



# Ethnobotanical study of *Silybum marianum* (L.) Gaertn in the Taounate Region (Northern Morocco): Knowledge and Use of the Plant for Food and Medicinal Purposes

Boutaina Louafi, Chaimae Slimani, Aymane Bessi, Chaimae Rais, Lahsen El Ghadraoui and Meryem Benjelloun

## Correspondence

**Boutaina Louafi\*<sup>1,2</sup>, Chaimae Slimani<sup>1</sup>, Aymane Bessi<sup>1,2</sup>, Chaimae Rais<sup>2</sup>, Lahsen El Ghadraoui<sup>1</sup> and Meryem Benjelloun<sup>1</sup>**

<sup>1</sup>Laboratory of Functional Ecology and Environmental Engineering, Faculty of Sciences and Technology, Sidi Mohamed Ben Abdellah University, Fez, 30000, Morocco

<sup>2</sup>Laboratory of botany, National agency of Medicinal and Aromatic Plants, Taounate 34025, Morocco

\*Corresponding Author: Boutainalouafi@gmail.com

**Ethnobotany Research and Applications 28:25 (2024)** - <http://dx.doi.org/10.32859/era.28.25.1-11>

Manuscript received: 10/10/2023 - Revised manuscript received: 26/01/2024 - Published: 29/02/2024

## Research

### Abstract

**Background:** in order to highlight the knowledge and use of *Silybum marianum* (L.) Gaertn plant, an ethnobotanical investigation was carried out amongst Taounate local population. This study aims at raising the degree of valorization of the plant studied by the local population of this region.

**Methods:** An ethnobotanical survey was conducted amongst the population of some communes of Taounate region between October and December 2022. The survey was conducted in the study area on a sample of 121 people of different age categories, gender, educational level, and socioeconomic level.

The data was collected through detailed and well-structured questionnaires. It was statistically analyzed using SPSS software (IBM SPSS Statistics version 26).

**Results:** The results of our study indicate that the knowledge and use of *Silybum marianum* (L.) by the local population of the rural and urban communes of Taounate province remains very limited. The Pearson chi-square test carried out showed the existence of a statistically significant correlation between the different variables studied. This means that there is a correlation between these variables that is not simply due to chance. That is, we found a strong significant relationship between Age and knowledge of the *S. marianum* plant. This may indicate that older individuals generally have a more knowledge of *S. marianum* than younger people. Similarly, we found that there was a strong relationship between educational level and knowledge of *S. marianum*. This may suggest that people with higher levels of education are more likely to have a deeper understanding of the plant. Finally, we found that there was a significant relationship between socio-economic level and the use of our plant. This suggests that people with a low socio-economic level tend to use the *S. marianum* plant more frequently than those with a higher socio-economic level.

**Conclusions:** The study revealed that *Silybum marianum* (L.) Gaertn. remains among the most neglected species in Morocco. Scientific data and research on this plant remain rare despite its economic and therapeutic virtues.

**Keywords:** Ethnobotanical, medicinal plants, *Silybum marianum* L., Socio-economic, Taounate, Morocco

## Background

*Silybum marianum* (L.) Gaertn is an annual or biennial plant belonging to the *Asteraceae* family, (Pereira et al. 2013) used for more than 2000 years in traditional European medicine (Morazzoni et al. 1995, Sewell RDE et al. 2014). In classical medicine, it is used for the prevention and treatment of various liver disorders (hepatitis, cirrhosis, gallstones, jaundice...) (Fraschini et al. 2007), as well as in the regeneration of damaged of liver tissues (Benchachouaa 2019).

The medicinal properties of *S. marianum* are due to the presence of silymarin which is responsible for most of the therapeutic effects of this plant (Kroll et al. 2007, Braun & Cohen 2010, Svobodova et al. 2006, corchete 2008).

Milk thistle and silymarin were used as a complementary treatment for cancers and as a hepato-protective agent (Bahmanet al. 2015, Rafieian-Kopaie et al. 2012). As a matter of fact, silymarin can protect liver cells during chemotherapy recognized for its aggressiveness on the liver. Thus, the studies approve the usefulness of silymarin to improve the effectiveness of treatments that aim at slowing the growth of tumors (Kumaraguruparan & Rajesh 2008).

Some studies tend to demonstrate the positive effect of silymarin on type 2 diabetes. They have shown an improvement glycemia control and a reduction in cholesterol blood level (Wu CH et al. 2011, Brodniewicz et al. 2012, Velussi & Cernigoi 1997).

