Ethnobotanical survey of *Olea europaea* L. subsp. *europaea* var. *sylvestris* (Mill.) Lehr (Oleaster) in the Fez-Meknes Region (Morocco): Traditional knowledge, uses, and conservation insight

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Research

Abstract

Background: This study investigates traditional uses and local knowledge of wild olive (*Olea europaea* L. subsp. *europaea* var. *sylvestris* (Mill.) Lehr), commonly known as oleaster, in traditional medicine, agriculture, food, and other local practices in Fez-Meknes region of Morocco.

Methods: From October 2023 to January 2025, an ethnobotanical survey was carried out in the Fez-Meknes area using a structured questionnaire. A total of 420 informants were interviewed to document knowledge and uses of oleaster.The Chi-square test and Factorial analysis were used to explore and visualize associations between variables and identify profiles of knowledge and practices.

Results: The survey shows that traditional knowledge and use of oleaster are mainly preserved by older people (>60%), rural residents (56%), low-education groups (57%), and married individuals (55%). Therapeutic uses dominate (30.5%), followed by agricultural uses (28.6%). In traditional medicine, oleaster is often used to treat oral problems (33.72%), diabetes (15.12%), and gastro-duodenal disorders (6.28%). In agriculture, it is mainly used as a rootstock (35.63%). Leaves are primarily employed for therapeutic purposes (55.3%), while the whole plant is used in agriculture (64.3%), fruits are favored in cosmetics (76.1%) and cooking (95%). Dosage is imprecise and toxicity is rare with minor side effects reported.

Conclusions: This study confirms a multifield important interest (mainly medicinal) of the oleaster in Fez-Meknes (Morocco). Further research should validate its medicinal properties, encourage safe use, and preserve such knowledge.

Keywords: medicinal plants, indigenous practices, rural communities, health disorders, toxicity

Background

In the Mediterranean basin, plants have played a fundamental role in human life for thousands of years, providing food, medicine, and other essential natural resources (Idolo *et al*. 2010, Monari *et al*. 2022). Morocco is one of the main biodiversity hotspots in the Mediterranean, with a rich flora spread across diverse climates and landscapes (Benabid 2000, Rankou *et al*. 2013). However, this rich diversity of plants and the associated traditional knowledge are increasingly at risk. Modern lifestyles, urbanization, and globalization can reduce the transmission of practices across generations (Ghanimie *et al*. 2022). In this context, an ethnobotanical study can be an important tool for documenting and preserving traditional knowledge and practices related to plant resources (Besnard *et al*. 2018, Harshberger 1896, Liunokas & Uki 2020). The Oleaster (*Olea europaea* L. subsp. *europaea* var. *sylvestris* (Mill.) Lehr) also known as the wild olive (WO) belonging to the Oleaceae family (Green 1989, Green 2002, Vargas & Kadereit 2001, Zohary & Spiegel-Roy 1975), is one of the wild plants that contribute to Mediterranean biodiversity (Benabid & Fennane 1994, Gagour *et al*. 2024). In Morocco, oleaster holds particular cultural, ecological, and economic importance (Ater *et al*. 2016). It is commonly found in maquis vegetation, dry coastal woodlands, and rocky hillsides, where it thrives in harsh conditions and poor soils (Cavaca *et al*. 2020, Fanelli *et al*. 2022, Gagour *et al*. 2024). Its resilience makes it important for Mediterranean ecosystems and useful as a bioindicator of local climate and environmental change (Aumeeruddy-Thomas *et al*. 2017, Belaj *et al*. 2010, Breton *et al*. 2006, De la Rosa 2014, Lumaret *et al*. 2004, Mulas & Cani 1999). In addition to its ecological role, WO is widely used in Morocco for food, medicine, and other traditional purposes (Addo-Fordjour *et al*.2008, Benamar *et al*.2025, Gagour *et al*. 2024, Kaniewski *et al*. 2012,Thiébault & Moatti 2016).People often use its leaves and fruits in folk medicine to treat several health problems, including diabetes, heart disease , digestive issues, respiratory ailments, and dermatological disorders (Alqethami *et al*. 2017, Bennani-Kabchi 1999, 2000, Daoudi *et al*. 2016, Hashmi *et al*. 2015, Kabach *et al*. 2023, Soldo *et al*. 2024, Zeriouh *et al*. 2017). Oleaster oil has been utilized in cooking, lighting, soap making, and perfumes, while the pressed cake is used as animal feed (Bartolini & Petruccelli 2002, Belarbi *et al*. 2011, Caruso *et al*. 2014, Gianguzzi & Bazan 2019, Oflaz *et al*. 2019). Moreover, the oleaster is still employed in Moroccan agriculture as a robust rootstock for grafting local olive varieties (Ater *et al*. 2016). Most recent research on oleaster in the Mediterranean region, particularly in Morocco, has focused mainly on morphological and genetic traits.(Belaj *et al*. 2010, De la Rosa *et al*, 2014, Lumaret *et al*. 2004). In contrast, no ethnobotanical study has fully examined its traditional uses in food, medicine, culture, and agriculture in the Fez-Meknes region. The absence of complete ethnobotanical data creates a significant gap in understanding how this wild plant affects local communities. This study represents the first comprehensive ethnobotanical survey to document and analyze traditional knowledge of the oleaster in the Fez-Meknes region. It documents how oleaster is used in medicine, food, cosmetics, and farming, and examines how this traditional knowledge is preserved, changing, or disappearing in rural and urban areas.

Materials and Methods

Study area

Located in north-central Morocco, the Fez-Meknes region has about 4.47 million residents and encompasses eight municipalities. According to the High Commission for Planning (HCP 2024), almost half of the people live in the prefectures of Fez (28.1%) and Meknes (21.1%), followed by Taounate (13.7%) and Taza (11.2%). The provinces of Sefrou, El Hajeb, Moulay Yacoube, Boulemane, and Ifranerepresent less than 26% of the region's population. In this area, Arab and Berber communities live together,and share their traditions which helped preserve plant knowledge across generations (TeixidorToneu 2017). The area includes fertile plains, large plateaus, and mountainous regions, such as the Rif in the north and the Middle Atlas in the south, resulting in diverse ecological conditions (Dauteuil *et al*. 2016). The climate is typically Mediterranean, meaning hot, dry summers and cooler, wetter winters. However, in recent years, rainfall has decreased and temperatures have increased, especially in mountainous (Kessabi *et al*. 2022, El Fakir 2023). This environmental diversity affects how plants grow and how people use them in daily life. The wild olive tree is a common plant of this landscape. People, in rural areas, use it for ecological, cultural, and medicinal purposes. This plant can be found near orchards (Hanchane *et al*. 2023) or grows alongside other wild species such as *Pistacia lentiscus*, *Chamaerops humilis*, *Quercus ilex*, *Juniperus phoenicea*, and *Tetraclinis articulate* (Figure 1).

Ethnobotanical Survey

Sampling design

An ethnobotanical survey was carried out in the Fes-Meknes region between October 2023 and January 2025 and included 420 individuals from eight municipalities. The majority of respondents were from rural communities (79.76%, 335 participants), while only a smaller portion lived in urban areas (20.23%, 85 participants). The two groups also differed in age, marital status, occupation, and educational level.To collect a wide range of traditional knowledge, this study focused on experienced people such as farmers, elders, herbalists, and traditional healers.

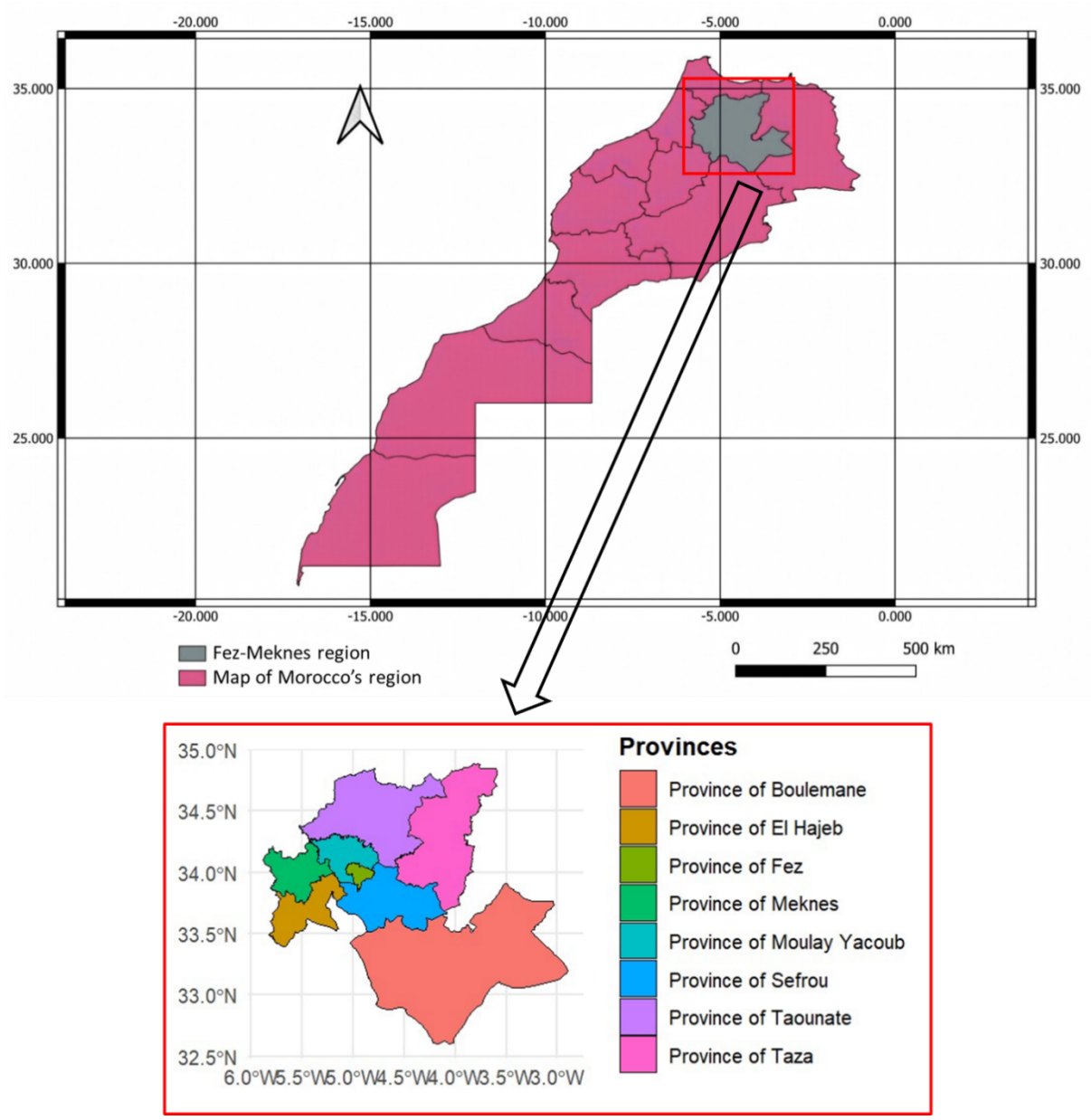

Figure 1. Map of Fez-Meknes region, Morocco, showing the study area.

The two groups also differed in age, marital status, occupation, and educational level. To collect a wide range of traditional knowledge, this study focused on experienced people such as farmers, elders, herbalists, and traditional healers. The primary method of data collection was interviews using a structured questionnaire that covered socio-demographic information and the main uses of oleaster in medicine, farming, food, cosmetics, and crafts (Polat *et al*. 2011). Focus group discussions were also organized to gather additional details from the community. Interviews took place in different locations, including homes, farms, and local markets. The same questionnaire was shared online using Google Forms to people who could not be interviewed directly. A mixed sampling method was employed, combining random, purposive, and snowball techniques. Cluster sampling within the communes ensures that the sample represents the whole population. The design utilized in this survey (Gebre *et al*. 2025, Tadesse *et al*. 2025, Tessema *et al*. 2025) was previously validated by the Council of our Laboratory of Biology, Ecology, and Health, FS, Abdelmalek Essaadi University and Applied Biology for Health, Environment and Sustainable Development Team (BASED), Polydisciplinary Faculty, Sultan Moulay Slimane University (Table 1, Figure 2).

Questionnaire structure

A structured questionnaire was prepared to collect information on knowledge and utilization of the wild olive tree. The complete questionnaire is available in the supplementary material (Table 1S). The design was based on previous ethnobotanical surveys (El Rhaffari & Zaid 2002, Juhé-Beaulaton 2020, Zahir *et al*. 2020). An extensive review of the literature

guided the development of the questionnaire sections. It ensured that all cultural practices and safety aspects were covered, with a particular attention given to its traditional uses, preparation methods, the plant parts involved, and the reported side effects. Searches were carried out in databases such as ScienceDirect, PubMed, Scopus, and Google Scholar using keywords like “ethnomedicinal uses”, “traditional knowledge”, “indigenous knowledge”, “local practices”, “side effects”, ”wild olive”, “oleaster”. The final version of the questionnaire included 17 questions grouped into three sections. The first section collected sociodemographic data (age, gender, occupation, and education level) to examine how these factors influence the use and transmission of traditional knowledge about oleaster within the population. The second section focused on plant’s practical uses. It explored which plant parts people use, how they prepare them, the usual dose, and the frequency of use. It covered uses in food, traditional medicine, cosmetics, agriculture, and industry. In the third section, participants shared their own experiences and views, especially about safety and any side effects. The questionnaire was pre-tested with 25 participants to ensure clarity and reliability, including informed consent and respect for local communities (Albuquerque & Hanazaki 2009; Vandebroek *et al*. 2025).

Table 1. Description of surveyed communes and sample characteristics in the Fez-Meknes region.

