

ORIGINAL RESEARCH ARTICLE

Ethnobotanical study of a Medicinal Plant -*Ephedra alata*- In the North-East of Algeria

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ABSTRACT

The objective of this study is to contribute to the valorization of one of *Ephedraceae* family species, *Ephedra alata*, at the level of Ouenza region in Tébessa city, which is situated in the North-East of Algeria. This plant is endowed with a great pharmacological importance and known by its resistance to drought.

This work begins with an ethnobotanical survey. Its objective is to learn about the use of *Ephedra alata* in herbal medicine, and then to carry out a phytochemical study (chemical screening).

According to the ethnobotanical survey, the pharmacological importance of the plant seems to be ignored by a large part of the population. The chemical screening has shown the presence of various secondary metabolites in the plant's aerial part, such as alkaloids, polyphenols, tannins, saponosides and terpenes.

Therefore, regarding these last results, it is appropriate to confirm to what extent *Ephedra alata* can be useful, particularly, by its phytotherapeutic participation, namely the harvest period, the used part and the way of use. Finally to avoid the progressive extinction of this species, it is necessary to intensify the actions of knowledge and prevent

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INTRODUCTION

Since the earliest times, man has sought remedies for his illnesses in plants. In Africa, where herbal medicines are still used by many populations for health care, The use of medicinal plants as a fundamental component of the traditional healthcare system is perhaps the oldest and the most assorted of all therapeutic systems.. And the practice of traditional healing is much older than some of the other traditional medical sciences.¹

The Algerian flora, with its different species belonging to several botanical families, remains not thoroughly explored phytochemically and pharmacologically. Algeria is the largest country in the Mediterranean basin, Africa, and the Arab region with a total area of almost 2.4 million km² and 1,600 of coastline. In addition to a diversified climate, Algeria is characterized by a rich flora consisting of 4,000 taxa, 917 genera, and 131 families. Moreover, Algeria possesses an important and rich cultural diversity. Although several studies have been undertaken to document the local knowledge regarding the use of medicinal plants to treat different diseases.²

Medicinal plants are still considered important and promising sources of drugs to treat various diseases. Their therapeutic uses, vernacular names, modes of preparation, and routes of administration were orally transmitted to constitute a local ancestral knowledge characterizing each population or ethnic group living in a specified area. Actually, from the identification of morphine in opium in the 19th century, drug discovery is based on ethnobotanical investigations and local ethnomedicinal knowledge. Certain vegetal species, recognized as medicinal plants, are capable of producing natural substances, whose specificity remains intimately linked to the species' better nature, in question.³

In addition to the fact that they constitute an undoubted biological richness, plant's genetic resources are at the origin of many virtues due to the active principles that they generate. Nearly 50% of the therapeutic agents currently used come from natural sources, while less than 10% of species have been studied for their biological activities. These figures indicate that there is still a lot of room for improvement and that the in-depth study of plant species could lead to the discovery of new therapeutic molecules.⁴

KEYWORDS:

Alkaloids,
Biodiversity
Chemical screening.
Ephedra alata.
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Algeria, by its geographical position presents a wide range of bioclimatic floors inducing a biodiversity of plants used as condiments, natural food and for therapeutic purposes.⁵ The Ephedraceae family, represented by the only gender *Ephedra*, involves about 40 species in the whole world. The species of this gender can grow in semi-arid and desert conditions. Among the most prevalent plants in the North-East of Algeria, the Ouanza region, the *Ephedra alata* species is known for its use in traditional medicine, yet it is still little studied in the literature at the local level. The *Ephedra* species kind contains: The alkaloids ephedrine, pseudoephedrine, norephedrine, norpseudoephedrine, methylephedrine and methyl pseudoephedrine. The medicinal significance of *Ephedra* is primarily based on the sympathometric properties of ephedrine.⁶

In addition, ecological and climatic conditions greatly influence this plant's chemical composition; despite the fact that, it is still poorly used by the population (harvest period, method of preparation, dose to be prescribed). In this context, this study focuses on:

1. An ethnobotanical scan on the *Ephedra alata* plant was conducted in the study area in order to evaluate the interest and the use of this plant in the target population using questionnaires on knowledge, the part used, how to use it, and the diseases treated.
2. Preliminary phytochemical tests are then conducted on an *Aqueous extract and a Methanolic extract* of the aerial parts to prove the existence of groups of chemical families found in the plant.
3. Therefore, the present study is a part of a global issue which is the preservation of biodiversity research axis, around which a certain number of themes revolve, including the valorization of natural products or sub-products.