In Morocco, medicinal and aromatic plants represent an economic alternative (Betaf 2021). Morocco has a rich and diverse biodiversity consisting of more than 4200 species. Of these, 600 of the total flora of Morocco are exploited as medicinal and aromatic and medicinal plants. (fennane 1998, Hafsé et al. 2013, Aafi 2009). Among others, there is *S. marianum*, known as the milk thistle.

An ethnobotanical study was carried out among the population of the Taounate region. The main objective of this study is to identify the extent to which the local population of the region values the *S. marianum* plant. Based on a range of data, we determined the level of knowledge and use of *S. marianum* and we identified the medicinal and culinary use of *S. marianum* in the region to characterize the methods of use and the parts used to understand the therapeutic use and to determine the toxicological risks.

Our aim is also to document exhaustively the ethnomedical information of the population of the Taounate region on *S. marianum* in order to create a database on this medicinal plant and its traditional uses.

Based on the literature review, we also documented the ethnomedical use of the plant in other regions, the composition and biological properties of this medicinal plant.

This ethnobotanical study can be a valuable source of information for scientific purposes.

## Materials and Methods

### Study area

Taounate is located in the Northern part of Morocco and covers an area of 5585 km<sup>2</sup> within the Fez-Meknes region. It borders the regions of Hoceima and Chefchaouen to the North, Taza to the East, Ouezzane and SidiKacem to the West, and Fez to the South (Fig. 1). The territory of Taounate region is managed by administrative sectors consisting of four circles (Tissa, Taounate, Ghafssai and Karia Ba Mohamed), five Pacheliks (Taounate, Tissa, Taher Souk, Ghafssai and Karia Ba Mohamed), five urban communes (Taounate, Tissa, Taher Souk, Ghafssai and Karia Ba Mohamed), and forty-four rural communes.

The Mediterranean climate of Taounate has two seasons, one humid and cold, and the other warm and dry. Temperatures can reach 45°C during the summer and the average rainfall in a year is 790 mm. The region of Taounate is one of the wettest regions with a maximum that can sometimes reach 1800 mm in Jbel Outka (Table 1).

Table 1. Average monthly precipitation recorded at reference weather stations

Name of the station	Rainfall amounts received(mm)							Total (mm)
	year 2021				year 2022			
	Sep	Oct.	Nov.	Dec	Jan.	Feb	Mar	
Outka	3.2	0	157.4	116	18.6	24.8	201.3	521.3
Assfalou	11.20	14.00	41.80	43.20	7.60	22.50	103.80	244.10

(The data concerning the study area was provided by national water and forestry agency of Taounate)

The participants of this study are from Taounate region belong to different rural and urban communes (Taounate, Ghafssai, Karia Ba Mohamed, Ain Aicha, Ourtzagh, and Khelalfa) (Fig. 1).

Before starting the actual survey, a preliminary study was necessary to obtain the relevant elements and questions for the preparation of a detailed questionnaire. This pre-survey allowed us to contact the local officials, resource persons and local population.

The ethnobotanical study was carried out during the period from 01/10/2022 to 25/ 12/2022 using the Closed-ended questionnaire. This latter, was divided into two parts: the first part concerns the participants' personal information including gender, age, educational and socio-economic levels. The second part concerns the ethnobotanical characteristics of *S. marianum* (knowledge of the plant, use and consumption of the plant, harvest period, preparation method, administration method, side effects...)

The survey was carried out in a random way; respondents were invited to answer in a voluntary and anonymous way.