Municipalities	**Urban commune**	**Rural commune**	**Field accessibility**	**Area (km^2)**	**Sample size (n)**	**Sampling rate (%)**
Fez	Fez Jdid Saiss Zouagha	Ain Bida Oulad Tayeb Sidi Harazem	Easy	332	35	8.33
Meknes	Meknes City Toulal Moulay Driss Zerhoune	Aït Ouallal Sidi Ali Oued Jamaa	Moderate and difficult	1786	29	6.9
Taza	Taza City Tahla Oued Amlil	Maghraoua Zrarda Bab Boudir	Moderate and difficult	7098	26	7.64
Sefrou	Sefrou City Imouzzer Kandar Bhalil El Menzel Ribate El Khair	Aïn Cheggag Aït Sebaa Lajrouf Azzaba Bir Tam Tam Tazouta Ighezrane	Easy and difficult	4008	104	30.58
Taounate	Taounate City Tissa Karia Ba Mohamed Ghafsai	Aïn Aïcha Mezraoua Ourtzagh Bouadel	Moderate and difficult	5585	67	19.7
Elhajeb	El Hajeb City Aïn Taoujdate Agourai Sabaa Aiyoun	Aït Nouamane Agourai Aït Oufella Ras Ijerri	Easy and moderate	2209	14	4.11
Boulemane	Boulemane Missour	Skoura Mdaz Ouled Ali Youssef Taghzout	Moderate and difficult	14395	34	8.09
Moulay Yacoube	Moulay Yacoube city	Douiate El Mhaya	Easy	1700	10	2.38
Total				**37113**	**420**	**100**

Data Analysis

Data collected was first entered in Microsoft Excel (Version 2016) and later analyzed using Statgraphics Centurion 19 and RStudio (Posit, 2025.09.1+401), respectively. Descriptive and inferential statistical methods were used to explore the association between variables and identify patterns in the data. Three levels of statistical analysis were carried out:

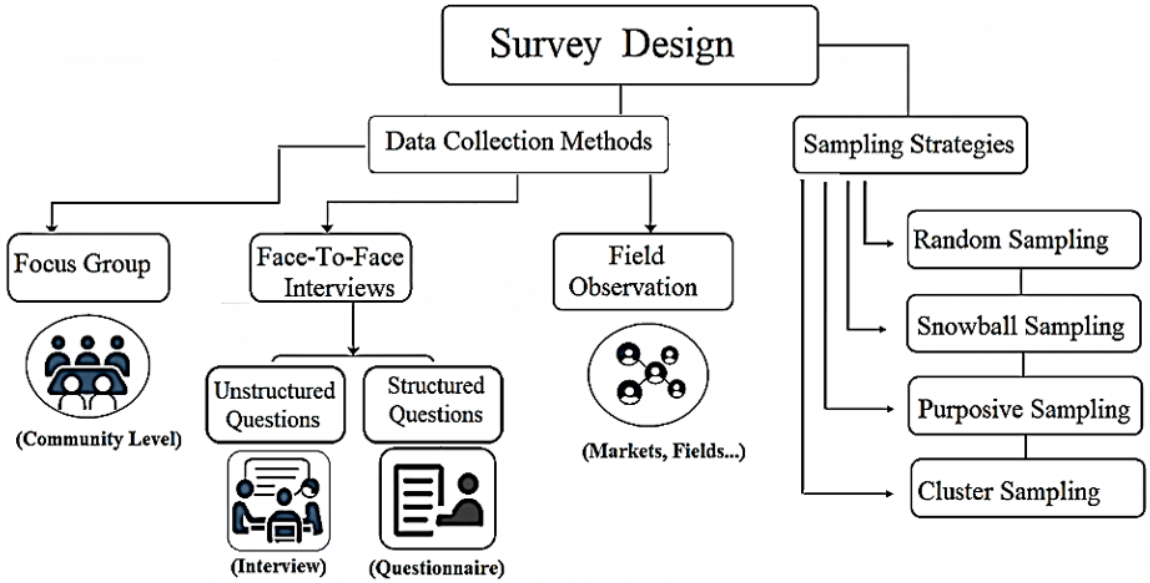

Figure 2.Design of the survey and sampling methods.

Univariate analysis

Abundance (n) and relative frequency (F) were calculated to summarize categorical variables, including socio-demographic characteristics such as age, gender, and education level, as well as the reported uses of the wild olive in the medicinal, agricultural, cosmetic, nutritional, and industrial sectors.

Bivariate analysis

This part of the analysis explores possible relationship between variables. It tests whether sociodemographic factors affect participants' knowledge and use of oleaster, and whether the mode of use (alone or combined) is associated with the application domain (therapeutic or cosmetic). A non-parametric Chi-square (χ^2) test of independence was used, with a significance level of $p < 0.05$. To measure the strength of the association between variables, Cramer's V coefficient was calculated.

Multivariate Analysis

Multiple correspondence analysis (MCA) and correspondence analysis (CA) was required at this advanced stage of statistical analysis using RStudio (Posit, 2025.09.1+401) to visualize and interpret relationships between categorical variables and identify groups with similar characteristics. Based on the Chi-square test, only the variables that had a significant association ($p < 0.05$) and a Cramer's V of 0.1 or more, were presented. The sociodemographic factors, local knowledge and use of the oleaster were included in the MCA, while the use form (sun or shade dried) and preservation methods(Plastic bags, Paper bags, Vials and herbarium) were analyzed by CA. In addition, a Hierarchical Clustering on Principal Components (HCPC) was applied to the distribution obtained by MCA in order to identify homogeneous clusters with similar socio-demographic and ethnobotanical features.

Quantitative indices

To evaluate the specificity of oleaster uses by domains, quantitative ethnobotanical indices including the fidelity level (FL%), Informant Consensus Factor (ICF), and Simpson Index (1-D), were calculated (Begossi 1996, Tardío & Pardo-de-Santayana 2008):

Fidelity Level (FL%)

The Fidelity Level (FL%) indicates how much informants agree on the use of a plant for a specific purpose. In this study, FL indicates how often the oleaster is mentioned and used for the same practical purpose by people in the local community. The FL index is calculated using this formula (Friedman *et al.* 1986): $FL(\%) = (Np/ N)\times100$. Where Np is the number of informants citing the wild olive tree for a specific use and N represents the total number of informants mentioning it for any use.

Informant Consensus Factor (ICF)

The Informant Consensus Factor (ICF) assesses the level of consensus among informants concerning the various applications of oleaster for addressing specific uses (Heinrich *et al*. 1998).The formula of calculation is: ICF=(Nur-Nt) /(Nur-1). Where Nur is the number of use-reports mentioning the oleaster within a specific use and Nt is the number of distinct use types or plant parts of the oleaster cited for that category. In this study, Nt represents the application richness, noted as k.

Simpson's diversity index (1-D)

Simpson's diversity index (1-D) was used to evaluate the diversity of oleaster uses. This index helps determine whether local knowledge is concentrated in a few areas or spread across different use categories. It is calculated as: $1-D=1-\sum ni\,(ni-1)/(N(N-1)$, where ni represents the number of citations for each use category (therapeutic, agricultural, cosmetic, food, etc.) and N is the total number of citations across all categories. The index ranges from 0 (one dominant use) to 1 (all uses equally represented) (Simpson 1949).

Inclusion and exclusion criteria

For this ethnobotanical survey, 420 people aged 18 and over from the Fez-Meknes region were selected, mainly from areas where oleaster grows naturally and is widely used. In contrast, people who were younger than eighteen, lived outside the study area or refused to provide informed consent were not allowed to participate.

Results

Study population

The survey was conducted in the Fez-Meknes region and involved 420 participants from rural and urban areas. 340 people (80.95%) of the targeted population were questioned directly , while 70 (19.05%) answered the questionnaire online via email(Table 1).

Knowledge and use of oleaster across sociodemographic groups

The sample regrouped individuals with a range of sociodemographic characteristics, including age, gender, educational level, occupations and marital status. The Chi-square test was employed to measure the association between socio-demographic variables and the traditional knowledge and utilization of oleaster. This test validated or not the hypothesis of an association between variables, with a significance level set at $p < 0.05$. When a significant association is observed, Cramer's V coefficient is calculated to assess the strength of this relationship (Table 2).

Age

The results indicate that people of different ages know and use oleaster differently. Although 85% of people know more about the plant, only 72.38% use it. Knowledge (48.33%) and use (37.38%) are highest among those aged 40-60, and those over 60. Younger people, those under 40, know and use oleaster less (13.57% and 13.09%, respectively). Chi-square test confirmed that age has a significant association with knowledge ($\chi^2 = 99.166$, $p < 0.001$, Cramer's V = 0.4859) and use ($\chi^2 = 33.525$, $p< 0.001$, Cramer's V = 0.2826) which means that age affect strongly traditional knowledge of oleaster (Hopkins *et al*.2015). These findings support previous studies showing that older generations are the main holders of traditional plant knowledge (Ghanimi *et al*. 2022). This knowledge can gradually disappear, especially among younger generations because their modern lifestyles (Bhatia *et al*. 2018, Kaoutar-Naciri *et al*. 2022; Łuczaj *et al*. 2013; Voeks 2007) (Figure 3).

Gender

The results show that a high percentage of men reports familiarity (60.71%) and utilization (54.9%) of oleaster compared to women (24.3% and 17.4%, respectively).However, Chi-square calculated indicates there was no significance association between gender and knowledge or utilization of oleaster (χ^2 (Knowledge) =0.0664, χ^2(Use) =10.116, $p > 0.05$).These results differ from previous studies (Acosta-Naranjo 2021, Gomes *et al*. 2024,Voeks 2007)showing that women know more about wild plants and use them more than men. The difference in this case could be because of the local situation. Most of the time, men in the agricultural areas use oleaster for farming, such as grafting, protecting the soil, and feeding animals (Ater *et al*.2016). Women, on the other hand, seem to know oleaster mostly for its uses in medicine, cosmetics, or cooking (Liunokas & Uki 2020) (Figure 4).

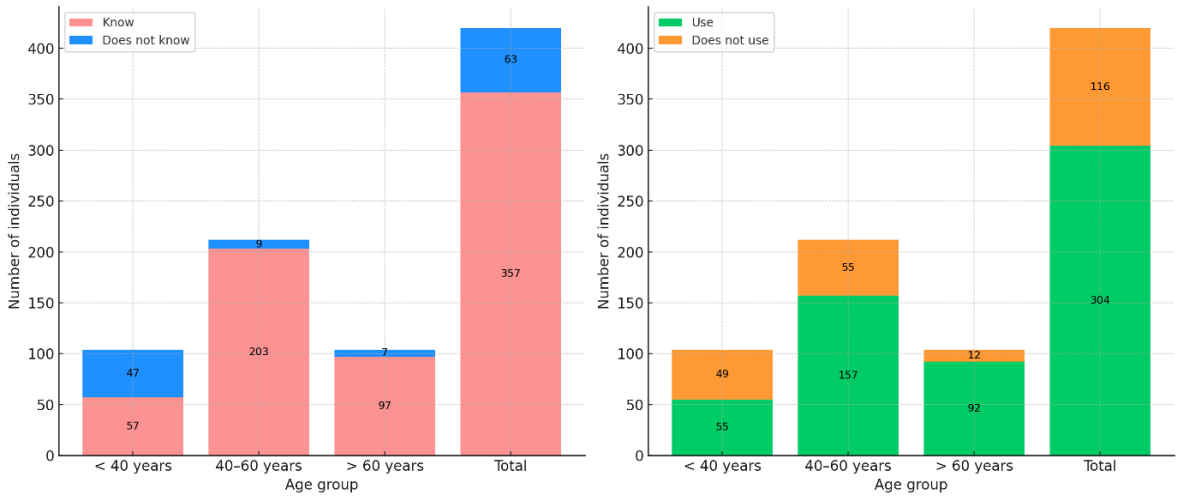

Figure 3. Comparison of knowledge and use of oleaster by age group.

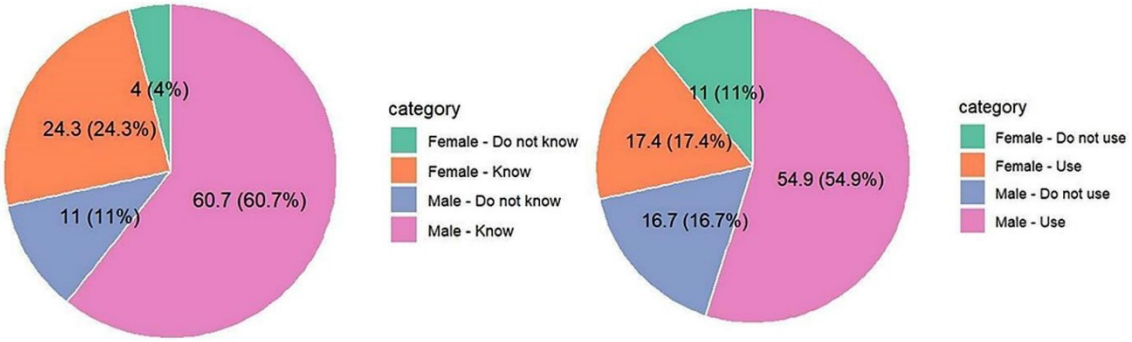

Figure 4. Comparative distribution of oleaster knowledge and use across gender.

Marital status

Results show that married individuals exhibited the highest levels of knowledge (66.67%) and usage (58.10%), followed by single participants (knowledge: 10%; use:7.62%), widowed individuals (knowledge: 5.23%; use: 4.52%), and divorced individuals (knowledge: 3.09%, use: 2.14%).Chi-square tests confirmed the statistical significance on association between variables (knowledge: $\chi^2 = 31.691$, $p < 0.001$, Cramér's V = 0.275, use: $\chi^2 = 27.174$, $p < 0.001$, Cramér's V = 0.254). These findings indicate that the familial context affect strongly the preservation and dissemination of traditional knowledge. Married individuals may acquire more knowledge through consistent interactions within the household. In contrast, single and divorced individuals have less opportunities to acquire such knowledge. The moderate rates among widowed people (knowledge: 6.62%, use: 5.95%) suggest that what they learned in their family life may stay with them and continue to be used over time (Barkaoui *et al*.2022, Eddouks *et al*.2021, Gonçalves & Hanazaki 2023, Naceiri *et al*. 2020) (Figure 5).