MATERIALS AND METHODS

The study area

The Ouenza massif is located in northeastern Algeria. It is located 160 km south of the city of Annaba, in the Eastern Saharan Atlas, near the Algerian-Tunisian borders. The distance between this massif and the city of Tébessa to which it is administratively attached reaches 72 km. The topography is very characteristic of that of the Saharan Atlas. Its relief is quite rugged. The maximum altitude reported at Djebel Ouenza is 1206m at Chagoura mountain. The region has a semi-desert climate: relatively cold winter and a hot and dry summer, with an average annual precipitation of 400 mm. (figure 1)

The main rivers are: Oued Mellègue, Oued Harraba and Oued El Ksab, whose flows are irregular and vary according to the season and the amount of precipitation. The vegetation cover is poor; it is represented by small pine forests.

The Ouanza region is part of the city of Tébessa. It is a meteorological transition zone, it is distinguished by four bioclimatic stages:

- **Sub-humid** (400 to 500 mm/year), very little extended, it is limited to the summits of a few reliefs (Djebel Serdies and Djebel Bouroumane).

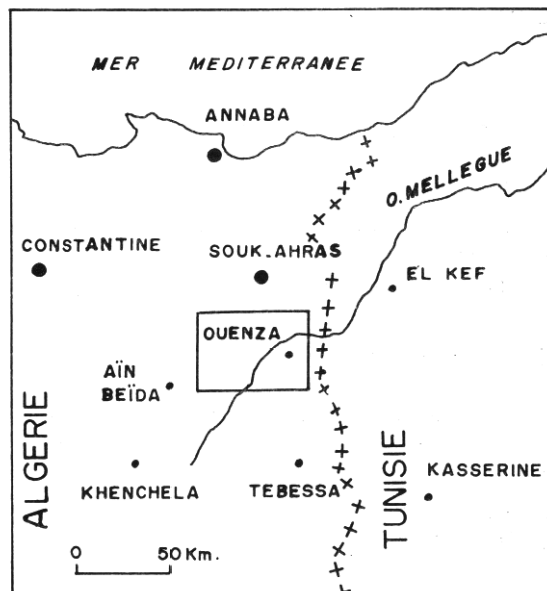


Fig. 1 : Geographical location of the study region (Ouenza region- Tébessa city- Algeria)⁷

- **Semi-arid** (300 to 400 mm/year), covers the entire northern part of the city.
- **The Sub-arid** (200 to 300 mm/year), covers the steppe plateaus.
- **The arid or mild Saharan** (less than 200 mm/year), extends beyond the Saharan Atlas. The commune of Ouenza located on the high plateaus, it has a dry and cold climate in winter, hot in summer.⁷

Vegetal Material (harvesting and drying)

The vegetal material used corresponds to the aerial part composed of *Ephedra alata* (*Ephedraceae* family) species' leaves.

Ephedra alata is represented by perennial shrubs with jointed branches, which can reach 1 to 2 meters in height, with thin upright stems, yellowish green, intersecting and slightly ribbed, with canaliculi 1.5 mm in diameter and which ends with an often sharp point. At the nodes, which are 4-6 cm apart, the scale-like leaves appear triangular which develop in opposite pairs or whorls of three, giving the plant the appearance of a leafless shrub. Small flowers appear in summer. They can grow in semi-arid and desert conditions. The latter usually grows in sandy soils, dry slopes and dry sides of mountains.⁸

The harvest was carried out at the level of Ouenza locality (Tébessa city -North-East of Algeria-). Drying was done at an ambient temperature, protected from light and humidity in order to avoid the active ingredients' degradation and the molds' development. After drying, the plant's aerial part was crushed and carefully stored in a dry place for analysis.

Ethnobotanical Survey

According to literature, The genus *Ephedra* of the *Ephedraceae* family contains more than 60 species of nonflowering seed plants distributed throughout Asia, America, Europe, and North Africa. These *Ephedra* species have medicinal, ecological, and economic value. *Ephedra alata* is a plant of a great importance

on a global scale.. It has been known for thousands of years and occupying a significant place in traditional medicine. In contemporary times, it has received an additional interest as an effective herb for weight loss and physical performance enhancement.⁹

In order to account for this plant's value, represented in the region of Ouenza by the *Ephedra alata* species, an ethnobotanical survey was launched among the population. During this survey, 150 people from the region of Ouenza, aged from 25 to 90 (60 men and 90 women) were questioned.

