio-demographic profiles and the knowledge of the plant

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

Overall, 65% of all respondents reported using *Cistus ladanifer* L.. Among the 72 participants who were aware of the plant, 65 reported using it. This corresponds to 90.3% of knowledgeable individuals, calculated by dividing the number of users (65) by the total number of participants who knew the plant (72) and multiplying by 100. Therefore, nearly all respondents who knew the plant actively used it, highlighting its importance in the local ethnobotanical practices.

Note: The percentages discussed are based on the 72 participants who know the plant, including 65 who reported using it.

Relationship and correlation between Usage of *C. ladanifer and variables*

Plant use correlated significantly with age ($p = 0.028$), with adults aged 20 to 40 years showing the highest reported use (Fig. 4). Gender, origin, education level, and socio-economic status were not significantly associated with use (Table 4).

These findings are generally consistent with those reported by two other studies conducted in the same region, which also examined correlations between plant use and demographic profiles. However, they differ in that, in those studies, age was not correlated with plant use, whereas socioeconomic status showed a significant association (Abou el anouar *et al*. 2024, Louafi *et al*. 2024).

Use of *C. ladanifer* according to age

The chi-square test (X^2) revealed a significant association between age and the use of *Cistus ladanifer* L. ($X^2 = 9.106$, $df = 3$, $p = 0.028$). The strength of this relationship was evaluated using the Phi coefficient, which indicated a strong association ($\Phi = 0.356$).

This finding may be explained by several factors. Firstly, the majority of younger users belong to a middle socioeconomic level and are mainly farmers or unemployed, which likely increases their reliance on natural resources that are freely available in the environment. Secondly, there is a growing preference among younger generations for natural remedies over conventional medicine, encouraging greater use of *C. ladanifer*. Additionally, all users reported positive experiences regarding the plant's effectiveness, which reinforces their motivation to continue using it. Together, these cultural, economic, and experiential factors help explain the significant association observed between age and the use of *C. ladanifer*.

This interpretation is further supported by findings from a comparative ethnobotanical study conducted in three northern provinces of Morocco. Among these, only the province of Al Hoceima showed a statistically significant link between age and the use of medicinal plants. In this region, young adults were identified as the most frequent users, confirming the trend observed in our results and highlighting the importance of local context in shaping patterns of traditional plant use (Smaili *et al.* 2023).

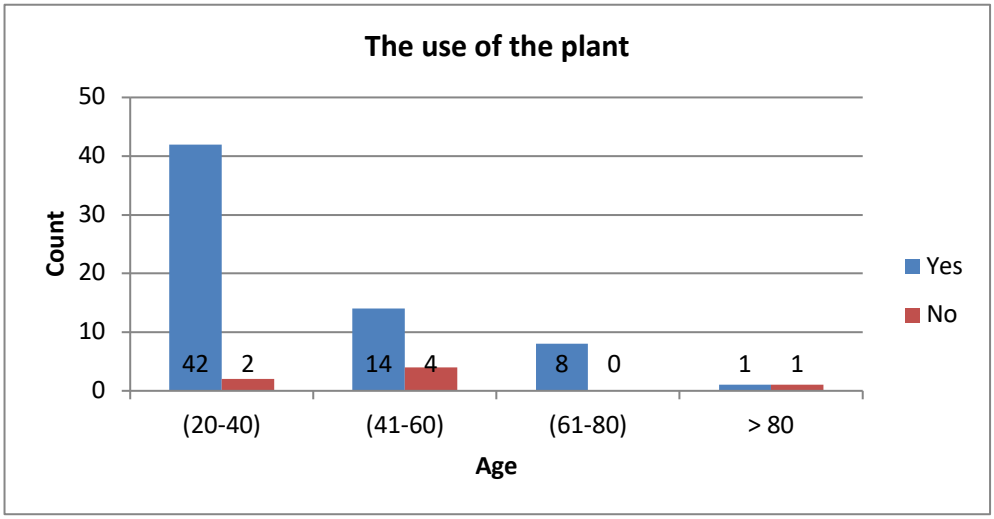

Figure 4. Age and the use of the plant

Table 4. Results of statistical treatment: Chi-square test.