Education level

The results reveal that illiterate people know the most about oleaster (48.10%) and use it more (41.90%) and those with primary education (knowledge: 21.43%, use: 17.86%). Conversely, individuals with secondary or university education indicate significantly lower levels of knowledge and use. The Chi-square test confirms this difference for knowledge ($\chi^2 = 43.217$, $p < 0.001$) and for use ($\chi^2 = 31.517$, $p < 0.001$) respectively. These results indicate that an increase in formal education is associated with a decrease in traditional knowledge and utilization of oleaster. This may be explained by the lifestyles change among educated individuals, who strongly depend on modern medicine and commercial products (Benkhnigue *et al*.2023, Bouayyadi *et al*.2015, El Hachlafi *et al*. 2022, Ghanimi *et al*. 2022, Smaili *et al*.2023) (Figure 6).

Table 2. Association between sociodemographic characteristics and knowledge and use of the oleaster.

Features	Categories	Known (%)	Does not know (%)	Chi-square (χ^2)	P-value*	V-Cramér*	Use (%)	Does not use (%)	Chi-square (χ^2)	P-value	V-Cramér
Age	< 40 years	57 (13.57)	47 (11.19)	99.166	< 0.001	0.4859	55 (13.09)	49 (11.66)	33.525	< 0.001	0.2826
	40-60 years	203 (48.33)	9 (2.14)				157 (37.38)	55 (13.10)			
	> 60 years	97 (23.10)	7 (1.67)				92 (21.90)	12 (2.86)			
Total n (%)		**357 (85.00)**	**63 (15.00)**				**304 (72.38)**	**116 (27.62)**			
Gender	Male	255 (60.71)	46 (10.95)	0.0664	0.7966	0.0126	231 (55.00)	70 (16.67)	10.116	0.0014	0.155
	Female	102 (24.29)	17 (4.05)				73 (17.38)	46 (10.95)			
Total n (%)		**357 (85.00)**	**63 (15.00)**				**304 (72.38)**	**116 (27.62)**			
Marital status	Single	42 (10)	23 (5.48)	31.691	< 0.001	0.275	32 (7.62)	33 (7.86)	27.174	< 0.001	0.254
	Married	280 (66.67)	29 (6.90)				244 (58.10)	65 (15.48)			
	Other (Divorced/ Widowed)	35 (8.33)	11 (2.62)				28 (6.67)	18 (4.29)			
Total n (%)		**357 (85.00)**	**63 (15.00)**				**304 (72.38)**	**116 (27.62)**			
Education level	Illetrate	202 (48.10)	11 (2.62)	43.217	< 0.001	0,321	176 (41.90)	37 (8.81)	31.517	< 0.001	0.274
	Non Formal	14 (3.33)	5 (1.19)				14 (3.33)	5 (1.19)			
	Primary	90 (21.43)	21 (5.00)				75 (17.86)	36 (8.57)			
	Secondary	25 (5.95)	9 (2.14)				19 (4.52)	15 (3.57)			
	University	26 (6.19)	17 (4.05)				20 (4.76)	23 (5.48)			
Total n (%)		**357 (85.00)**	**63 (15.00)**				**304 (72.38)**	**116 (27.62)**			
Occupation	Herbalist	40 (9.52)	5 (1.19)	5.971	0.1130	0.1192	37 (8.81)	8 (1.90)	38.418	< 0.001	0.3024
	Farmer	202 (48.09)	29 (6.90)				211 (50.24)	52 (12.38)			
	Healer	15 (3.57)	6 (1.43)				11 (2.62)	10 (2.38)			
	Other	100 (23.80)	23 (5.48)				45 (10.71)	46 (10.95)			
Total n (%)		**357 (85.00)**	**63 (15.00)**				**304 (72.38)**	**116 (27.62)**			
Residence	Rural	296 (70.48)	39 (9.29)	14.641	< 0.001	0.1867	258 (61.43)	77 (18.33)	10.718	< 0.001	0.2058
	Urban	61 (14.52)	24 (5.71)				46 (10.95)	39 (9.29)			
Total n (%)		**357 (85.00)**	**63 (15.00)**				**304 (72.38)**	**116 (27.62)**			

*****Significant associations were at $p < 0.05$.The strength of association was interpreted according to Cramer's V coefficient: weak (<0.3), moderate (0.3-0.5), and strong (>0.5).

Occupation

The results show that people across diverse occupations have different levels of knowledge and use of oleaster. Due to their close interaction with nature, farmers demonstrate highest levels of knowledge (48.09%) and use (50.24%) ,following by herbalists (knowledge: 9.52%, Use : 8.81%), while healers contribute less (3.57% knowledge, 2.62% use), confirming the plant's medicinal value. In contrast, the other groups including consumers, shepherds, nomads and housewives show higher implication (knowledge: 23.80% , Use: 10.71%). Chi-square test confirmed no significant association between occupation and knowledge (χ^2 = 5.971, p = 0.1130, Cramér's V = 0.1192), but a significant association with use (χ^2 = 38.418, p <0.001, Cramér's V = 0.3024). This indicates that the utilization of oleaster by people is more influenced by their occupation than by their knowledge. These findings corroborate previous studies showing that traditional practices are largely preserved by farmers and healers, who use the plant regularly in their daily activities (Kachmar *et al*. 2021, Karakaya *et al.* 2020, Maache *et al.* 2024) (Figure 7).

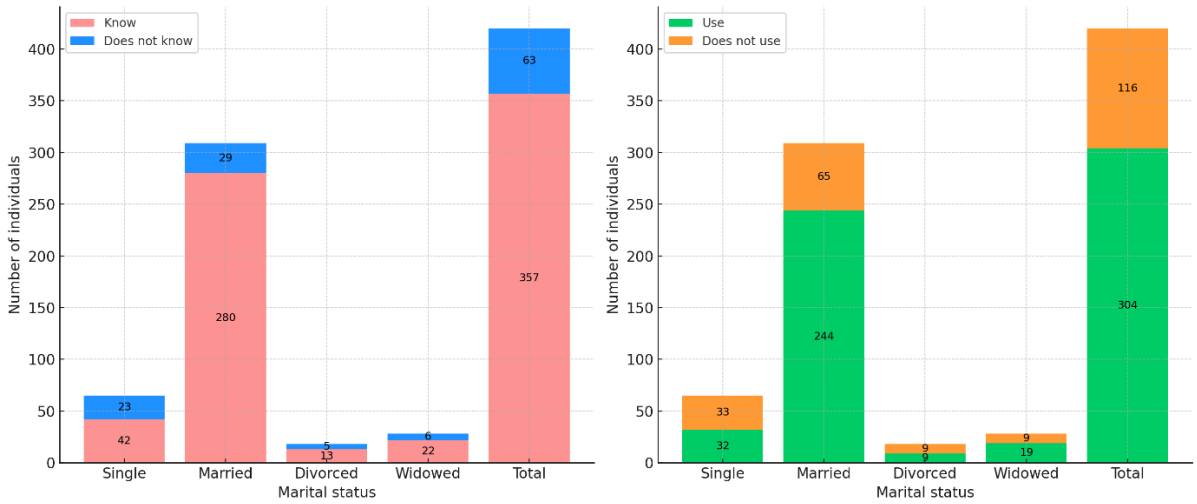

Figure 5. Variation in Oleaster knowledge and use according based on marital status, including total respondents.

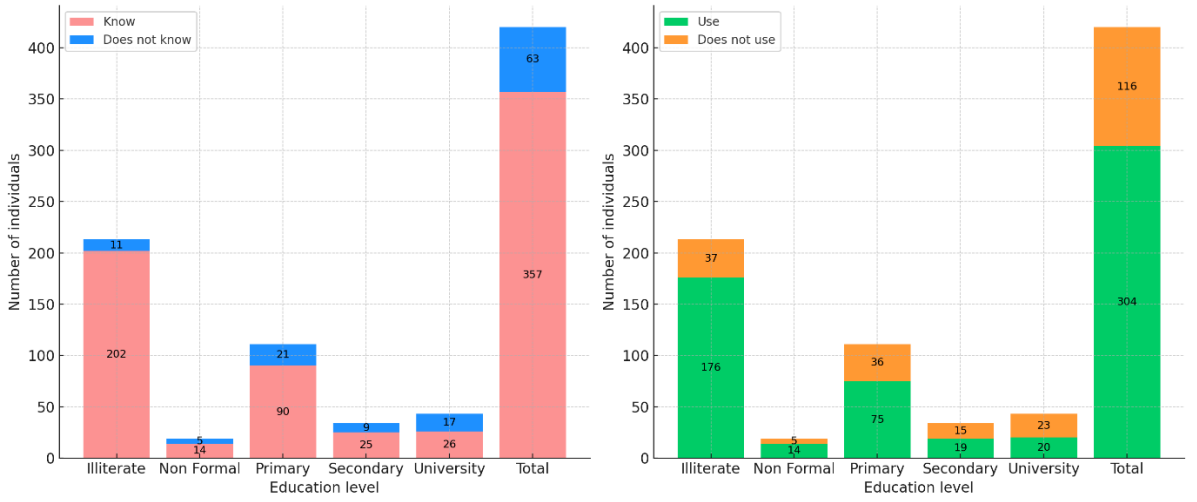

Figure 6. Variation in oleaster knowledge and use based on education level.

Place of residence

Urban participants reported lower levels (14.52% knowledge, 10.95% use), whereas rural participants reported 70.48% knowledge and 61.43% use respectively. These variations are statistically significant for knowledge (χ^2 = 14.641, p<0.001, Cramer's V = 0.1867) and use (χ^2 =10.718, p<0.001; Cramer's V =0.2058). This suggests that oleaster is more common in rural areas, where people still use natural resources and traditional remedies (El-Ghazouani *et al*.2024, Jeddi *et al.* 2024). Conversely, it is less used in cities, probably because people use modern healthcare services more and have less access to natural resources (Chiocchio *et al*. 2024) (Figure 8).

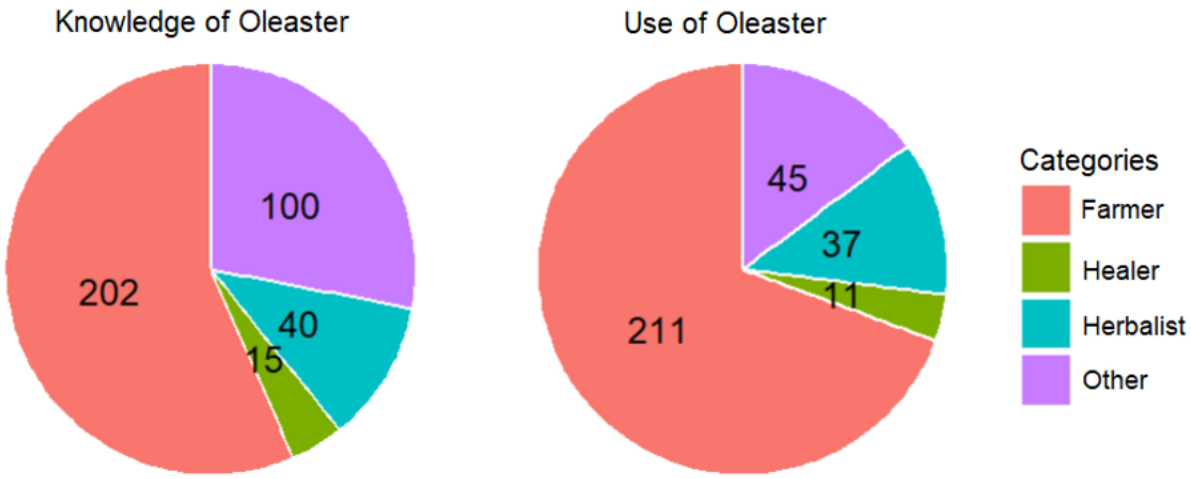

Figure 7. Relationship between occupation and knowledge and use of oleaster.

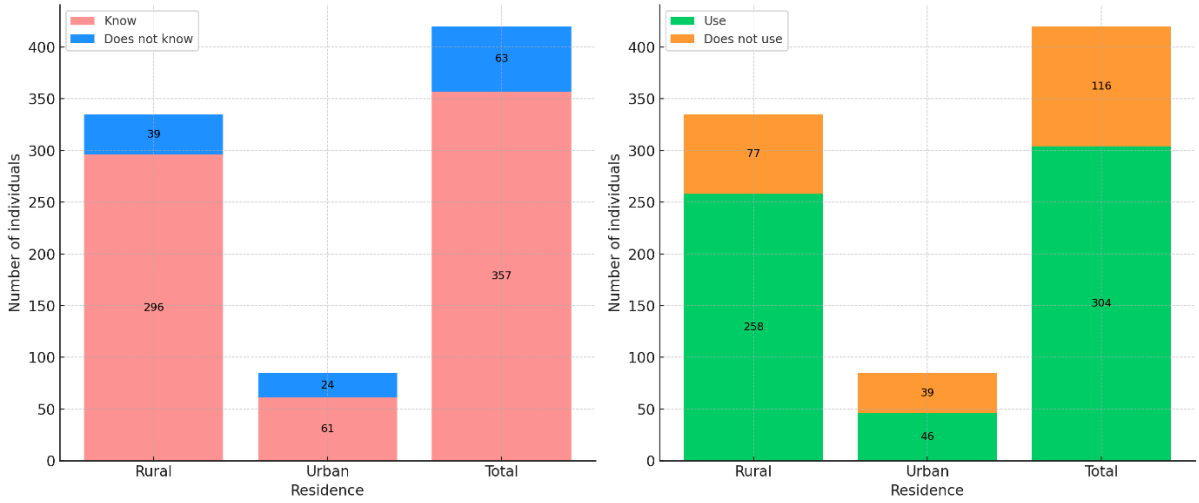

Figure 8. Influence of residence on knowledge and use of oleaster.

