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► To cite this version:

Fatma Zohra Chakou, Zakaria Boual, Mohamed Didi Ould El Hadj, Atallah Badreddine, Zainab El Alaoui-Talibi, et al.. Ethnobotanical utilization of *Alhagi maurorum* Medik. in traditional recipes of Algerian Sahara Illizi Wilaya. Euro-Mediterranean Journal for Environmental Integration, 2021, 6 (3), pp.1–8. 10.1007/s41207-021-00277-0 . hal-03463078

HAL Id: hal-03463078

<https://uca.hal.science/hal-03463078v1>

Submitted on 2 May 2024


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Ethnobotanical utilization of *Alhagi maurorum* Medik. in traditional recipes of Algerian Sahara Illizi Wilaya

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Abstract

Alhagi maurorum Medik. (Fabaceae) is a spontaneous shrub native to the region extending from Russia to the Mediterranean and used by rural and Saharan Algerian people for its medicinal effects. This study aims to document the medicinal uses of *A. maurorum* in Illizi (southern Algeria). Ethnobotanical survey was carried out in Illizi between June and September 2018 through face-to-face interviews with 73 residents and traditional practitioners, using prepared questionnaire and specimen indexed of the plant. The data collected were analyzed using χ^2 test of independence to study the association between categorical variables. Findings revealed four local names for this plant, the main one being Atjer (57.98%), and the preferential use of leaves (59.42%) and seeds (37.58%). It is consumed mainly by illiterate people (82.60%) over 55 years of age (56.52%) and to treat various ailments such as fever (28.99%) and gastrointestinal disorders (26.08%). The majority of remedies are prepared in the form of a macerate (43.47%). Recorded ethnomedicinal properties of the plant should be subjects of further pharmacological studies to validate their popular use.

Keywords Ethnobotany · *Alhagi* · Sahara · Algeria · Fabaceae · Medicine

Introduction

Medicinal plants and seaweeds are considered as a rich source of important bioactive compounds (Agisho et al. 2014; Benarba et al. 2015; Hentati et al. 2020), and their traditional use has a long history of practice in therapy of different diseases (Eddouks et al. 2007). Indeed, about 80% of the world's population depend on traditional medicine for their health care (Agisho et al. 2014). For a significant percentage of this population and notably for those in developing countries, these local and free medicinal substances of the traditional pharmacopoeia are often the sole drugs available. Many academic studies have been undertaken to study the botanical and therapeutic aspects of medicinal plants, to validate and integrate their medicinal properties in a model health system exploiting their active ingredients (Biyiti et al. 2004). The term ethnobotany was first proposed at the beginning of the twentieth century by the botanist John William Harshberger (White James 1931). It defines the study of plants from a geographic region through local people's knowledge of their usage in foods and medicine. Ethnobotanical studies are proving to be one of the

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dependable approaches to document, validate, and explain from mechanistic point of view popular and ancestral knowledge (Magwede et al. 2014) to develop new drugs (Koné 2009). Moreover, this practice allows the conservation of ancestral popular culture. These ethnobotanical approaches have resulted in numerous currently active compounds used as drugs in medicine. For examples, digoxin (*Digitalis glycoside*) first identified from *Digitalis purpurea*, a plant traditionally used by European populations for its positive cardiovascular effects, is now a drug of choice for the treatment of disturbances in cardiac rhythm or congestive heart failure (Pervaiz et al. 2006). In the same way, etoposide and teniposide (semisynthetic derivatives of podophyllotoxin) extracted from rhizome of *Podophyllum peltatum*, a plant consumed by Native Americans to treat some cancers, is now a chemotherapy medication for numerous cancer treatments as these compounds act as topoisomerase inhibitors (Imbert 1998). Another ethnobotanic success was that of vinca alkaloids of *Catharanthus roseus* G. Don (pink periwinkle plant) from Madagascar. Traditional medicinal applications of this plant to cure patients suffering from diabetes, to reduce blood pressure, or as disinfectant led to the identification of several vinca alkaloids such as vinblastine, vindesine, vinorelbine, and vincristine, which are currently the second class of most used cancer fighters (inhibitors of cell division) (Moudi et al. 2013). It is therefore of utmost importance to screen ethnobotanic practices in the context of climate warming and/or changing lifestyle of rural and indigenous populations. Therefore, ethnobotanical investigations have been carried out on plants widely used in folk medicine and distributed in the dry lands of Saharan Algeria. The ethnobotanical survey carried out by Chehma and Djebbar (2008) identified 62 spontaneous species regrouped in 31 botanical families used in traditional pharmacopoeia in northern Algerian Sahara. Kemassi et al. (2014) inventoried 33 species belonging to 19 families in Ghardaia region (north of Algerian Sahara) used by the local population of "M'zab" to treat diabetes. In addition, Bouallala et al. (2014) have identified 22 medicinal species belonging to 21 genera and 16 families practiced by people of the region of El-Oued (northeast of Algeria).