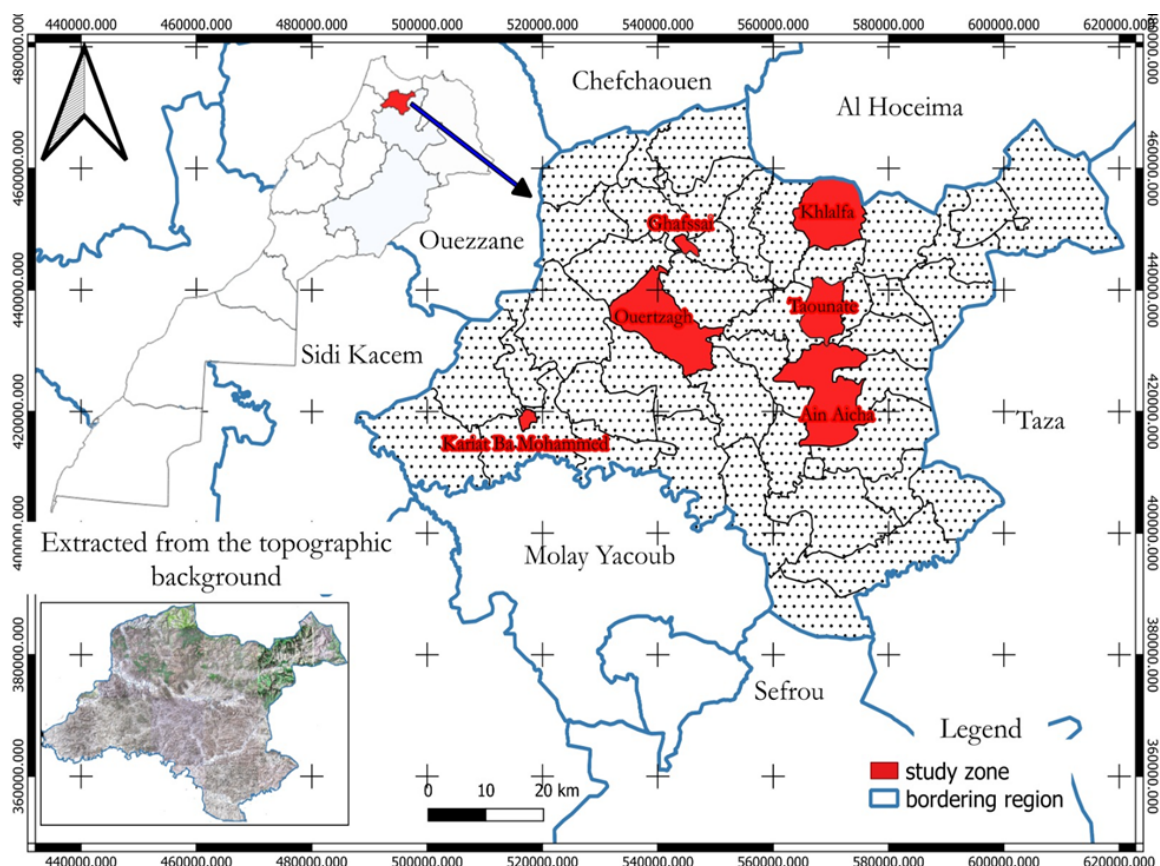


Figure 1. Location map of the study area (QGIS). –The maps designed by QGIS software version 3.26.3.

#### Data Analysis

The data collected from the survey were digitally processed and statistically analyzed using SPSS version 26 software (Statistical Package for the Social Sciences).

In order to check the correlation between the variables (age, gender, education level, and socio-economic level) and knowledge/use of the plant, we adopted the Pearson's chi-square test.

#### Pearson's Chi-Square statistical test:

The chi-square test was developed by Karl Pearson

The term chi-square test covers many statistical tests:

- Fit Test
- Independence Test
- Homogeneity test

In our study, the test that interests us is the  $X^2$  independence test. This test is used to verify the existence or not of a significant relationship between two nominal variables (X, Y) within our population.

The Null Hypothesis (H0) of the Chi-square test is as follows:

H0: the two variables X and Y are independent

H1: the two variables X and Y are dependent

The calculated chi-square expression:

$$X^2 = \sum \frac{(O - E)^2}{E}$$

With:

$X^2$ : the calculated Chi-square value

O: the observed number of people

E: the expected number of people

As soon as the value is calculated, it must be compared with the theoretical Chi-square value from the Chi-square distribution corresponding to our calculated degree of freedom value (Annex 1).

#### **Degree of freedom:**

In statistics, the degree of freedom (ddl) refers to the number of random variables that cannot be determined or fixed by an equation

$$ddl = (I-1) (J-1)$$

Where:

ddl: Degree of freedom

I: Number of values/modalities or categories of X. (Number of lines)

J: Number of values/modalities or categories of Y. (Number of columns).

If the calculated chi-square < theoretical chi-square H0 is accepted

If the calculated chi-square > theoretical chi-square H0 is rejected

Once the correlation between two variables has been established, the Cramer's V coefficient or phi coefficient (Akoglu2018) can be used to measure the intensity of the correlation using SPSS software.

## **Results**

### **Study population of the survey**

The survey was carried out among the population living in the different rural and urban communities of Taounate region, with a total number of 121 participants.

### **Profile of persons surveyed**

#### **Age**

In the study area, most of the participants surveyed belong to the age group [30-50 years] (33.88%), followed by the participants over the 60 (28.10%), then age groups [18-30 years] and [50-60 years] with a percentage of 14.05 %, while participants under the age of 18 come last (9.92%) (Table 2).

#### **Gender**

The majority of the survey interviewees are men with 64.46%, and 35.54% of women (Table 2).

#### **Education level**

In the Survey Area, we targeted different education level (Table 2): the participants being mostly illiterate (48.76%), followed by primary school level (29.75%) and secondary school level (12.40%), and the participants with a university level were the least interviewed.