Factorial analysis of sociodemographic factors influencing oleaster knowledge and use

Multiple Correspondence Analysis (MCA)

MCA examines the sociodemographic features of participants in relation to their knowledge (KO) and utilization (UO) about oleaster. The first two dimensions explain 25.5% of the total variance (15.9% for Dimension 1 and 9.6% for Dimension 2).

Dim 1 discriminates between two respondent profiles. On the negative side of the plot, it shows a group of participants who are rural, older (≥40 years), less educated, married, and mostly female. This group links to indigenous practices, such as farming and healing reflecting a strong connection to local traditional knowledge and use of oleaster (El-Ghazouani *et al.* 2024). On the positive side of the plot, younger, urban, single, and university-educated individuals appear. This group knows and uses oleaster less, which means that traditional knowledge is gradually disappearing due to modern lifestyles (Chiocchio *et al*. 2024).Dim 2 separates individuals based on gender and marital status. The positive part of the plot shows women (Female), especially widows and housewives. They are closer to KO_No and UO_No, reflecting their tendency to know and use oleaster more less. In contrast, men (Male) in the negative part, indicate that they are closer to KO_Yes and UO_Yes, meaning they tend to know and use oleaster more. In conclusion, MCA confirms that age, residence, education,

and social occupation of respondents impact significantly their knowledge and utilization of oleaster , supporting the relationships between variables already established by the Chi-square test (Figure 9).

Hierarchical clustering on principal components (HCPC)

The HCPC analysis indicates three different clusters. The first group (1) represents essentially rural participants who know and use oleaster strongly. The second group (2) covers semi-urban individuals with moderate knowledge and occasional use.

The third group (3) is formed mostly by urban participants, who show limited familiarity with oleaster. In general, the integration of both MCA and HCPC shows that traditional knowledge of oleaster is still mostly held by older, rural, and less educated women, while its transmission is gradually declining among younger, urban, and educated groups. These findings aligned with prior research made in the Mediterranean region, where modernization and changing lifestyles have affected the transmission of knowledge from older generations to younger people (Bhatia *et al.* 2018, Łuczaj *et al*. 2013, Kachmar *et al*. 2021, Karakaya *et al*. 2020, Kaoutar-Naciri *et al*. 2022, Maache *et al*. 2024) (Figure 10).

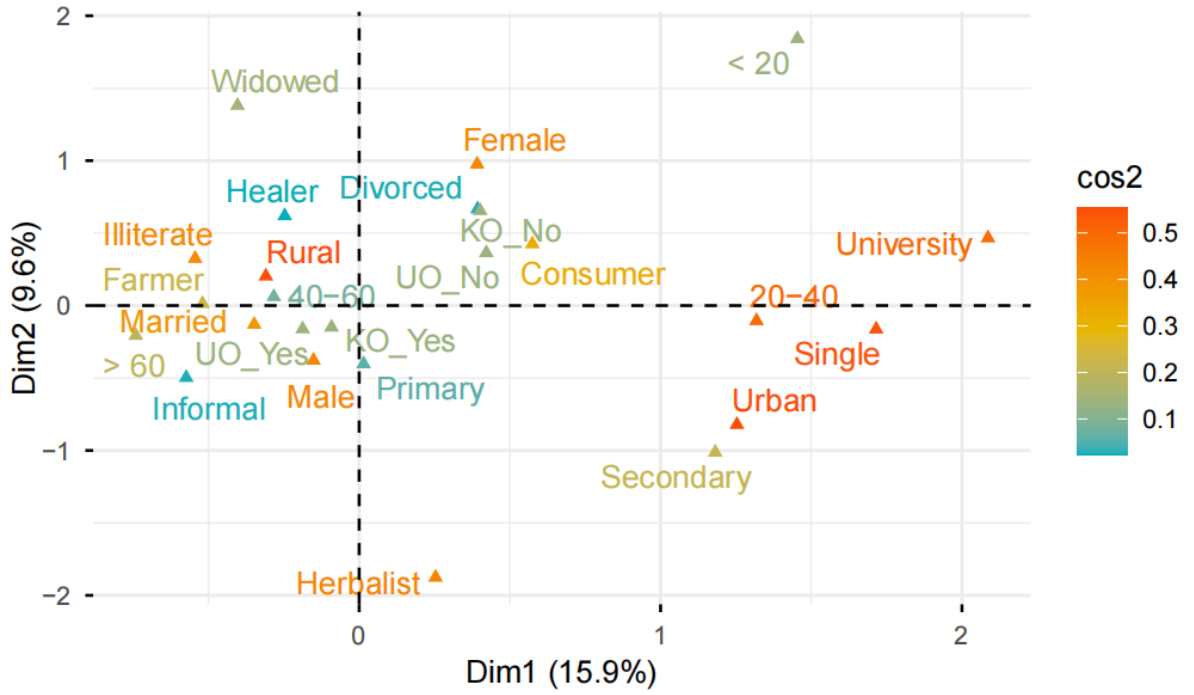

Figure 9. MCA map of sociodemographic categories and their association with knowledge and use of oleaster.

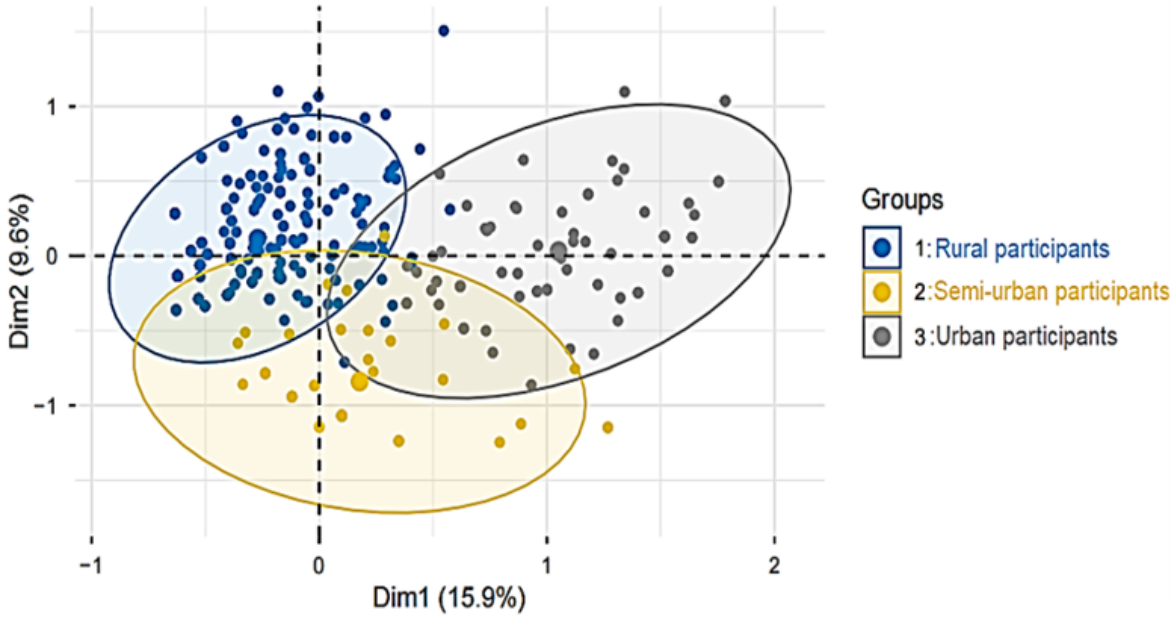

Figure 10. Typological distribution of respondents using HCPC.

Use of Oleaster

Domains of oleaster use

The use of oleaster covers multiple fields, therapeutic (30.50%) and agricultural (28.60%) applications were the most cited, followed by industrial (19.75%) and nutritional (12.40%) uses, while cosmetic use was the least represented among

participants (8.76%). The Simpson diversity index, calculated for oleaster use categories, was 0.763. This value shows that oleaster is used in all domains with a moderate balance across the different types of use. This result aligns with some ethnobotanical studies on oleaster, which emphasize its important medicinal and agronomic uses (Ater *et al*. 2016, Kabach *et al*. 2023) (Figure 11).

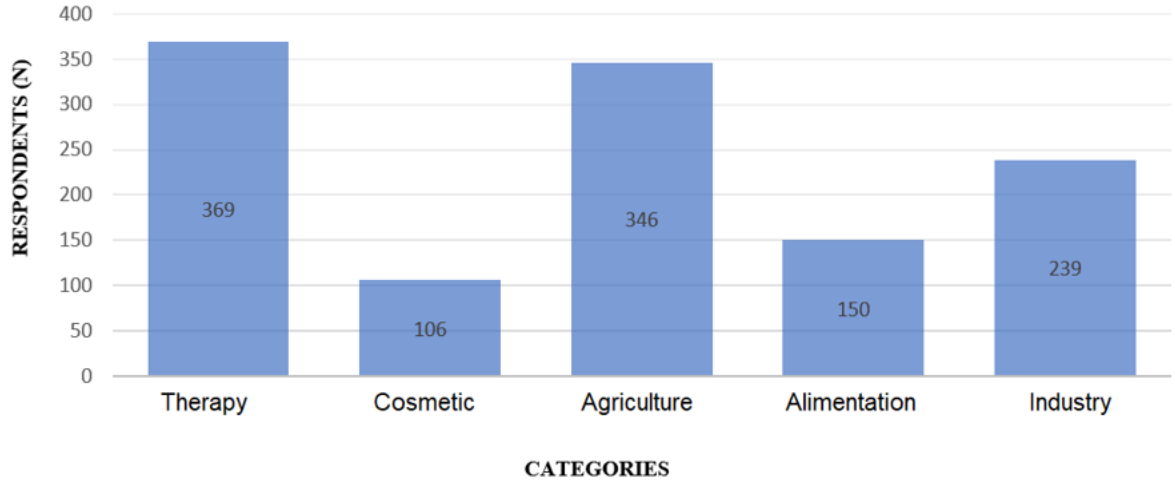

Figure 11. Frequency distribution of oleaster uses by domains.

Major applications of oleaster

The ethnobotanical data reveal that oleaster is widely used across several socio-economic domains. The Informant Consensus Factor (ICF)calculated indicates a high degree of agreement among informants**,** confirming that the plant is culturally and practically important. Table 3 highlights the main applications reported within each domain.

Table 3. Domains of use and main applications of oleaster.

Domain	**Use reports n_1* (%)**	**Application richness (k*)**	**ICF**	**Rank**	**Main applications (n_2* , FL* %)**
Therapeutic	981 (43.06)	30	0.97	1	- Oral diseases (408,41.59%) - Diabetes (183,18.65%) - Gastro-duodenal disorders (76, 7.74%)
Agricultural	595 (26.11)	6	0.99	2	- Fodder (228,38.31%) - Rootstock (212, 35.63%) - Pollination (65, 10.92%)
Industrial	183 (8.03)	5	0.97	3	- Handicraft manufacturing (166 ,90.71%) - Carpentry (7 , 3.82%) - Papermaking (5 , 2.73%)
Food	181 (7.94)	3	0.98	4	- Olive oil (141, 77.90%) - Olives (38, 20.99%) - Tea (2, 1.10%)
Cosmetic	149 (6.54)	3	0.98	6	- Hair care (73, 48.99%) - Face and body lotion (68, 45.63%) - Other uses (8,5.37%)
Other uses	159 (6.97)	4	0.98	5	- Firewood (141, 88.67%) - Field boundary markers (14, 8.8%) - Erosion control (18,11.32%)

* n_1 = use reports in the domain,% Total = n_1 / N_total × 100 , k = number of distinct applications (Richness), FL = n_2 / n_1 × 100, ICF = (n_1 − k) / (n_1 − 1), n_2 = count of a subcategory ,Rank = sorted by n_1 (ties → ICF, then % total).

Therapeutic applications

The therapeutic use of oleaster was the most cited domain (n_1 = 981). A high ICF (0.92) illustrated that respondents had a consistent level of ethnomedicinal knowledge. The most frequent therapeutic applications included: Oral diseases (33.72%), Diabetes (15.12%), and Gastro-duodenal disorders (6.28%). These findings emphasize oleaster's significance in traditional

medicine, especially for metabolic disorders, digestive issues, and oral hygiene, which corresponded with the recognized pharmacological features of oleaster, mainly its antioxidant, anti-inflammatory, and antimicrobial properties (Bouchoucha *et al*. 2025, Gagour *et al*. 2024, Kabach *et al*. 2023, Mansour *et al*. 2023, Soldo *et al*. 2024, Zaouani *et al*. 2018) (Figure 12).