Profil		Percentage of knowledge	Pearson's Chi-squared Test				Interpretation
			P-value	calculated Pearson's X^2 value	theoretical Pearson's X^2 value	Cramer's V value	
Age	[20-40]	64.6%	0.028	9.106	7.815	0.356	Very strong correlation
	[41-60]	21.6%					
	[61-80]	12.3%					
	>80	1.5%					
Gender	Men	58.5%	0.130	---	---	---	No Correlation
	Women	41.5%					
Socio-economic level	Medium	90.8%	0.703	---	---	---	No Correlation
	Low	4.6%					
	High	4.6%					
Origin	Village	98.5%	0.741	---	---	---	No Correlation
	Municipality	1.5%					
Educational level	Illiterate	41.6%	0.197	---	---	---	No Correlation
	University level	24.6%					
	Primary school	21.5%					
	High school	7.7%					
	Middle school	4.6%					

Multiple Correspondence Analysis (MCA) of socio-demographic factors and usage of *C. ladanifer*

The MCA plot illustrates the relationship between socio-demographic variables and the use of *C. ladanifer*. Younger (20-40) and middle-aged (41-60) respondents with a medium socio-economic status are located near the category 'Yes,' indicating more frequent use of the plant. In contrast, individuals over 80 years old, those with middle or high school education, and participants with a high socio-economic level appear closer to the 'No' category, suggesting less frequent use. University-educated respondents and men are positioned on the positive side of Dimension 1, while illiterate individuals and villagers are on the negative side. This indicates that Dimension 1 primarily contrasts urban, educated profiles with rural, less educated ones (Fig. 5).

Overall, age and socioeconomic level emerge as the main factors influencing the use of *C. ladanifer*. This finding is consistent with the results of the chi-square test, which showed a significant association between age and plant use, and supports the idea that plant-based practices are more prevalent among certain demographic groups.

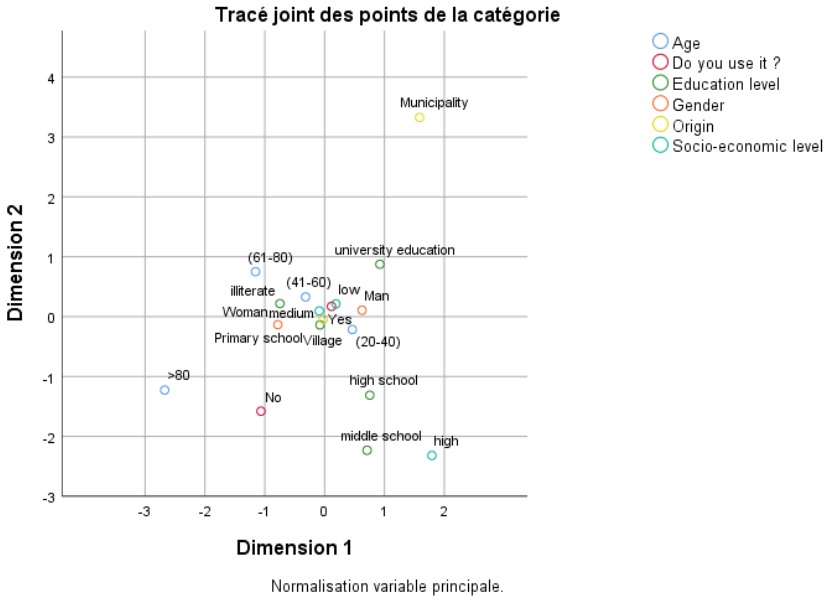

Figure 5. Graphic representation of the MCA showing the association between socio-demographic profiles and the use of the plant