Preliminary phytochemical tests

The aerial part of *Ephedra alata* which was reduced to powder, has experienced various chemical tests in order to highlight the presence or absence of the main families of secondary metabolites.

- **Aqueous extract:** Consists of introducing 1g of vegetal powder into 20ml of boiling water, which is left to infuse for 15 minutes. Then, to be filtered and rinsed, with a little hot water to obtain 20 ml of filtrate.
- **Methanolic extract:** Consists of introducing 1g of vegetal material into 20ml of methanol, and then leaving it to macerate for 24 hours.

Characterization of polyphenols

The reaction with ferric chloride (FeCl₃) makes it possible to characterize polyphenols. The appearance of a blue-blackish or green color more or less dark, indicates the presence of polyphenols.¹⁰

Reducing compounds

Their detection was carried out by Fehling's liquor. Obtaining a red precipitate indicates the presence of the reducing compounds.¹¹

Cardiac glycosides

In the presence of chloroform, the appearance of a reddish-brown color after adding H₂SO₄, indicates the presence of cardiac glycosides.¹²

Alkaloids

The tests are carried out by precipitation reactions with Dragendroff's reagent. Introduce 10 g of dry vegetable powder into an Erlenmeyer flask, to which 50ml of H₂SO₄ diluted 1/10 with water distilled is added. This mixture was stirred and macerated for 24 h. Then, in 1ml of the filtrate, 5 drops of reagent of Dragendroff are added. The appearance of an orange precipitate reveals the presence of alkaloids.¹³

Flavonoids

The flavonoids were sought by the cyanidin reaction. Two (2) ml of each extract were evaporated and the residue was taken up in 5 ml of hydrochloric alcohol diluted twice. By adding 2 to 3 shavings of magnesium, there is a release of heat then a pinkish-orange or purplish color. The addition of 3 drops of isoamyl alcohol intensified this coloration which confirmed the presence of flavonoids.¹²

Tannins

Ten grams of the dry powder are extracted with an aqueous solution of C₂H₅OH at 1%. The appearance of a green color in the presence of FeCl₃ solution indicates the presence of tannins.¹⁴

Saponosides

After stirring, the filtered broth from the plant. The appearance of a foam that lasts a few moments, indicates the presence of saponins.¹²

Cardiotonic cardenolides

The appearance of a green-blue color in the acid phase, indicates the presence of cardenolides.¹⁵

Sterols and terpenes

Sterols and terpenes were sought by the Liebermann reaction. 5 ml of each of the three extracts were evaporated on a sand bath. The residue is dissolved hot in 1 ml acetic anhydride; we added 0.5 ml of concentrated sulfuric acid to the triturate. The appearance, at the interphase, a purple or violet ring, turning blue then green, indicated a positive reaction.¹²

Coumarins

1 mL of the extract was kept as a control and 1 mL was brought into contact with 0.1 mL of NH₄OH (10%). After that, a spot from each preparation was put on a filtered paper and examined under UV light. Their presence is revealed by intense fluorescence.¹⁶

RESULTS AND DISCUSSIONS

Interpretation of the ethnobotanical survey

Knowledge of *Ephedra alata*

After questioning a sample of the population of Ouanza-North-East Algeria on the knowledge of the plant and its uses, we obtained the following results :

According to the obtained results, we notice a very strong knowledge of the species in the region of Ouenza (Figure 2).