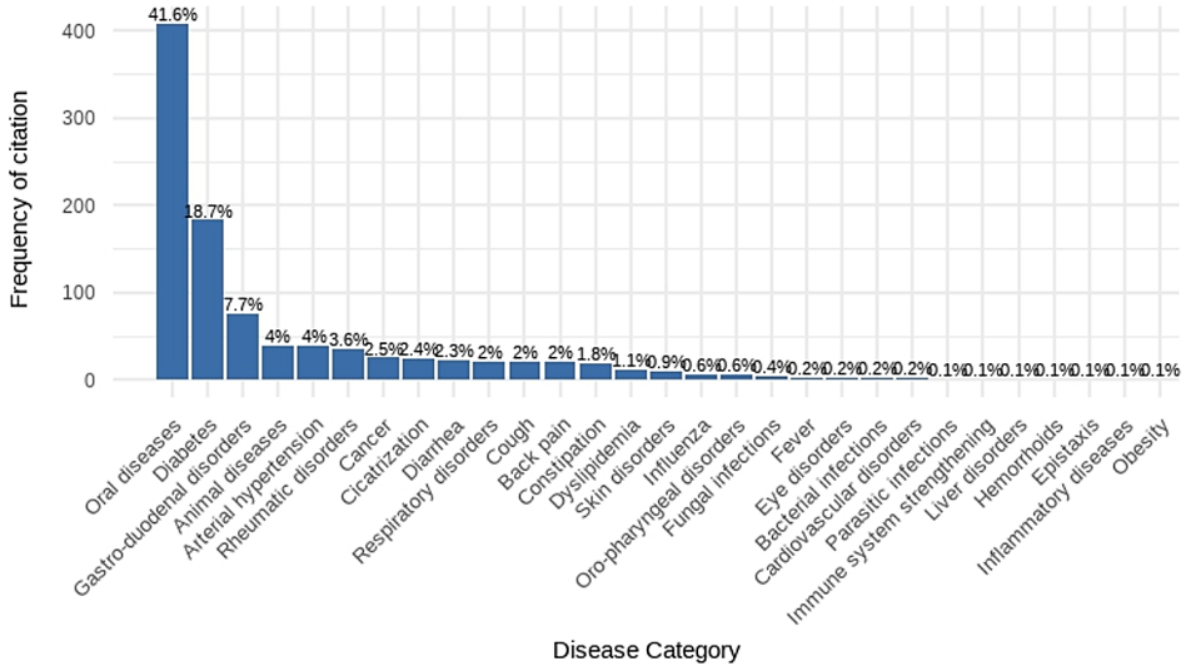

Figure 12. Frequency of diseases treated with oleaser.

A review of scientific evidence on the therapeutic benefits of oleaster

Multiple scientific articles were reviewed by consulting several databases like Google Scholar, PubMed, and ScienceDirect to confirm the traditional therapeutic uses of oleaster. These studies evaluate the biological effects of oleaster and report several pharmacological activities with their mechanisms. Overall, the literature shows that oleaster has many biological activities. Studies on diabetes confirm that oleaster may help reduce blood glucose (Kabach *et al*. 2022). Other work reports antiproliferative activity, suggesting potential benefits against cancer (Soldo *et al*. 2024). In addition, its high antioxidant effects can limit oxidative stress (Kabach *et al*. 2022; Pennisi *et al*. 2023).Its anti-inflammatory activity supports its traditional use against inflammation (Soldo *et al*. 2024). The antidiarrheal effects confirm its use for managing diarrhea (Zaouani *et al*. 2018), its antimicrobial and antiviral properties ,particularly against herpes simplex virus type 1 (HSV-1), have also been demonstrated (Khan *et al*. 2019, Pennisi *et al*. 2023). Additionally, oleaster shows cardioprotective and vasodilatory effects, which may benefit cardiovascular problems such as hypertension and atherosclerosis (Khan *et al.* 2007). Some gastrointestinal benefits have been confirmed, including the stability of oleuropein during digestion (Soldo et al. 2026) and protection against intestinal fluid loss (Zaouani *et al.* 2018). The hypocholesterolemic effect was validated reducing total cholesterol, mainly by lowering LDL and VLDL fractions (Bennani-Kabchi *et al*. 2000). However, no scientific study has evaluated the effects of oleaster on many diseases reported in the present survey such as rheumatic disorders, respiratory problems, cough, skin and eye diseases, oro-pharyngeal issues, fever, parasitic infections, liver disorders, hemorrhoids, immune-related issues, among others. Although these traditional uses are widespread, they are still based essentially on empirical knowledge rather than scientific validation. Therefore, further pharmacological investigations are needed to confirm or refute these uses (Table 4).

Agricultural applications

Almost everyone agrees that oleaster is useful for farming (ICF = 0.99), making it the second most important use. The main uses arefor animal feed (38.5%) and as a rootstock for grafting (33.9%). It is also used for demarcation of cultivated fields (3.6%), to prevent soil erosion (2.5%), and to provide shade and pollination (10.7% each). These uses show that oleaster is an important part of agroecosystems (Ater *et al*. 2016, Aumeeruddy-Thomas *et al*. 2017, Fanelli *et al*. 2022) (Figure 13).

Industrial applications

Most industrial uses of oleaster were related to its wood. It is mainly used for making handicrafts (90.71%), with lower uses in carpentry (3.82%) and paper making (2.73%). For a long time, people have liked it for making tools, sculptures, and other

decorative items (Nedelcheva *et al*. 2011). Despite its relatively limited use, it demonstrates significant economic potential as a sustainable material (Ater *et al*. 2016) (Figure 14).

Table 4. Main biological activities of extracts of *Olea europaea* L. subsp. *europaea* var. *sylvestris* .

Biological activity	**Part used**	**Extract type**	**Key findings**	**Proposed mechanisms**	**Reference**
Antidiabetic	Leaves	Hydromethanolic and hydroacetonic extracts	-Strong inhibitory effect on α-amylase. -Highest inhibition by hydromethanolic (76.55%) at 4mg/mL . -Lower inhibition by hydroacetonic extract (69.03%). IC_{50} = 0.91 ± 0.02 (mg/ml).	-Enzyme inhibition (α-amylase)→reduction of starch →hydrolysis Reduced postprandial blood glucose.	Mezouar *et al*. 2021
Antidiabetic	Fruits	Methanolic extract (ME)	-ME inhibited α-amylase (IC_{50} = 2.367 mg/mL) and α- glucosidase (IC_{50} = 1.272 mg/mL) activities in vitro. -Less potent than acarbose. -The extract showed dose-dependent inhibition, suggesting a moderate and potentially safer	-Inhibition of sugar autoxidation and generation of ROS (reactive oxygen species). -Reduction of Schiff base and Amadori product formation. -Protection of protein thiol groups. -Prevention of diabetes-related complications.	Kabach *et al*. 2023
Antioxidant	Leaves	Hydroethanolic extract	-Strong antioxidant activity in phosphomolybdate assay and Nitric Oxide (NO) radical scavenging. -Protected HeLa cells against lipid peroxidation (reduced malondialdehyde (MDA) levels).	-Scavenging of ROS and RNS (Reactive Nitrogen Species). -Reduction of lipid peroxidation, evidenced by a decrease in MDA . -Up-regulation of endogenous antioxidant en zymes, including: Catalase (CAT), Superoxide Dismutase (SOD), Glutathione peroxidase (GPx). -Protection of cells against oxidative damage.	Pennisi *et al*. 2023
Antioxidant	Fruit	Aqueous and methanolic extracts	-Methanolic extract showed high antioxidant capacity by several assays, including DPPH (2,2-diphenyl-1-picrylhydrazyl radical scavenging assay), FRAP (Ferric Reducing Antioxidant Power	-Polyphenol-mediated scavenging of free radicals (DPPH• and ABTS•+) -Electron-donating and reducing power (FRAP) -Chelation of pro-oxidant metal ions (Fe^{2+}).	Kabach *et al*. 2023

			assay), ABTS (2,2'-azino-bis(3- ethylbenzothiazoline-6-sulfonic acid) radical cation assay), and metal-chelating activity assays. - Correlated with higher total phenolic content.		
Anticancer	Leaves	Phenolic	-Inhibited growth of colon cancer cells (HCT116, HCT8). -Induced cell apoptosis→ Reduced tumor volume in xenograft mouse model -Strong cytotoxic effect on cancer cells while sparing healthy cells. .	-Phenolic extract increase intracellular Ca^{2+}. -Mitochondrial dysfunction. -↑Mitochondrial ROS + Cytochrome c release. - Activation of caspase-9 followed by caspase-3/7, and PARP cleavage (Poly ADP- ribose -Polymerase)→Caspase-dependent apoptosis.	Zeriouh *et al*. 2017
Antiviral	Leaves	Pure oleuropein	-Oleuropein strongly inhibited HSV-1 (Herpes Simplex Virus type 1) replication at 300-400 µg/ml. -More effective than acyclovir (antiviral drug).	-Activation of PKR (protein kinase R) via phosphorylation. -Activation of downstream signaling (c-Jun and c-Fos phosphorylation). -Stimulation of innate antiviral response. -Suppression of viral gene transcription and protein synthesis. -Blockage of HSV-1 replication at multiple stages.	Pennisi *et al*. 2023
Gastrointestinal stability	Leaves	Oleuropein extracted from methanolic extract	-Oleuropein degraded in gastric phase (35.66% stability), but better stability in intestinal phase (65.97%).	-Gastric phase (low pH + enzymes) : *Oleuropein hydrolysis → degradation -Intestinal phase (neutral pH): *Higher oleuropein stability *Potential absorption	Soldo *et al.* 2024
Cardioprotective and Vasodilator	Leaves	Aqueous and ethanolic extracts	-Olive leaf extracts showed : *Vasodilation, anti-atherosclerotic effect *Decreased LDL oxidation; hypotensive effect in rats	-Inhibition of LDL oxidation. -Smooth muscle relaxation. -Vasodilation. -Antioxidant- dependent protection.	Khan *et al.* 2007
Antidiarrhoeal	Leaves	Aqueous extract	-Significant inhibition of diarrhoea: 64.58% (100	-Inhibition of prostaglandin synthesis (ricinoleic acid pathway).	Zaouani *et al*. 2018

			mg/kg), 70.83% (200 mg/kg), 77.08% (400 mg/kg). -Same effect to loperamide (72.91%).	-Reduced intestinal secretion. -Protection of intestinal mucosa.	
Hypocholesterolemic	Leaves	Aqueous extract	-Oleaster leaves improved carbohydrate and lipid metabolism in obese and prediabetic sand rats. -They significantly reduced blood glucose, insulin levels, and LDL/VLDL without causing toxicity.	-Hypocholesterolemic effect. -Strong reduction of total cholesterol (≈ 42%), mainly by lowering LDL and VLDL fractions.	Bennani-Kabchi *et al.* 2000
Antimicrobial	Leaves	Methanolic and aqueous extracts	-Strong antimicrobial effect against Gram+ (Staphylococcus aureus ATCC 6538; Staphylococcus aureus ATCC 43300). -No activity against Gram- (Escherichia coli ATCC 10536; Pseudomonas aeruginosa ATCC 9027) or yeast (Candida albicans ATCC 10231). -Rich phytochemical profile (phenolics, flavonoids, oleuropein derivatives).	-Access to Gram-positive cell wall. -Interference with vital bacterial functions. -Synergic effect between phytochimical compounds. -Inhibition of bacterial growth (bacteriostatic effect).	Ben-Amor *et al.*2021

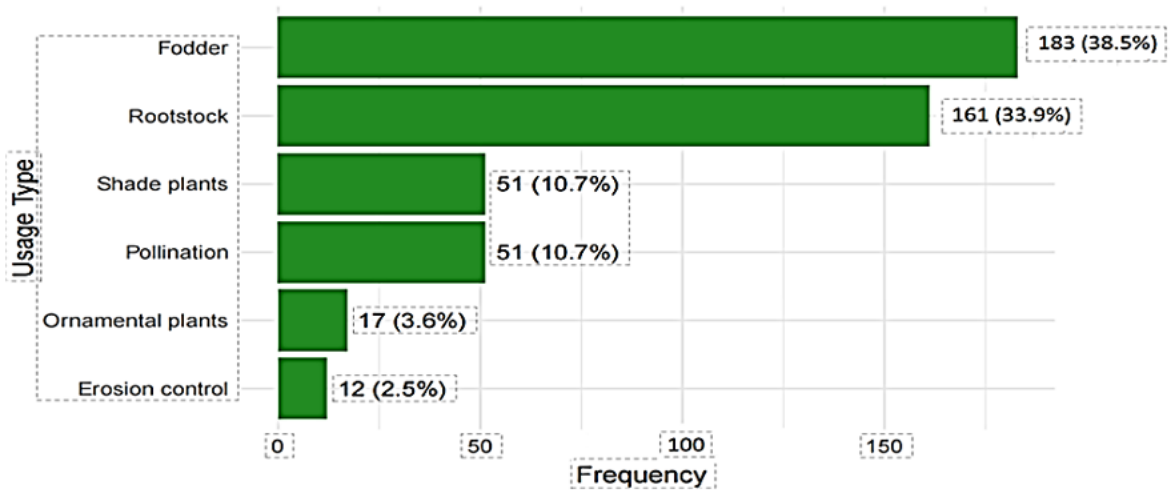

Figure 13. Distribution of agricultural uses of oleaster in the study region.

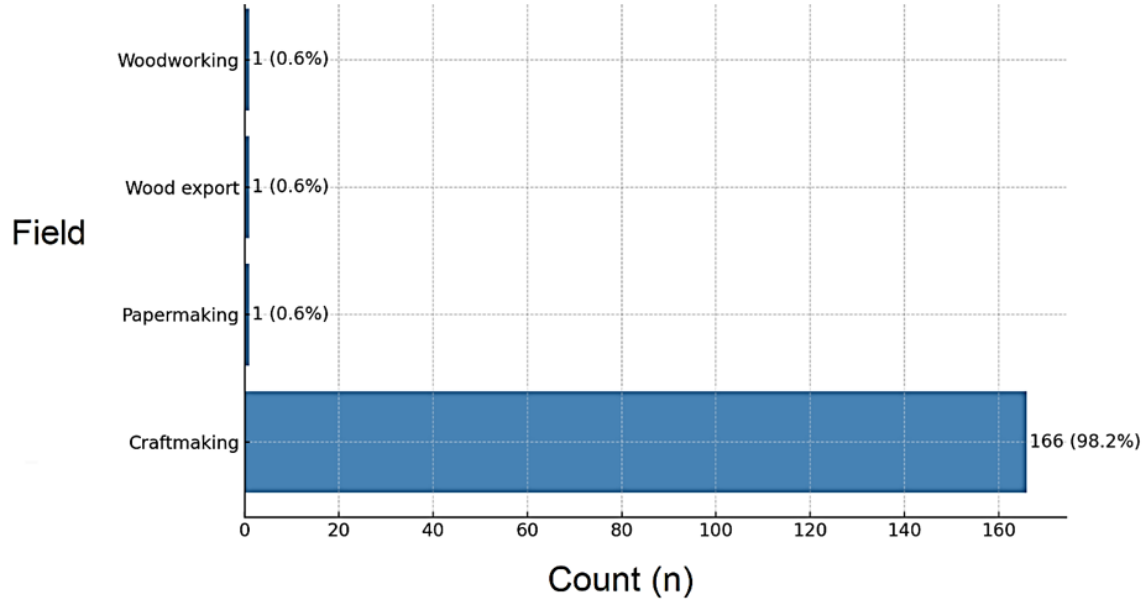

Figure 14. Relative frequency of wood and craft applications.