Categories of Use Based on Relative Frequency of Citation (RFC)

Use of *Cistus ladanifer* L. among participants was categorized based on RFC and FL calculations. Food use predominated, reported by 63 out of 100 informants (RFC_all = 0.63) and by nearly all actual users (63 out of 65, RFC_users = 0.97). Therapeutic applications were the second most frequent, cited by 20 informants (RFC_all = 0.20; RFC_users = 0.31), mainly addressing digestive discomfort, with some dermatological and occasional respiratory uses. Other applications—cosmetic, oven cleaning, livestock feeding, and beekeeping—were marginal (RFC_all ≤ 0.03; RFC_users ≤ 0.05) (Fig. 6). Here, RFC_all reflects the proportion of citations among all informants, whereas RFC_users considers only those who reported actual use. FL values were calculated exclusively for therapeutic sub-categories, reflecting the proportion of informants citing a specific therapeutic use relative to all therapeutic citations.

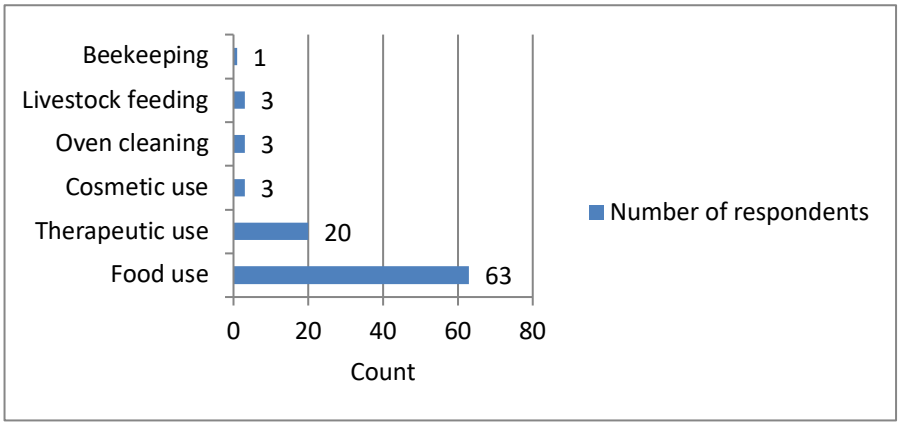

Figure 6. Categories of *C. ladanifer* use in Al Hoceima Province

Food Use: Traditional Practice and Promising Applications

Informants consistently described a preparation in which seeds are extracted, roasted (over fire or in a traditional oven), then mixed with barley and milled into a fine powder, to produce a local product known as *zembou* and commonly eaten with fresh figs in summer. This is, to our knowledge, the first detailed ethnographic record of this practice in North Africa. Prior Iberian reports mention edible seeds in general terms (eaten raw or ground into flour), without a specific recipe or social context (Tardío *et al.* 2005, Tardío *et al.* 2006, Aceituno Mata 2010). The nutritional profile reported for Portuguese seeds—high carbohydrates and fibre, moderate protein, predominantly unsaturated fatty acids, and notable minerals—suggests potential as a local food resource (Frazao *et al.* 2022), but comprehensive chemical, sensory, and safety assessments remain to be done.

Therapeutic use

Digestive disorders. A leaf decoction taken as needed for digestive pain and discomfort was cited by all 20 informants who reported this category (FL = 100%, RFC users = 0.31) (Table 5), indicating strong internal agreement. Experimental evidence of intestinal smooth-muscle relaxation supports this use (Aziz *et al*. 2006).

Dermatological conditions. Five informants reported applying dried leaf powder with olive oil to burns, itching, and wounds (FL = 25%, RFC users = 0.08) (Table 5). Reported antioxidant, antimicrobial, anti-inflammatory and analgesic activities of aqueous leaf extracts are consistent with perceived topical benefits (Barrajon-Catalan *et al*. 2010, El Youbi *et al*. 2016).