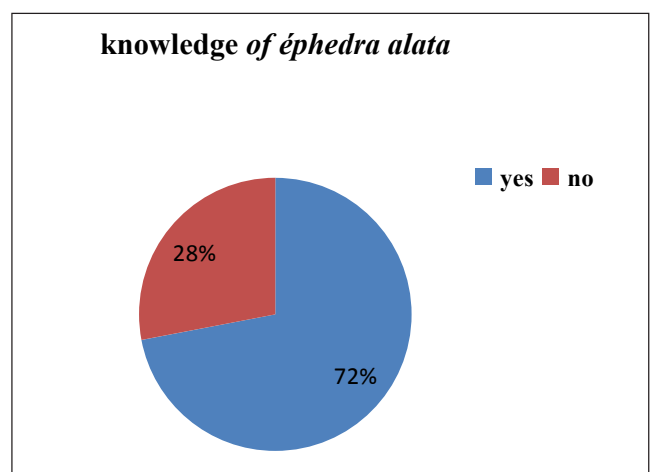


Fig. 2: Knowledge Percentage of *Ephedra alata*, in the region of Ouenza

This may be due to its abundance in that area. This is also confirmed by (17) who studied the plant in the region of Ouargla,¹⁸ recorded that 31.5% of respondents do not know the plant; 9.5% of people know the name of the plant but do not know how to use it; 59% of people know at least one of the uses of the plant.

The use of *Ephedra alata* According to gender

The obtained results show that *Ephedra alata* is used more by women, with a percentage of 67% and less by men with 33% (Figure 3). This is also confirmed by many authors in other regions of Algeria, particularly in Djelfa.¹⁹ Also by²⁰ in the region of M'Sila

Utilising according to the method of use

The results demonstrate that, the decoction is the most used method with 83% compared to the other methods of use (infusion 17% and powder 0%) (Figure 4).

According to,¹⁹ Infusion is the most practical way, in which the questioned people benefit from the plant in traditional medicine. According to.²¹ The macerate or boiled plant is administered orally to treat asthmatic problem ; The Chinese also drink a tea containing Ephedra to treat various diseases

The use according to the used part of *Ephedra alata*

In light of the acquired results, the *Ephedra alata* is used as a 100% whole plant in the study area. This can be explained by

the fact that, all of the plant's parts have a very remarkable therapeutic effect for its users(Figure 5).

Similarly, the commonly used organs are: the aerial part or green stems and the "fruits". The green stems are the most used organs with a rate of 93%. As for the "fruits", they are rarely used with only 7% (19).

Therapeutic use of *Ephedra alata*

We have found that, the inhabitants of this region use *Ephedra alata* to treat several illnesses. Especially in the case of cancerous diseases and coughs by 39%, cholesterol by 28% and blood pressure by 14% (Figure 6).

The *Ephedra alata* is also used for treating diabetes and the flu, which is also confirmed by (17) in the region of Ouargla.

According to,¹⁹ The survey revealed that, people questioned in the region of Djelfa mainly use *Ephedra alata* to treat cancer, asthma, allergies, general weakness, headaches, chills, fever, diabetes, nasal congestion and low blood pressure. Nose and throat frequent infections (colds) and respiratory infectious diseases (flus) are less treated with this plant. *Ephedra* is traditionally used in China for bronchial asthma, colds, flu, fever, nasal congestion, headaches, diaphoretic, antiallergic, antitussive,etc.⁸ in Morocco, Ephedra alata Dec. is used to fight diabetes²² Many authors such as,²³ report that the plant is used by the population of the Algeria to treat colds, flu, respiratory disorders, whooping cough and general weakness