#### **Socio-economic level**

The participants with low socio-economic level had the highest percentage (69.42%) compared to the other category (Medium (30.58%), High (0%)) (Table 2).

Table 2. Socio-demographic profile of the province of Taounate

	Group	Number	Percentage (%)
Gender	<b>Men</b>	78	64.64
	<b>Women</b>	43	35.54

Age	>60	34	28.10
	[50-60]	17	14.05
	[30-50]	41	33.88
	[18-30]	17	14.05
	<18	12	9.92
Education level	Illiterate	59	48.76
	Primary	36	29.75
	Secondary	15	12.40
	University	11	9.09
Socio-economic level	Highest	0	0
	Medium	37	30.58
	Lowest	84	69.42

### Knowledge of *S. marianum*

The results of the survey indicate that people who did not know the *S. marianum* plant had the highest percentage (54.5%) compared to those who knew the plant (45.5%).

### Correlation and relationship between variables and knowledge of *S. marianum*

#### Knowledge of *S. marianum* by Taounate local population according to age

The results indicated that in Taounate region, people over 60 years (67.65%) know the plant of *S. marianum* more than other categories; ([50-60 years] (47,06%), [30-50 years] (36,59%), [18-30 years] (41,18%), <18 (16,67%)) of age.

According to the results of chi-square statistical test ( $X^2$ ) and using SPSS software, we obtained a significant P-value lower than 0.05 ( $0.01 < 0.05$ ). As a result, we reject the hypothesis  $H_0$  and accept the hypothesis  $H_1$ . This means that there is a significant relationship between the knowledge of *S. marianum* and the age.

This is confirmed by comparing the calculated and theoretical Pearson's  $X^2$  values. We found that calculated Pearson's  $X^2 = "12.209" >$  theoretical Pearson's  $X^2 = "9.49"$

The Survey shows that older people have a better knowledge of *S. marianum* plant than younger people. This can be justified by the fact that older people have the essential knowledge about aromatic and medicinal plants. It can be concluded that the transmission of this knowledge from one generation to another is endangered and not always guaranteed.

#### Knowledge of *S. marianum* by Taounate local population according to gender

Knowledge of the *S. marianum* plant varies by gender; women know the plant slightly more than men. Our survey showed that 46.51% of women know the plant while (55.49% of men do not know the plant).

Based on the results of the chi-square ( $X^2$ ) statistical test, we obtained a significant p-value higher than 0.05 ( $0,862 > 0,05$ ). Therefore, the hypothesis  $H_0$  is accepted. That is to say, the gender and the knowledge of *S. marianum* are independent.

#### Knowledge of plant *S. marianum* by the local population of Taounate according to socio-economic level

According to the interpretation of our results (Fig. 2), we note that 42.86% of the population surveyed, who have a low socio-economic level, know the plant *S. marianum*, and 51.35% of the population surveyed who have an average socio-economic level confirm their knowledge of our plant.

These results indicate that the knowledge of the plant and the socio-economic level are independent variables, and this was confirmed by the chi-square test ( $X^2$ ). In fact, the results of SPSS software show that the p-value is higher than 0.05 ( $0.387 > 0.05$ ), so the hypothesis  $H_0$  was accepted.

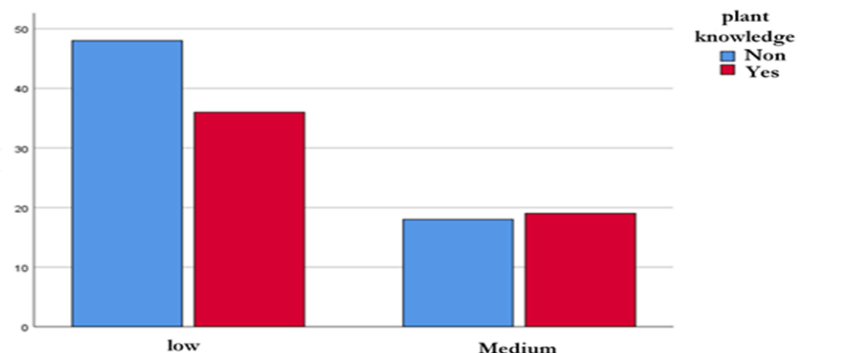


Figure 2. Bar chart: plant knowledge by socio-economic level

*Knowledge of S. marianum by Taounate local population according to the educational level*

In Taounate, it was noted that illiterate participants had the highest percentage of knowledge of *S. marianum* 58.62%, compared to the other categories. (Fig. 3).