Respiratory conditions. One informant noted inhalation of essential-oil vapours for chronic bronchitis symptoms (FL = 5%, RFC users = 0.02) (Table 5). Although clinical confirmation is lacking, the oil's antimicrobial and anti-inflammatory properties and composition make this plausible (Bechlaghem *et al*. 2019, El Karkouri *et al*. 2021, Guinoiseau *et al*. 2015, Vieira *et al*. 2017).

Note: The RFC values reported here are calculated based on the total number of respondents who reported using the plant (n = 65).

Cosmetic use

Cosmetic practices included leaf decoction applied to the scalp for dandruff and hair fall, diluted essential oil massaged on facial skin as an anti-wrinkle treatment, and using the adhesive leaf surface (resin) for epilation. These are compatible with

reported antimicrobial and antioxidant properties of *Cistus* extracts and of *C. ladanifer* essential oil and resin (Benamari *et al.* 2024, Chaloupkova *et al.* 2024, Frazao *et al.* 2022, Zalegh *et al.* 2021).

All three informants affirmed the effectiveness of these practices. However, given the limited number of citations (RFC = 0.05) and the uniqueness of each use (FL = 33.3% for each), these cosmetic applications appear to be occasional and personalized. Nevertheless, they reflect the plant's versatility and its incorporation into traditional beauty care.

Table 5. RFC and FL values by disease category.

Disease category	Disease examples	Number of uses	RFC	FL (%)
Digestive Disorders	Digestive difficulties, Bloating, Gastrointestinal diseases, Intestinal pain	20	0.31	100 %
Dermatological Conditions	Skin burns, Skin wounds, itching	5	0.08	25 %
Respiratory Conditions	Chronic bronchitis symptoms	1	0.02	5 %

Other Uses

Other practical applications included attraction of bees during flowering (melliferous resource), browsing by goats (with documented effects of condensed tannins on product quality and oxidative stability in small-ruminant systems under certain diets), and using leaves to sweep the interior of traditional ovens due to their stickiness. The plant's attractiveness to bees and role in pollination has been documented in Mediterranean settings (Brandt & Gottsberger 1988, De Vega *et al*. 2024, Silva *et al*. 2017, Talavera *et al*. 1993). In small-ruminant systems, effects on performance and product quality depend on inclusion level and diet composition (Castro *et al.* 2021, Chebli *et al.* 2022, Dentinho *et al.* 2020, Francisco *et al.* 2018, Guerreiro *et al.* 2016, Guerreiro *et al.* 2020, Guerreiro *et al.* 2022, Jeronimo *et al.* 2020, Jeronimo *et al.* 2020, Lamy *et al.* 2020).

These uses illustrate the plant's versatility and its integration into local agricultural and domestic practices.

Perceived Safety and Efficacy

Informants reported that all uses of *C. ladanifer* were effective and caused no side effects. This perception is consistent with toxicological data: sub-chronic oral administration of aqueous leaf extracts in rats caused no significant effects on body weight, behavior, organ weights, or blood parameters, except at very high doses (El Kabbaoui *et al*. 2017). Similarly, oral administration in rats at moderate doses induced no clinical, biochemical, or histopathological changes, confirming the safety of the extracts in traditional use (Moussaoui *et al.* 2023).

Part used of the plant

Seeds were the most commonly used organ (66.02%), followed by leaves (29.13%). The whole plant (3.88%) and flowers (1%) were seldom cited (Fig. 7).