Cosmetic applications

People use oleaster in cosmetics, showing a link between traditional and modern care. The most common uses are for hair (48.99%) and lotions for the face and body (45.63%), other smaller uses (5.37%) including treating skin wounds, reducing facial wrinkles, and soothing the skin. These uses confirm the emollient and antioxidant properties of oleaster oil, reinforcing its potential for cosmetic development (Angerhofer *et al*. 2009, Gonçalves & Hanazaki 2023, Tunç *et al*. 2025) (Figure 15).

Other uses

Other practical uses demonstrate the multipurpose nature of oleaster. The main uses are for firewood (78%), marking field boundaries (8%), controlling soil erosion (10%) and making lamp oil (4%). These indicate its ecological resilience (Kassout *et al*. 2023) and socio-environmental utility, particularly in rural land management and agroforestry systems (Ater *et al*. 2016) (Figure 16).

Modes of Oleaster Utilization

Utilization of oleaster in therapeutic and cosmetic

In general, of the 353 reported uses, 323 (91.5%) individuals use oleaster alone , while 30 (8.5%) associate it with other plants like rosemary, rose, lavender, or thyme. In therapeutic applications, oleaster is used alone in 93.9% of cases

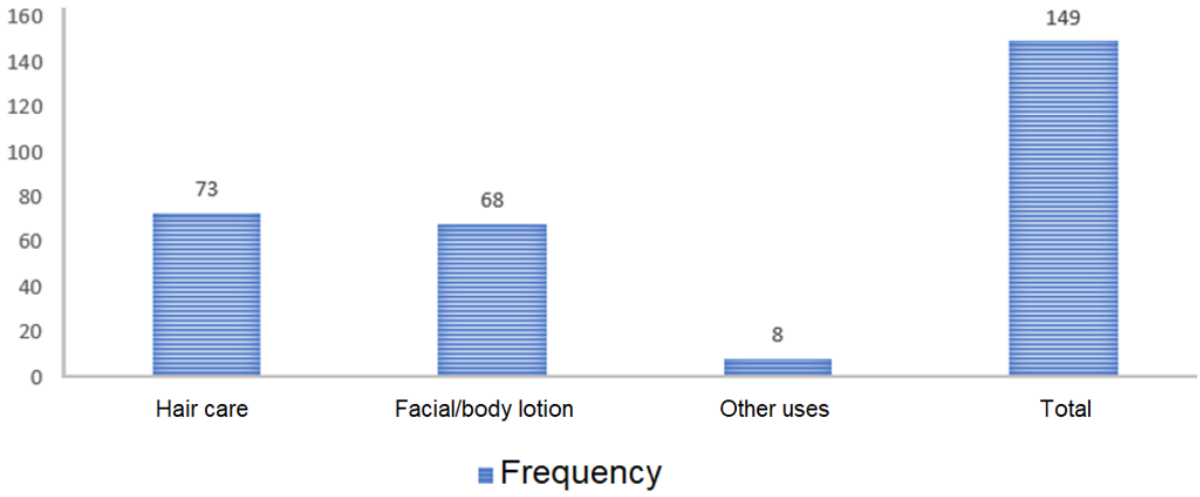

Figure 15. Distribution of cosmetic applications.

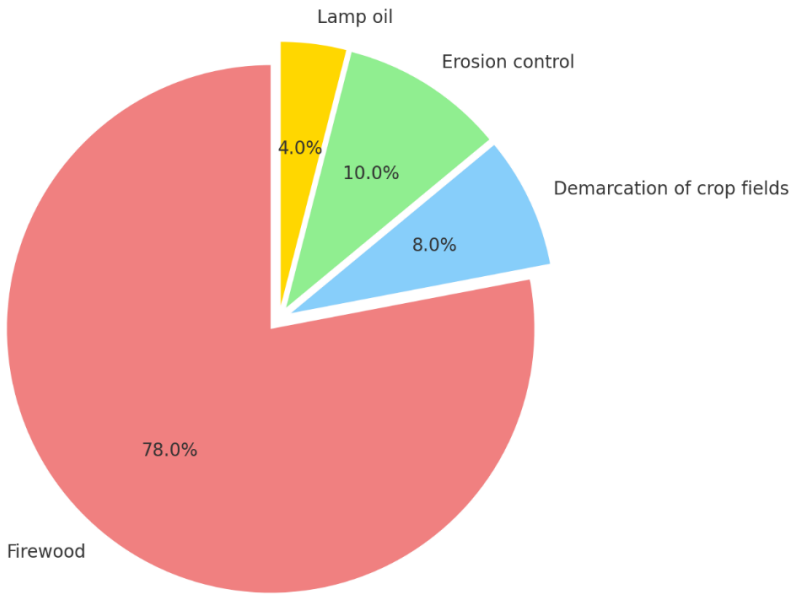

Figure 16. Relative frequency of other uses of oleaster.

(n = 310), and only 6.1% (n = 20) involved associations with other plants. It is employed alone likely for its pharmacological effects (Mansour *et al*. 2023, Soldo *et al*. 2024, Zaouani *et al.* 2018). In contrast, cosmetic uses show a balanced situation: 13 individuals used oleaster while 10 mixed it with other plants to obtain a synergic effect making the smell and skin-care benefits better (Bekdache 2018). This distribution shows that people use oleaster differently depending on their purposes (Figure 17).

Using and preserving oleaster

Forms of Oleaster Use

The graph shows that more than 300 people (71.42%) prefer to use oleaster in its fresh form. In contrast, the dried forms, whether sun-or shade-dried are used only by a small minority of respondents (28.58%). This strong preference for using fresh oleaster may reflect the existing knowledge and beliefs about its effectiveness, as suggested by Baccouri *et al.* (2022)

and Soldo *et al.* (2024). In contrast, the limited use of dried forms could be linked to a lack of experience with drying techniques (Figure 18).

Methods of preservation

The majority of respondents reported storing the oleaster in the shade (n=275 ; 65.16%). Other methods, like storing it in vials (n = 59; 13.98%) or plastic bags (n = 45; 16.66%), are less mentioned. Methods like exposure to light, storage in paper or herbarium form are rare (10.42%). This preference for shade storage is probably because it helps maintain the quality and stability of Oleaster materials avoiding damage from light and heat (Bueno *et al*. 2023) (Figure 19).

Relationship between use form and preservation methods

CA shows no association between oleaster use form and preservation practices. The first axis (Dim 1) explains 78.8% of the total variance, demonstrating a strong opposition between traditional drying techniques and general storage methods. The Sun-dried and Shade-dried group indicates that preservation choices are strongly linked to the use of dried plant material. In contrast, Plastic bags, Paper bags, and Vials are positioned on the opposite side of the plot, suggesting that they are preferentially associated with fresh and short-term storage. The second axis (Dim 2), represents 21.2% of the variance, giving additional differentiation among the storage options: Vials appear more distinct from bags, reflecting a more specific storage. Overall, the CA indicates that fresh use and dried use link to different preservation methods, while sun and shade drying are clearly distinct (Figure 20).

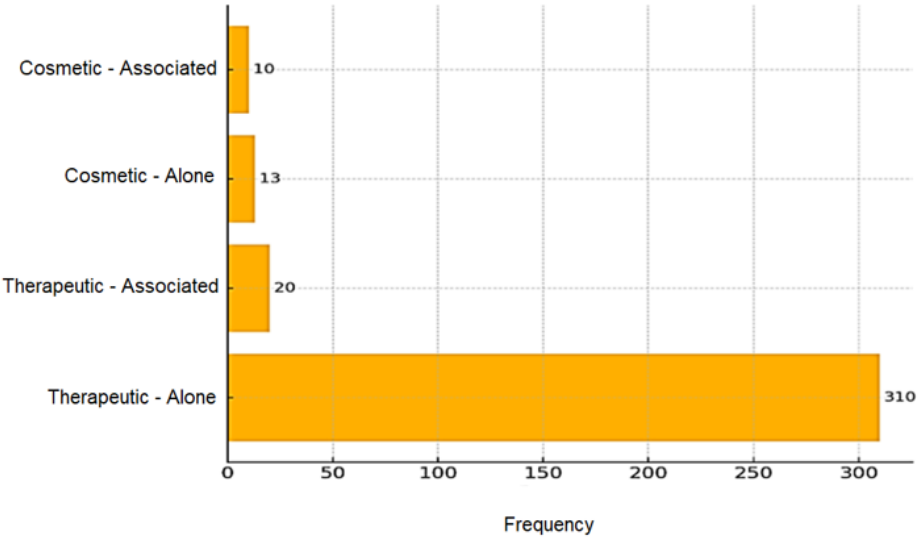

Figure 17. Distribution of oleaster usage modes across therapeutic and cosmetic domains.

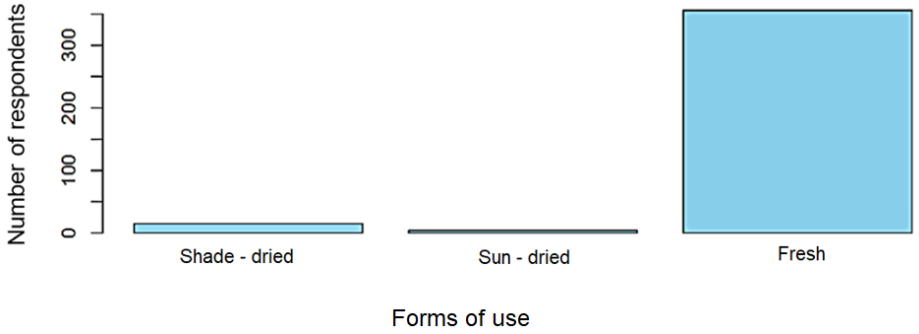

Figure 18. Forms of oleaster used by respondents.

Seasonal use of oleaster

The results show that 28.5% of people use oleaster all year, while 28.2% use it mainly in summer. Autumn (18.4%) and winter (15.8%) were mentioned less often, even though these seasons are important for harvesting and treating common seasonal diseases. Spring was the least season reported (4.8%). In general, oleaster is used all year, but it is used more in the summer (Figure 21).

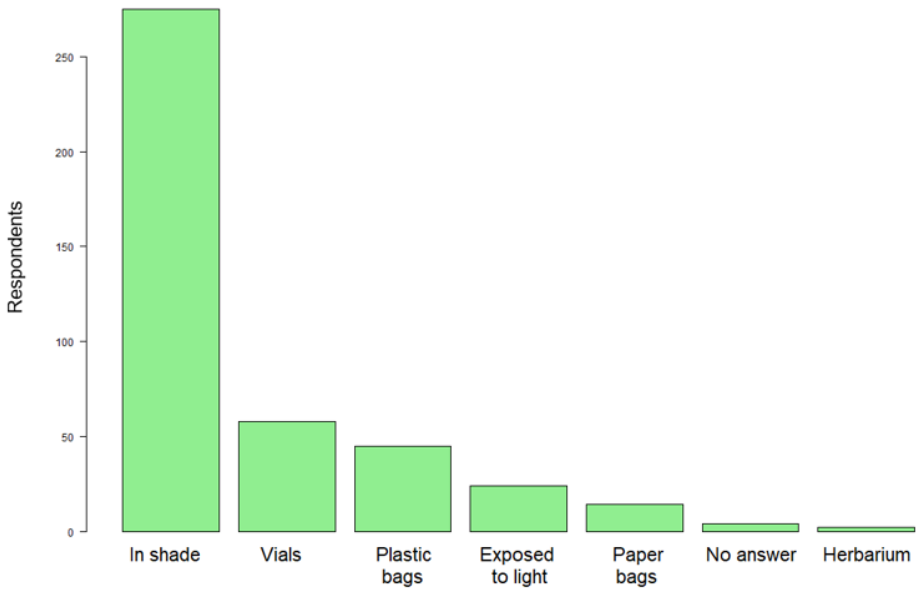

Figure 19. Preservation methods used for oleaster by respondents.

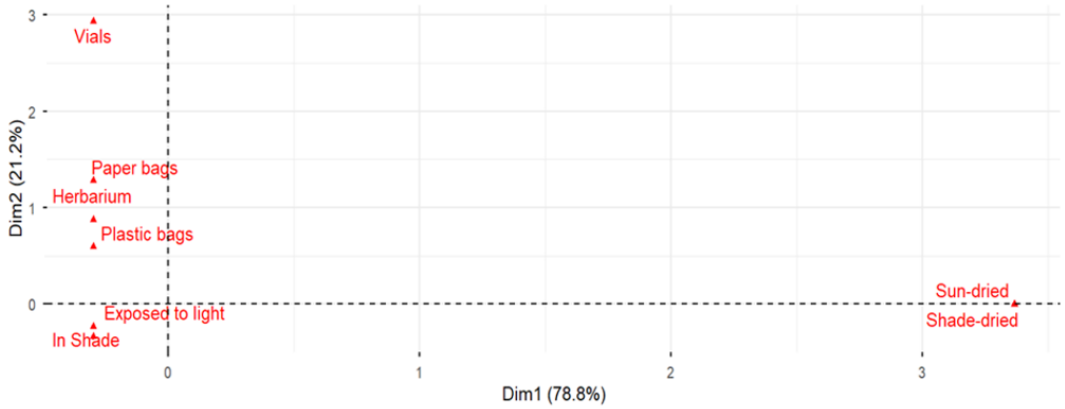

Figure 20. Correspondence analysis biplot showing the association between preservation methods and plant use form.