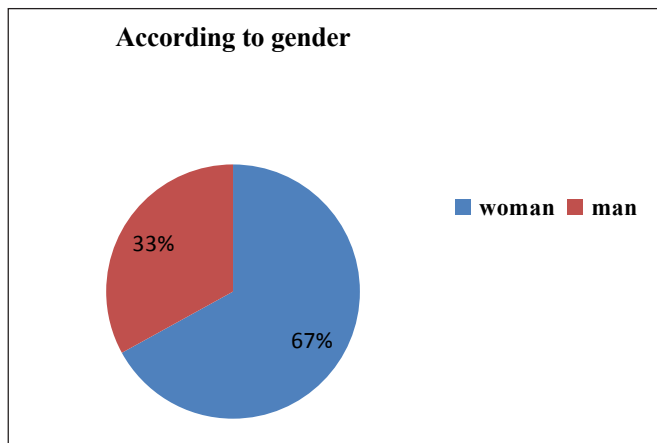


Fig. 3: The use of *Ephedra alata* According to gender

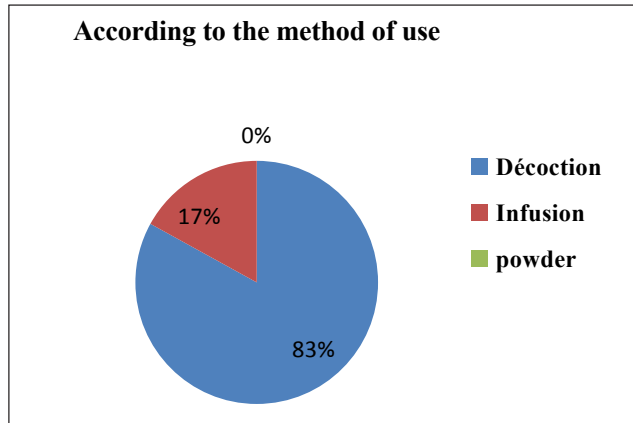


Fig. 4: Percentage of *Ephedra alata* usage according to the method of use

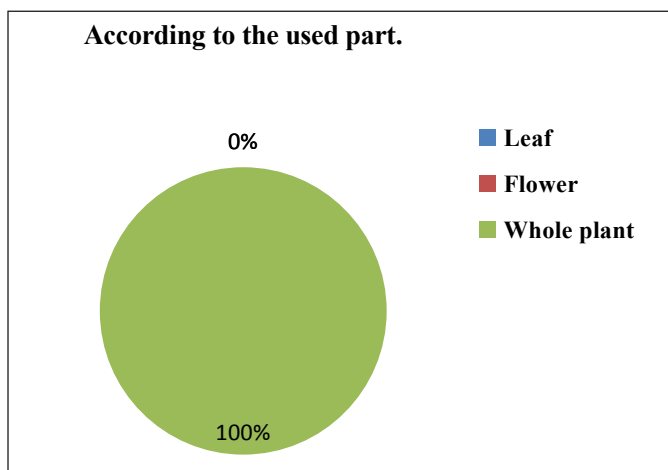


Fig. 5: Percentage of *Ephedra alata* use according to the used part

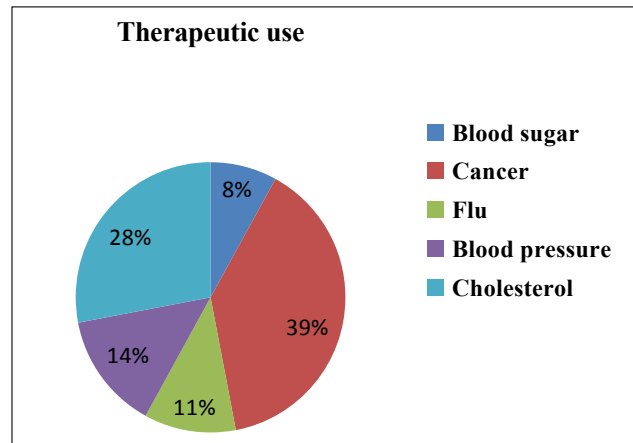


Fig. 6: Percentage of the plant's (*Ephedra alata*) therapeutic use in the study region

and confirm the traditional use of the herb in the treatment of various diseases.

Knowledge of the uses of medicinal plants and their properties are generally acquired following a long experience accumulated and transmitted from one generation to another. But in the case where the plant and its uses are not well known, its ethnopharmacology risks to disappear over time.

Preliminary phytochemical tests

The phytochemical screening revealed various secondary metabolites in the plant's aerial part: Alkaloids, Polyphenols, Tannins, reducing compounds, Saponins, Sterols and Terpenes, Flavonoids, Coumarins and cardiac Glycosides. They are considered as being present only in the aerial part (Table 1).

According to,²⁴ Phenolic compounds are vast, diverse, ubiquitous and widespread in nature. The biological significance of bioactive phenolic natural secondary metabolites is immense and of high and significant importance. Phenolic compounds are known to exhibit various biological activities such as antimicrobial, antioxidant and anti-inflammatory properties.

The presence of flavonoids can play an important role in the prevention of many diseases associated with oxidative stress such as cancer, cardiovascular diseases and neurodegenerative diseases. In general, because the phenolic hydrogen atom is much more readily removable, phenolic compounds are able to compete very effectively with an oxidizable substrate for free radicals. The flavonoid radical thus formed is stable and interrupts the cellular degradation events initiated by the radical attack.²⁵

Confirmed by,²⁶ Tannins, mainly proanthocyanidins, have been characterized by colorimetric reactions. These compounds are produced in large quantities in the stems of many species of *Ephedra* belonging to the two continents, Eurasian (such as: *E. intermedia*, *E. przewalskii*, *E. alata*, *E. distachya* and *E. fragilis*) and American (such as *E. californica*, *E. nevadensis* and *E. Torreyana*).