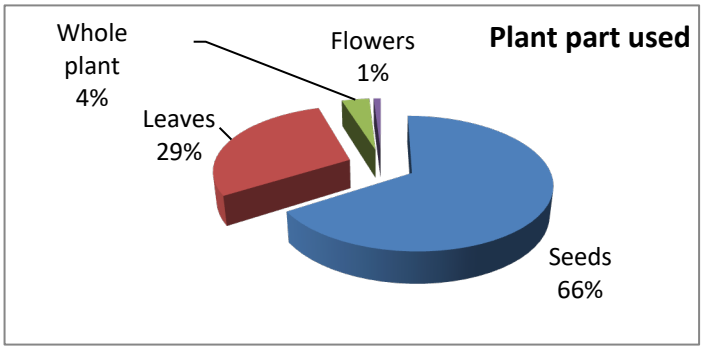

Figure 7. Part of *C. ladanifer* used in the Rif region

Method of preparation and application

Preparation methods were dominated by seed powder (70%), followed by decoction (20%), leaf powder (7%), and essential oil (2%) (Fig. 8).

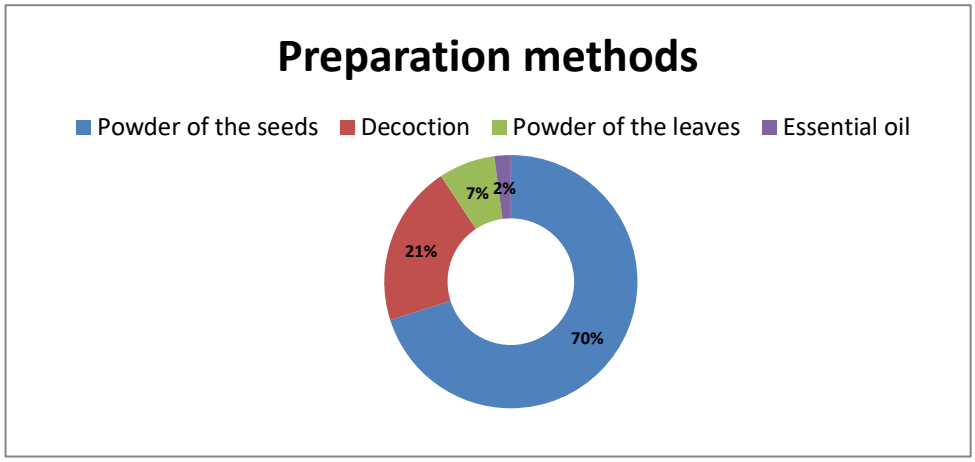

Figure 8. *C. ladanifer* preparation methods in the Rif region

The predominant use of powdered seeds and leaf decoctions reported by informants is supported by existing studies. The nutritional and compositional profile of the seeds has been documented in a single study, confirming their value as a food resource (Frazão *et al.* 2022). Likewise, the therapeutic and antimicrobial potential of aqueous leaf extracts has been widely described in the literature, providing further support for their traditional use (Zalegh *et al.* 2021).

Conclusion and perspectives

This study provides the first comprehensive documentation of *Cistus ladanifer* L. uses in Al Hoceima Province, revealing its importance as a versatile plant embedded in local food, medicinal, cosmetic, and agro-pastoral traditions.

Demographic trends show that rural origin and lower formal education are associated with greater traditional knowledge, while younger adults report the highest use. The distinctive seed-based preparation, *zembou*, emerges as a key cultural feature deserving further nutritional and sensory evaluation.

Future investigations should focus on detailed chemical and toxicological analyses of seeds and derived products, and on assessing the efficacy and safety of topical and inhalation uses. Additionally, agronomic and ecological studies exploring optimal cultivation conditions could support sustainable production and local livelihoods. Overall, *C. ladanifer* stands as an important bio-cultural resource whose study bridges ethnobotany, chemistry, nutrition, and rural development.

Declarations

Ethics approval and consent to participate: All participants were informed of the study aims and procedures and provided prior informed consent. Confidentiality and anonymity were maintained throughout.
Consent for publication: Not applicable.
Availability of data and materials: Data are available from the authors upon reasonable request.
Competing interests: The authors declare no competing interests.
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Authors' 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. L.B. analysis and interpretation (statistical analysis), manuscript revision and improvement. A.N. Ethnobotanical survey. B.M. and B.A. and B.A. Manuscript revision and improvement, supervision. 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 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.