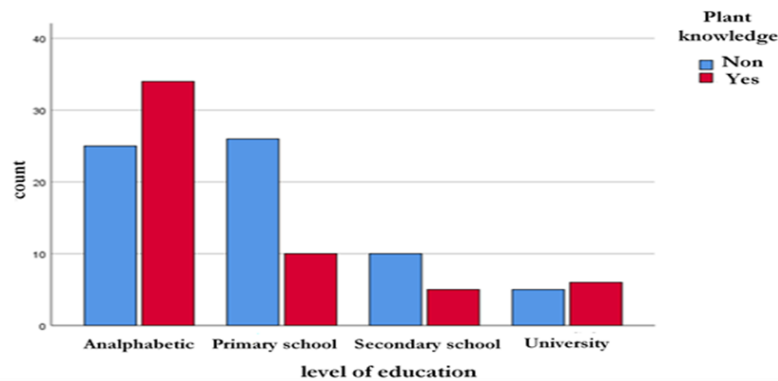


Figure 3 Bar chart: knowledge of the plant according to educational level

The chi-square test revealed a p-value of less than 0.05. Therefore, we rejected the H0 hypothesis, and affirm that there is a significant relationship between the educational level and the knowledge of the studied plant. This is also verified by comparing the calculated chi-square value (9,319) with the theoretical chi-square value (7.82) (Annex 1), with 3 as degree of freedom ( $7.82 < 9,319$ ).

Since the correlation between the two variables is established, we calculated the Cramer's V coefficient using SPSS software to measure the intensity of the correlation. According to the results, we have observed that the calculated value is 0.278, and this means there is an average intensity relationship between our two variables (Annex 2).

Based on our study, we can conclude that the knowledge of *S. marianum* is not only related to the transmission of knowledge or the nature of work (most of the illiterate people interviewed are farmers). Indeed, the more an individual reaches higher education, the more educated he or she becomes in various fields such as the domain of botany.

**Use of *S. marianum* by Taounate population**

The ethnobotanical survey conducted among the local populations of the Taounate region indicates a low share of use (15.70%). This means, among the people who know the *S. marianum*, only 34.54% use of this plant.

In order to correctly interpret our results, we analysed the use of the plant according to our variables (age, gender, educational and socio-economic level) using the chi-square statistical test and the SPSS software.

NB: the percentages quoted in the discussion are based on those who know the plant (55 participants).

*By age*

The chi-square test carried out showed that the use of the plant does not depend on age since we obtained a p-value (p-value=0.659). (We accepted H0) i.e. there is no significant relationship between age and the use of *S. marianum*.

*By gender*

The use of the *S. marianum* plant varies by gender; we have noted a dominance of use by women with 52.64%, whereas 47.36 % for men.

The results of the  $\chi^2$  test indicate that there is no correlation between our two variables, gender, and the use of *S. marianum* plant (p-value=0,218 >0,05).

*By educational level*

The p-value (p-value=0.132) is higher than 0.05, so the null hypothesis H0 is accepted. The use of the plant does not depend on the level of education.

*By socio-economic level*

In the study area, the results of our survey confirmed that there is a significant relationship between the use of the *S. marianum* plant and the socio-economic level. This is indicated by the comparison between the calculated Pearson's chi-square value and the theoretical chi-square value corresponding to ddl=1 (calculated chi-square=7.406 > theoretical chi-square=3.84) (Annex 1).

Since the correlation between the socio-economic level and the use of the *S. marianum* (plant is established, we calculated the Phi coefficient using SPSS software to measure the intensity of the correlation. According to the results, we have observed that the calculated value is 0.367. This value means that there is an average intensity relationship between our two variables.

According to our survey, most of the users of the *S. marianum* plant belong to the low socio-economic level. This can be explained by the fact that the population of low socio-economic level always seeks the exploitation of all available resources either for fodder, food or for phytotherapy use as regenerative income actions to improve their living conditions.

#### **Nature of use and the part used of *S. marianum* plant by the local population in Taounate province**

*S. marianum* is a very widespread plant in Taounate region, but its use by the local population is very limited. This is indicated by the results obtained during our survey. In fact, among of the 121 people surveyed, only 55 ones know about the plant and 19 use it.

#### **Plant part used**

The used part of the plant varies depending on the use. Based on the results the aerial part is used for fodder, the stem and seeds are used for food, and the seeds are also used for medicinal purposes.

Regarding the question asked about the nature of the use, we obtained three answers with a difference in percentage. Most of the users of the *S. marianum* plant use it for fodder only (74%), other categories use it for both food and fodder (21%), and finally the medical use remains in the last position (5%).