Plant parts and preparation techniques of oleaster

Plant parts used by domain

The choice of plant parts varies by domain of use. In agriculture, the whole plant is most used (64.3%), mainly in the grafting practices. In cosmetics and culinary uses, fruits dominate 76.1% and 95%, respectively due to their richness in lipids and antioxidants useful for skincare (Gacioui *et al*. 2013) and for their nutritional and flavor qualities (Irakli *et al.* 2024). In therapeutic applications, leaves are the most used part (55.3%), because of their high content of bioactive and medicinal compounds (Ahmad *et al*. 2022). In general, people select different parts of the plant for different purposes (Figure 22).

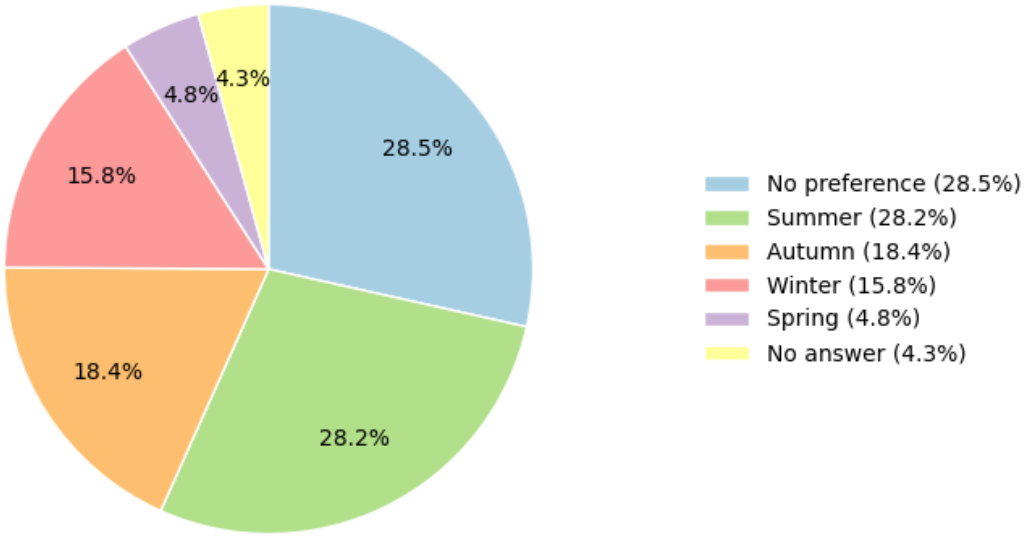

Figure 21. Seasonal preferences in the consumption of oleaster.

Preparation methods

Preparation methods vary by domain. Olive oil is the dominant form in food (90%) and cosmetics (80%). For therapeutic uses, people use diverse methods: decoction (45%) is the most frequently mentioned, followed by cooked plant (17%), infusion (15%), and raw plant (12%). Other methods (maceration, fruit salad, powder, poultice, and juice) are less cited (<10%). This suggests that food and cosmetic uses depend on oil preparations, while therapeutic practices use multiple methods for different health problems (Belarbi *et al*. 2011) (Figure 23).

Administration and dosage of oleaster

Routes of administration

The results show that the routes of administration vary by domains. In the food use, administration is essentially oral (100%). In cosmetics, the main routes are massage (75%), scalp massage (50%), and skin application (25%) for hair and skin care. The Therapy field shows the most variety, with internal routes such as oral intake (50%) and chewing(50%), and external ones

like rinsing (40%), gargling (25%), and topical use (20%). This diversity shows how therapeutic practices choose the route of administration adapting it to the type of treatment required (Figure 24).

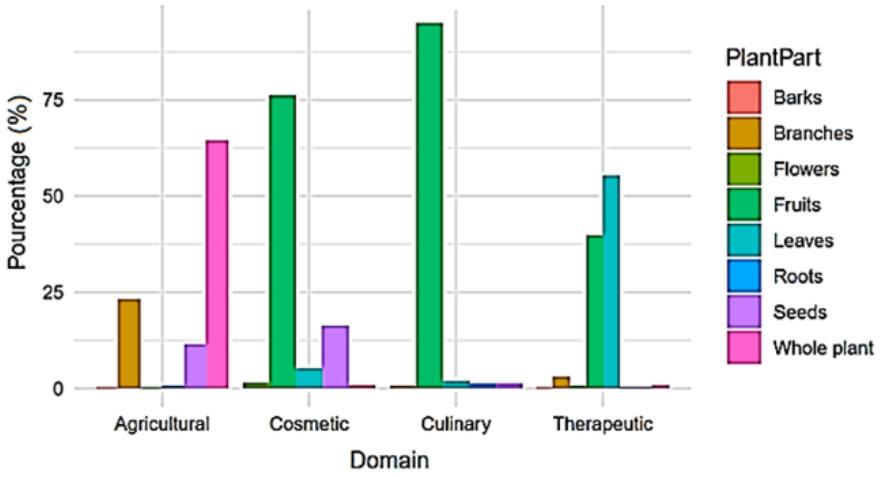

Figure 22. Comparative use of plant parts by application domain.

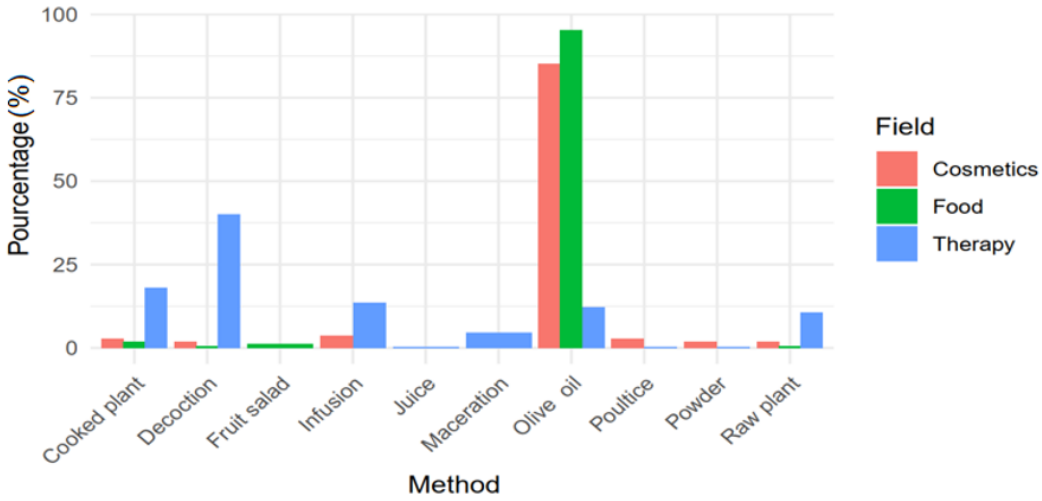

Figure 23. Distribution of preparation methods by fields.

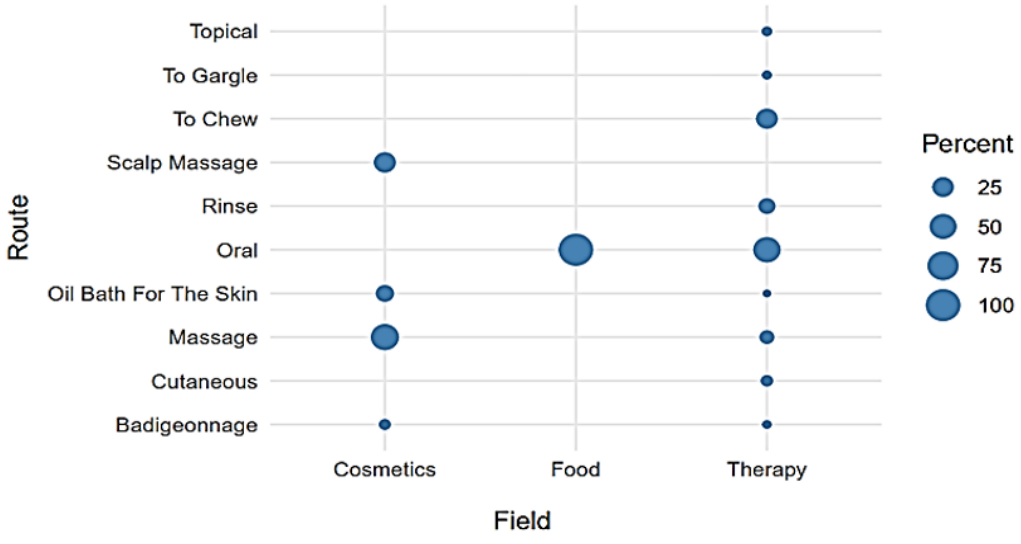

Figure 24. Administration routes according to application domain.

Type of dose

The results demonstrate that all respondents (100%) report non-precise doses (NPD), none report precise doses (PD), for therapeutic and cosmetic uses. In therapy, glass and handful are the most cited measures, whereas in cosmetics, a spoon and a drop are the most frequent. This shows that oleaster is usually used without exact measurements, so further research is needed to propose a clear and safe dosage.

Frequency of use

The study shows that people of all ages prefer taking oleaster once a day. Among adults, 72% use it for therapeutic purposes (320 responses), while 19% use oleaster for cosmetics (85 responses). For older adults, there are 170 therapeutic responses (65%) against 40 cosmetic responses (15%). Among children, 65% use it for therapeutic (170 responses) while 15% use it for cosmetic purposes (40 responses). Across all age groups, less than 10% reported taking oleaster two or three times a day in both domains (Figure 25).

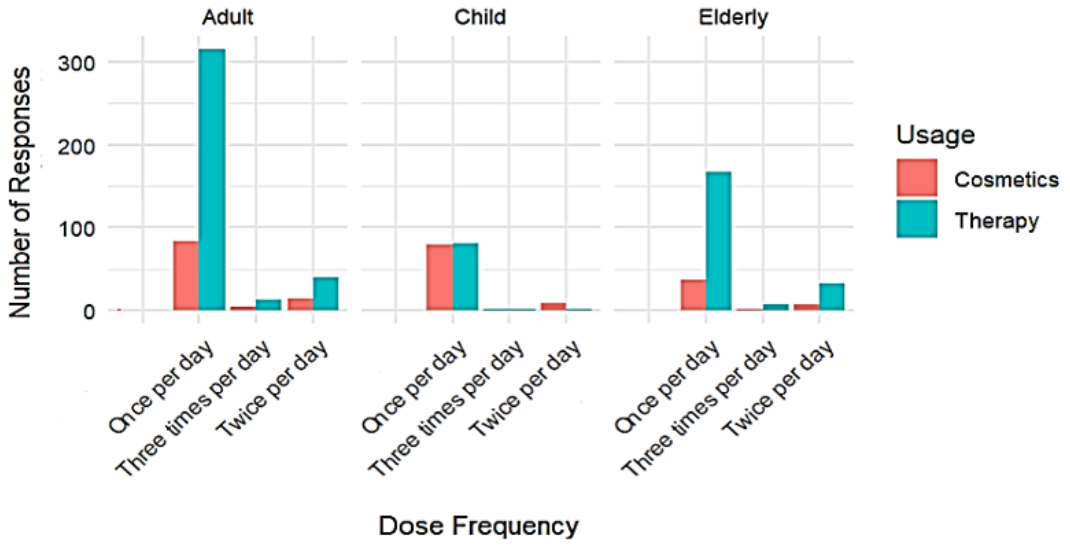

Figure 25. Dose frequency by age group and domains

Duration and timing of oleaster use

The results show that people mostly use oleaster in therapy until full recovery (39%), for three days (34%), or for one week (33%). In cosmetics, 52% use oleaster until recovery, while other durations such as one month or two days are rare. In terms of timing, therapeutic use is concentrated in the morning, especially before breakfast (58%), while cosmetic use is more flexible, with no fixed timing (49%) or use before lunch (27%). In general, therapeutic use is more organized, while cosmetic use is more open-ended (Figure 26).

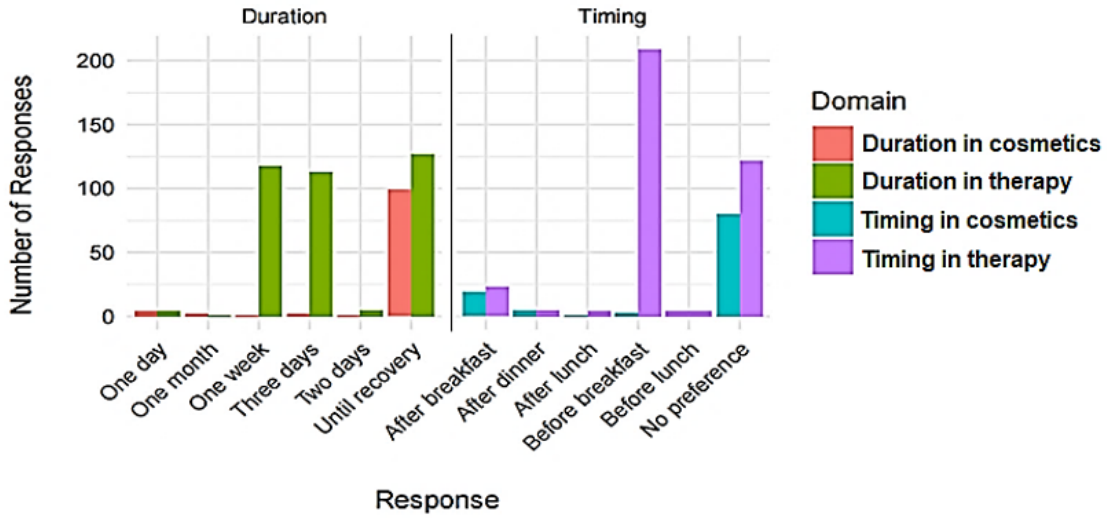

Figure 26. Use timing and duration across domains.