According to our results, the saponosides presented a Foam index= 3 cm \square very positive test. saponosides are usually hemolytic. This property is attributed to their interaction with the sterols of the erythrocyte membrane. The *Ephedra alata* subspecies derived from the region of Ouenza, is therefore rich with secondary metabolites. Most of these results are confirmed by,¹⁷ who worked on the same species in the region of Ouargla.

The phytochemical test was conducted on *Ephedra alata* harvested which is indigenous to the southern part of Tunisia demonstrated that Ethanolic extracts of the aerial part contain polyphenolic phytochemicals and elicit antioxidant activity the existence of alkaloids, , but there is a distinction in intensity.²⁷

Likewise, phytochemical tests on the aerial part of the *Ephedra alata* plant from the region of Bechar include alkaloids, flavonoids, reducing compounds, and combined anthracene derivatives.²⁶

In accordance with,⁶ the abundance of these active ingredients gives the plant significant pharmacological properties through the existence of alkaloids.

CONCLUSION

Today, modern medicine relies heavily on plants. Chemistry and biology laboratories around the world have followed in the footsteps of traditional medicine in the search for ways and means of overcoming various pathologies, this by the search for new active ingredients and the understanding of their modes of stock. Plants have so-called "secondary" metabolites as opposed to primary metabolites. These compounds differ according to the species and, although their roles are still poorly understood, it is however clear that they intervene in the relations that the plant maintains with the living organisms that surround it.

This research, the objective of which was to contribute and participate in the enhancement of one of the kinds of the

Table 1: Demonstration of the presence or absence of certain families of secondary metabolites in *Ephedra alata*

Metabolites	Picking of Extraction	The Presence
Alkaloids	Aqueous Extract	+
	Methanolic Extract	+
Flavonoids	Aqueous Extract	+
	Methanolic Extract	+
Tannins	Aqueous Extract	+
	Methanolic Extract	+
Saponosides	Aqueous Extract	+ (Foam index= 3 cm \square very positive test)
	Methanolic Extract	+ (Foam index= 3 cm \square very positive test)
Cardiotonic cardenolides	Aqueous Extract	+
	Methanolic Extract	+
Sterols and terpenes	Aqueous extract	+
	Methanolic Extract	+
Coumarins	Aqueous Extract	+
	Methanolic Extract	+
Reducing compounds	Aqueous Extract	+
	Methanolic Extract	+
Cardiac glycosides	Aqueous extract	+
	Methanolic Extract	+
Polyphenols	Aqueous Extract	+
	Ethanolic Extract	+

Ephedraceae family, *Ephedra alata*, from the Ouenza region, has enabled us to attain interesting results that can be summed up as follows:

- At first; based on the ethnobotanical survey, we have estimated the significance and benefit of *ephedra alata* by the population of this region, since its use is associated with its effects against several diseases.

Most of the uses of the plant cited by the subjects questioned are consistent with what is mentioned in the literature. We mainly cite a supposed effect for the treatment of cancer, an effect on glycaemia, cancer, cholesterol, influenza, .an antimicrobial and antiasthmatic.

Then the phytochemical screening highlighted several categories of secondary metabolites in the plant's aerial part: alkaloids, polyphenols, tannins, reducing compounds, saponosides, terpenes, flavonoids, polyphenols and alkaloids.

After studying and reviewing many previous studies for their work of assaying total phenolic compounds and flavonoids, and estimating the antioxidant activity of its extracts, we were able to conclude that *Ephedra alata* represents an abundant natural source of secondary metabolites and antioxidants.

Thus, with regard to this last outcome, it is appropriate to emphasize to what extent *Ephedra alata* can be beneficial, especially through its phytotherapeutic participation depending on the harvest period, the part used, and the use case.

Relying on the ecology side of this species, or its autoecology, it is significant to ensure that it is maintained; its protection and enhancement are goals to be promoted.

Disclosure Statement

There is no actual or potential conflict of interest in relation to this article.

Authorship contributions

- fellah imene carried out all the ethnobotanical surveys and Preliminary phytochemical tests
- Bouzata Chouhaira and Touil Wided collaborated to collecting information on the study area and participating in the discussion of the results.
- Gherib Imene translated the manuscript into English.

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