#### **Nature of use of *S. marianum***

##### **Food**

Preparation method: Raw

The results of the survey showed that 16% of the users of *S. marianum* consume the stem raw.

In Taounate region, 20% of the participants who use the *S. marianum* plant indicate their effect on milk coagulation. The part used for this purpose is the seeds harvested in May and July.

##### **Medical use**

The survey conducted in the study area showed that only 8% of the users use it for phytotherapy purposes.

Users report their therapeutic effect on digestive disorders: the *S. marianum* plant is used against symptoms of dyspepsia (abdominal pain, vomiting...)

#### **Method of using *S. marianum* to treat digestive disorders**

The interviewees, who consume the plant for its positive effect in curing digestive problems, indicate that it is necessary to infuse milk thistle seeds in boiling water: Seeds should be soaked in boiling water to extract the enzymes, and then it should be drunk to benefit from the plant.

According to the survey conducted with the local population, we found that the majority of our interlocutors who consume the *S. marianum* plant either raw or as an infusion confirm that it has no negative effects.

## **Discussion**

The information collected during our survey highlighted a number of parameters to give a socio-economic status to the *S. marianum* plant.

According to the results of our survey, knowledge and use of this plant remain very limited, despite the richness of the study area in *S. marianum* plants (Plants of the World Online 2023). Moreover, most of our interlocutors consider the *S. marianum* plant as a parasitic plant for which extinction treatment is necessary, which results in a loss of natural resources. This is due to ignorance of the importance of this plant. It is in this context that public awareness is needed. It is essential to recognize and value this plant, not only to preserve the region's cultural heritage, but also to exploit its untapped economic potential which could contribute to strengthening the sustainability and resilience of local communities.

The study also demonstrated that the knowledge and the use of *S. marianum* plant varies according to specific variables. In fact, the study showed that the knowledge of *S. marianum* varies according to age; that is, older people know the *S. marianum* plant more than younger people. The results agree with other surveys carried out in other regions of Algeria, which indicated that there participants over 55 years of age show a high frequency of knowledge of medicinal and aromatic

plants compared to other categories. So there is a high risk of loss of valuable ethnomedical information in the region. (Bouasla & Bouasla 2017, Djamel Miara et al. 2018).

On the other hand, the survey showed the existence of significant relationship between the use of *S. marianum* and the socio-economic level of the participants with a dominance of plant use among people of low socio-economic level. These results are in accordance with other surveys indicated that the use of aromatic and medicinal plants is more frequent among people with low socio-economic level (El-Assri et al. 2021, Merrouni et al. 2021 and Jaddi et al. 2021).

According to our results, 45.5% of the people who know *S. marianum* and only 15.70% of our interlocutors use it, with a distribution of use between fodder 11.57%, food 3.30% and medical use 0.82%. This showed a lack of awareness on the part of the population with regard to this plant, which is less valued despite its richness in bioactive substances (Svobodova et al. 2006).

Furthermore, it has been reported in other studies in Morocco that *S. marianum* stem is used as food item in its raw state (Nassif et al. 2013), and this is very similar to our results.

During our survey, some participants mentioned the effect of the *S. marianum* in milk coagulation. This has been verified and confirmed by a study carried out in Sidi Bel Abbès region of Algeria to obtain and characterize a milk-coagulating enzyme from *S. marianum*. (Benchaachoua 2010).

Other interviewees indicated the therapeutic effect of *S. marianum* seeds on the digestive tube. This finding (Mouzali 2016) showed that *S. marianum* is a medicinal plant that has many anti-emetic, antispasmodic virtues that soothe digestive cramps. Finally, according to the results of our investigation, consumption of the *S. marianum* reported that no adverse effects on health. In comparison with the findings of other research findings in animals, silymarin has no significant side effects, even when it is administered in high doses. In another study involving several thousand patients, very few adverse effects were noted, which were mainly limited to benign gastrointestinal disorders. (Bahmani et al. 2015, Bahmani et al. 2014).

## Conclusion and perspectives

The ethnobotanical study carried out in the region of Taounate revealed a lot of information about the knowledge and use of the *S. marianum* plant by the local population of the region.

It should be noted that there is a link between knowledge of the plant and the profile of the people interviewed. Thus, people over sixty years of age and people with no schooling are the category that knows the most about *S. marianum* and people from a low socio-economic level use the plant more than other categories. It should also be noted that the survey showed that a small percentage of users of the plant use it for medical purposes. therefore, the seeds are the most commonly used parts, infusion is the most frequent method of preparation, and the oral route is the most common method of administration. In terms of the pathologies, the majority of the participants who use the plant indicate their use to treat digestive diseases.