Evaluation of the therapeutic effects of oleaster

The results of this study show that oleaster is generally considered safe by users (Bennani-Kabchi *et al*. 2000, Zaouani *et al*. 2018). In cosmetics, 100% of participants reported no side effects, while in therapeutic use 79% claimed they did not experience any adverse reactions. The few effects reported included hypoglycemia (8%), low blood pressure (4.6%), and diarrhea (3.9%), among others (Figure 27).In addition, only 5% of people who claimed side effects saw a doctor, suggesting that most users feel confident and comfortable using this plant. This finding is supported by several studies indicating the absence of toxicity of oleaster (Bennani-Kabchi *et al*. 2000, Heilman *et al*. 2015). However, safety can vary depending on the method, dose, and duration of use. In fact, some studies have validated the cytotoxic effect of oleaster extracts, especially at high concentrations (Omer *et al*. 2012, Zeriouh *et al*. 2017).

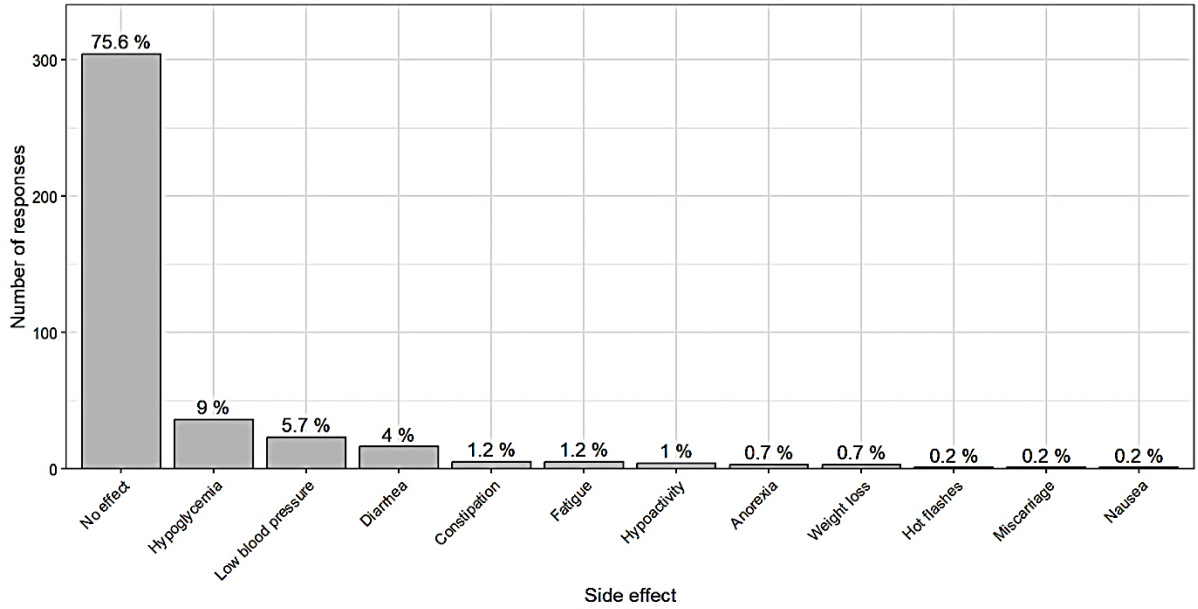

Figure 27.Side effects reported during therapeutic use of oleaster

Moreover, Acar-Tek and Ağagündüz (2020) noted that preparations made from olive leaves are generally safe but may lower arterial blood pressure and blood sugar levels, especially in people taking antihypertensive or antidiabetic medication. These outcomes joined our findings totally. Clinical sources report other side effects (WebMD Editorial Contributor 2024), such as stomach discomfort, diarrhea, headache, dizziness, and allergic reactions. These effects are often associated with excessive use. Of major phenolics like oleuropein and hydroxytyrosol, which are key bioactive compounds in oleaster. In light of these results, oleaster should be used carefully, despite its many health benefits. Overall, our study supports the traditional use of oleaster but highlights the need for further research to confirm its phytochemical properties, safe dosage, and potential risks, especially for people with allergies, pregnant women, and infants (Table 5).

Conclusion

This study is the first ethnobotanical survey conducted in the Fez-Meknes region, demonstrating the significance of the oleaster in Mediterranean culture and daily life. A number of 420 persons were interviewed. The results indicate that gender, age, educational level, marital status, and residential location influence people's knowledge and usage of oleaster. In this study, therapeutic use (30.5%) and agricultural use (28.6%) are the most reported by people, while nutritional, cosmetic, and industrial uses are less cited in local traditions. Many participants use oleaster to treat health problems (such as oral issues, diabetes, and stomach disorders) because it is natural and seen as safer than chemical medicines. However, some interviewees remain careful about its side effects. Farmers use this wild olive as a rootstock (64.3%) for olive cultivars because it tolerates harsh conditions and resists many diseases, helping grafted olive cultivars produce better yields. Moreover, this survey shows that young people do not know about oleaster and do not use it very much. If this continues, traditional knowledge about this plant may disappear. We need to collect and preserve this knowledge through research and sustainable practices for future generations. To sum up, this study is a first step to understanding how people use oleaster in traditional health practices. It can also be repeated in other Moroccan regions. More studies are required to examine the chemical composition, validate the pharmacological activities and examine the toxicological effects of oleaster.

Table 5. Summary of toxicity studies on oleaster leaf extracts.

Biological activity	Plant material	Extract type	Key findings	Reference
Acute oral toxicity	Leaves	Aqueous extract	-No mortality or toxicity observed at 2000 mg/kg. -LD_{50} > 2000 mg/kg →considered safe.	Zaouani *et al*. 2018
Sub-chronic toxicity	Leaves	Aqueous extract (Decoction at 10%)	-No mortality or signs of toxicity observed during 3 months of treatment. -Safe at administered dose (1.5 mL/100 g body weight). -Increasing of metabolic parameters.	Bennani-Kabchi *et al.* 2000
Sub-chronic toxicity	Fruits	Polyphenol	-No mortality or clinical toxicity. -No changes in body weight or food intake. -Normal hematological and biochemical Parameters. -No liver or kidney dysfunction. -Normal organ weights and histopathology → considered safe.	Heilman *et al* . 2015
Sub-chronic toxicity	Leaves	Aqueous extract (0.2-0.9%)	-No mortality or clinical toxicity observed. -High doses (0.9%) induced hematological alterations and mild to moderate liver and kidney histopathological changes, indicating dose-dependent toxicity.	Omer *et al*. 2012

Declarations

List of abbreviations: WO-wild olive; FL-Fidelity Level; ICF- Informant Consensus Factor; CA-Correspondence Analysis; MCA-Multiple Correspondence Analysis; HCPC- Hierarchical Clustering on Principal Components; NPD- Non-Precise Doses; PD-Precise Doses; KO-Knowledge of Oleaster; UO-Utilization of Oleaster

Ethics approval and consent to participate: This survey was conducted with permission from regional and local authorities in the Fez-Meknes region and followed the International Society of Ethnobiology Code of Ethics (ISE, 2006). Participation was voluntary, and informed consent was obtained from all respondents.

Consent for publication: Not applicable

Availability of data and materials: Not applicable

Competing interests: The authors declare no competing interests

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Author contributions: Mohamed Maai collected the data, made the analysis, and wrote the first draft. Amal Nissmouya and Tarik Moubchir supervised the work, supported the interpretation, and revised the manuscript. Ilham Zahir and El Hassan Sakar guided the manuscript from the first draft to the final version, ensuring integral coherence and making the necessary corrections.

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Appendix - Questionnaire (Table 1S)

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Polydisciplinary Faculty of Beni Mellal

Applied Biology for Health, Environment and Sustainable Development Team

Ethnobotanical Assessment of Traditional Knowledge and Uses of Oleaster (*Olea europaea* var. sylvestris) in the Fez-Meknes Region(Morocco)

This is survey is conducted as part of a doctoral study on the valorisation of the oleaster (*Olea europaea* subsp. *europaea* var. *sylvestris*), with the objective of documenting indigenous knowledge and ethnopractices associated with this species in the Fez-Meknes region. All responses are confidential and used only for research purposes. Thank you for your participation.

Location:	Date:	Questionnaire N°:.....

A. Sociodemographic factors

1- Interviewee Profile:

☐ Herbalist ☐ Farmer ☐ Healer ☐ Consumer ☐ Other(specify):.....

2- Age: .....

3- Sex: ☐ Male ☐ Female

4- Education level: ☐ Illiterate ☐ Primary ☐ Secondary ☐ University ☐ Non-formal

5- Marital status: ☐ Single ☐ Married ☐ Divorced ☐ Widowed

6- Place of residence: ☐ Urban ☐ Rural ☐ Other (specify): .....

B. General Knowledge

1- Have you ever heard of the oleaster (wild olive)? ☐ Yes ☐ No

2- Have you ever used it? ☐ Yes ☐ No

3- Do you know different types/varieties of oleaster? ☐ Yes ☐ No

- If yes, please specify: .....

C. Domain of utilization

1- Therapy

☐ Diabetes ☐ Wound healing ☐ Lipid disorders ☐ Gastro-duodenal disorders ☐ Diarrhea ☐ Constipation ☐ Gallstones ☐ Respiratory conditions ☐ Cough ☐ Flu ☐ Fever ☐ Cardiovascular diseases ☐ Hypertension ☐ Oral diseases ☐ Skin conditions ☐ Urinary disorders ☐ Genital conditions ☐ Oropharyngeal conditions ☐ Rheumatologic diseases ☐ Parasitic infections ☐ Ocular conditions ☐ Inflammatory diseases ☐ Cancer ☐ Renal disorders ☐ Liver disorders ☐ Obesity ☐ Viral diseases ☐ Fungal infections ☐ Bacterial infections ☐ Human infertility ☐ Nose bleeding ☐ Back pain ☐ Hemorrhoids ☐ Animal diseases ☐ Other (specify):.....

2- Cosmetic

☐ Hair care ☐ Skin/face/body lotion ☐ Perfumes / natural aromas ☐ Other (specify):.....

3- Agriculture

☐ Rootstock ☐ Fodder ☐ Pollination ☐ Ornamental plant ☐ Shade plant ☐ Other (specify): …..

4- Food

☐ Olive oil ☐ Olives ☐ Other (specify): .....

5- Industry

☐ Paper manufacturing ☐ Carpentry ☐ Handicraft manufacturing ☐ Wood exportation ☐ other…….

6- Other traditional uses:

☐ Lamp oil ☐ Firewood ☐ Other (specify): ……..

7- Mode of use (Single or Combined)

Domain	Used alone	Used in combination with other plants
In therapy	……	……
In cosmetic	……	……

-If combined, which plants? .....

- Form of the plant used: ☐ Fresh ☐ Dried

- If dried, which drying method? ☐ Exposed to sunlight ☐ In the shade ☐ I do not know

8- Conservation method

☐ Kept away from light ☐ Exposed to light ☐ Stored in bottles ☐ Stored in plastic sachets

☐ Stored in paper sachets ☐ Herbarium ☐ Other (specify): .....

9- Season of collection

☐ Winter ☐ Spring ☐ Summer ☐ Autumn ☐ All year round ☐ No preference ☐ I do not know

10- Plant part(s) used

☐ Leaves ☐ Stems ☐ Roots ☐ Flowers ☐ Fruit ☐ Shoot ☐ Seeds

☐ Buds ☐ Bark ☐ Wood ☐ Whole plant ☐ Stems- Twigs ☐ Other: …….

In therapy… In cosmetics……. In agriculture…. In food……. Other…….

11- Form(s) of use

☐ Powder ☐ Essential oil ☐ Vegetable oil ☐ Extract ☐ Infusion ☐ Decoction

☐ Juice ☐ Raw form ☐ Other (specify): .....

In therapy……. In cosmetics……

12- Preparation method

☐ Raw plant ☐ Cooked plant ☐ Infusion ☐ Decoction ☐ Maceration ☐ Olive oil

☐ Juice ☐ Powder ☐ Diffusion ☐ Cataplasm ☐ Fumigation ☐ Fruit salad ☐ Other:……

In therapy……. In cosmetics……. In food……..

13- Route of administration

☐ Oral ☐ Rinse ☐ Gargling ☐ Topical application (skin) ☐ Chewing

☐ Inhalation ☐ Oil bath for skin ☐ Cutaneous application ☐ Scalp massage ☐ Massage

☐ Rectal ☐ Nasal or ocular drops ☐ Other:……..

In therapy……. In cosmetics……. In food……

14- Dosage used

- In therapy and cosmetic (approximate/traditional= DNP):

☐ Pinch ☐ Handful ☐ Spoon ☐ Drop ☐ Glass ☐ Other: .....

- In therapy and cosmetic (precise = DP):

☐ g / glass ☐ g / liter ☐ Other (specify): .....

15- Frequency of administration

☐ Once per day ☐ Twice per day ☐ Three times per day ☐ Other: .....

In therapy..... In cosmetics.....

16- Time of intake / application

☐ Before breakfast ☐ After breakfast ☐ Before lunch ☐ After lunch

☐ Before dinner ☐ After dinner ☐ No preference ☐ Other: .....

In therapy..... In cosmetics.....

17- Duration of treatment

☐ One day ☐ Two days ☐ Three days ☐ One week

☐ One month ☐ Until recovery ☐ Other:.....

In therapy..... In cosmetics.....

18- Perceived effectiveness

☐ Satisfactory result ☐ No result ☐ Harmful result ☐ Other:.....

In therapy..... In cosmetics.....

D. Toxicity assessment

1- Is the plant considered toxic? ☐ Yes ☐ No ☐ I do not know

- If yes, which side effects were observed?

☐ Fatigue ☐ Hypoactivity ☐ Abdominal swelling ☐ Diarrhea ☐ Hypotension ☐ Anorexia ☐ Constipation

☐ Weight loss ☐ Miscarriage ☐ Renal disturbance ☐ Hepatic disturbance ☐ Other (specify):.....

2- After the appearance of side effects, did you consult a doctor? ☐ Yes ☐ No

3- What advice would you give to users of oleaster?.....