In vivo studies are needed to demonstrate the biological activities of *S. marianum*. In addition, other pharmacological properties should be demonstrated to confirm the therapeutic uses of this plant. Furthermore, a toxicological analysis is required to verify the posology of *S. marianum* extracts. Preclinical and clinical trials are also needed to study the efficacy and safety of *S. marianum*.

## Declarations

**Ethics approval and consent to participate:** The data were collected with confidentiality, anonymity and consent. All respondents were informed of the purpose of the study and provided prior informed consent.

**Consent for publication:** Not applicable.

**Availability of data and materials:** Data used in this article are available for any requests.

**Competing interests:** Authors declare no conflict of interest

**Funding:** This research is financed by a CNRST grant, as part of the preparation of a National Doctorate thesis at Sidi Mohammed Ben Abdellah University.

**Authors' contributions:**



L.B. Study design, ethnobotanical survey, active participation in structuring the methodology, data analysis and interpretation (statistical analysis), drafting of the original manuscript, revision and editing of the manuscript. S.C. manuscript improvement and revision, supervision. B.A. Revision and editing. G.L. : Conceptualization, supervision  
R.C. and M.B. Conceptualization, Methodology, botanical description and identification, supervision of work, validation.  
All authors have read, reviewed and approved the manuscript.

## Acknowledgements

Authors wish to express their sincere thanks to all respondents who have participated in this survey. Authors are also grateful to all those who contributed to the realization of this work.

## Literature cited

- Aafi A, Ghanmi M, Satrani B, Aberchane M, Ismaili M.R, EL Abid A. 2009. Diversity and valorization of the main aromatic and medicinal plants (AMP) linked to the cedrusatlantica's ecosystem in Morocco. Centre de Recherche Forestière, Morocco p 1-2.
- Akoglu H. 2018. User's guide to correlation coefficients. Turkish Journal of Emergency Medicine 18: 91-93. doi: 10.1016/j.tjem.2018.08.001
- Alami M, Kharchoufa L, Bencheikh N, Elachouri M. 2021. Ethnobotanical profile of medicinal plants used by people of North-eastern Morocco: Cross-cultural and Historical approach (Part I). Ethnobotany Research & Applications 21:34. DOI:10.32859/era.21.34.1-45
- Bahmani M, Shirzad H, Rafieian S, Rafieian-Kopaei M. 2015. *Silybum marianum*: Beyond Hepatoprotection. Journal of Evidence-Based Complementary and Alternative Medicine 20(4):292-301. doi: 10.1177/2156587215571116
- Bahmani M, Zargarani A, Rafieian-Kopaei M. 2014. Identification of medicinal plants of Urmia for treatment of gastrointestinal disorders. Revista Brasileira de Farmacognosia 24:468-480. doi:10.1016/j.bjp.2014.08.001
- Bataf 2021. Study of the development, mapping, assessment, management and conservation of aromatic and medicinal plant (MAP) resources in the province of Taounate. Reports 3, Morocco, Taounate. p 1-2
- Belkacem.A.A ,Ahnou N, Barbotte L, Wychowski C, Pallier C, Brillet R, Pohl R, Pawlowsky J-M. 2010. Silibinin and related compounds are direct inhibitors of hepatitis C virus RNA-dependent RNA polymerase. Gastroenterology 38:1112-1122. doi: 10.1053/j.gastro.2009.11.053
- Benchaachouaa A. 2019. Caractérisation et Valorisation d'une plante de la famille des astéracées de la région de Sidi Bel Abbès : Évaluation des substances bioactives de *Silybum marianum*. PhD dissertation Université Djillali LIABÈS: p 26-27
- Benchaachoua A. 2010. Obtention et caractérisation d'une enzyme coagulant le lait à partir du chardon marie *Silybum marianum* et à partir de Mucor mèche isolé du sol de Sidi-Bel-Abbès. Phd dissertation Université Djillali LIABÈS : p 10-43
- Bouasla A, Bouasla I. 2017. Ethnobotanical survey of medicinal plants in northeastern of Algeria. Phytomedicine 36:68-81. doi: 10.1016/j.phymed.2017.09.007
- Braun L, Cohen M. 2010. Herbs & Natural Supplements: An Evidence-Based Guide. 3 rd ed. London, England: Churchill Livingstone; 2010. p 310-319.
- Brodniewicz T, Gryniewicz G. 2012. Plant phenolics as drug leads—what is missing? Acta Poloniae Pharmaceutica-Drug Research 69:1203-1217.
- Corchete P. 2008. *Silybum marianum* (L.) Gaertn: the Source of Silymarin In: Bioactive Molecules and Medicinal Plants. Springer edition. Department of Plant Physiology, Faculty of Pharmacy, University of Salamanca, Salamanca, Spain, p 125-128.
- DjamelMiara M, Bendif H, Ait Hammou M, Teixidor-Toneu I. 2018. Ethnobotanical survey of medicinal plants used by nomadic peoples in the Algerian steppe. Journal of Ethnopharmacology 219:248-256. doi: 10.1016/j.jep.2018.03.011
- El-Assri E, El Barnossi A, Chebaibi M, Hmamou A, El Asmi H, Bouia A, Eloutassi A. 2021. Ethnobotanical survey of medicinal plants in Taounate, Pre-Rif of Morocco. Ethnobotany Research & Applications 22:36. doi: 10.32859/era.22.36.1-23
- Fennane M. & Ibn Tattou M. 1998 : Catalogue des plantes vasculaires rares, menacées ou endémiques du Maroc. Bocconea 8 :1-243
- Fraschini F, Demartini G, Esposti D. 2002. Pharmacology of Silymarin. Clinical Drug Investigation 22 (1): 51-65. doi: 10.2165/00044011-200222010-00007.

- Hafsé M, FikriBenbrahim K, Saidi A, Farah A. 2013. Volatile Components and Antibacterial Profile of Essential Oils Extracted from Leaves and Twigs of *Pistacia lentiscus* L. *British Microbiology Research Journal* 3(4):602-611
- Jeddi M, Ouaritini ZB and Fikri-Benbrahim K. 2021. Ethnobotanical study of medicinal plants in northern Morocco (Taounate): case of Mernissa. *Ethnobotany Research & Applications* 21:1-23. doi: 10.32859/era.21.35.1-23
- Kumaraguruparan R, Rajesh A. 2008. Multitargeted therapy of cancer by silymarin. *Cancer Letters* 269:352-362. DOI: 10.1016/j.canlet.2008.03.053
- Kroll DJ, Shaw HS, Oberlies NH. 2007. Milk thistle nomenclature: why it matters in cancer research and pharmacokinetic studies. *Integrative Cancer Therapies* 6(2):110-119. doi: 10.1177/1534735407301825
- Morazzoni P, Bombardelli E. 1995. *Silybum marianum* (*Carduus marianus*). *Fitoterapia* 66:3-42.
- Mouzali L. 2016. Le chardon-marie (*Silybum marianum*) : une plante aux multiples vertus. *Société Algérienne De Nutrition Et De Médecine Ortho Moléculaire, Algerie*. p 132.
- Nassif F, Tanji A. 2013. Gathered food plants in morocco: the long forgotten species in ethnobotanical research. *Life Sciences leaflets* 3: 17-54.
- Pereira C, Calhelha RC, Barros L, Ferreira ICFR. 2013. Antioxidant properties, anti-hepatocellular carcinoma activity and hepatotoxicity of artichoke, milk thistle and borututu. *Industrial Crops and Products*, 49: 61-65.
- Plants of the world online. Royal Botanic garden kew. *Silybum marianum* (L.) Gaertn. Distribution. 2023 <https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:249211-1> (Accessed 31/12/2023)
- Rafieian-Kopaie M, Nasri H. 2012. Silymarin and diabetic neuropathy. *Journal of Renal Injury Prevention* 1(1):3-5. doi: 10.12861/jrip.2012.02
- Sewell RDE, Rafieian-Kopaei M. 2014. The history and ups and downs of herbal medicine usage. *Journal of HerbMed Pharmacology* 3(1):1-3.
- Svobodova A, Walterova D, Psotova J. 2006. Influence of silymarin and its flavonolignans on H<sub>2</sub>O<sub>2</sub>-induced oxidative stress in human keratinocytes and mouse fibroblasts. *Burns* 32:973-979. doi:10.1016/j.burns.2006.04.004
- Velussi M, Cernigoi A M, Montre A, Dapas F, Caffau C, Zilli M. 1997. Long-term (12 months) treatment with an anti-oxidant drug (silymarin) is effective on hyperinsulinemia, exogenous insulin need and malondialdehyde levels in cirrhotic diabetic patients. *Journal of Hepatology* 26:871-879. doi:10.1016/S0168-8278(97)80255-3
- Wu CH, Huang SM, Yen GC. 2011. Silymarin: a novel antioxidant with antiglycation and anti-inflammatory properties in vitro and in vivo. *Antioxid Redox Signal* 14:353-366. doi: 10.1089/ars.2010.3134

**ANNEX**

Annex 1. Chi-square Distribution table

Degrees of Freedom	Chi-Square ( $\chi^2$ ) Distribution									
	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. H. Akoglu 2018