Algeria is characterized by a diverse flora of medicinal and aromatic plants (Azzi et al. 2012) of which 3164 species of vascular plants have been recorded (Vasisht and Kumar, 2004). According to Benarba et al. (2014), several ethnobotanical studies have been undertaken to explore the efficiency and biological activities of Algerian medicinal plants (Benarba et al. 2015). However, some ancestral knowledge of Saharan rural people regarding the use of *Alhagi maurorum* is still insufficient. *Alhagi maurorum* Medik. (*Fabaceae*), a perennial plant, is a spiny shrub (Suthar et al. 2016) native to North Africa (Algeria, Egypt, Libya, Niger, and Sudan), the Middle East, and

South East Europe (International Union for Conservation of Nature and Natural Resources 2005). It has numerous disease therapy properties (Al-Snafi 2015; Chakravarty 1976) and applications depending on area, such as Shook, Aqool, Shooq El Jamal, Shprim, and Lehlah (Al-Snafi 2015). Turkish people decoct it to obtain a tonic agent called Devediúi (Altundag and Ozturk 2011). In Iran, it is known as Khareshotor, Oshtorkhar, and Khardaro (Tonekaboni and Tohfán 2008; Tavassoli et al. 2020) and used to treat aphthous ulcers and diarrhea, and as an appetite suppressant (Tavassoli et al. 2020; Emami et al. 2012; Amiri et al. 2014). Traditional knowledge is conveyed informally through oral traditions of elders that may disappear after their death, leading to the exhaustion of this imperative information. There is no documentation of *Alhagi maurorum* Medik. plant in medicinal preparations of Algerian traditional medicine. Hence, the aim of this study is to document the local knowledge and traditional uses of the plant from the people of Illizi, providing data for further work to investigate the pharmacological and phytochemical importance of this plant.

Material and methods

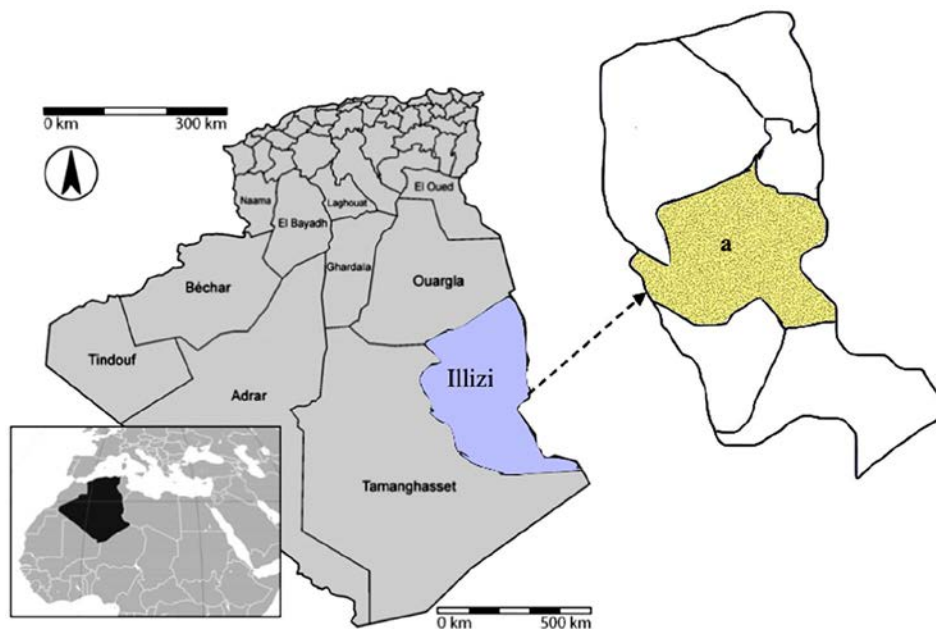
Presentation of the study area

The wilaya of Illizi is located in the far southeast of the country (Fig. 1). It is bordered to the north by the wilaya of Ouargla, to the northeast by Tunisia, to the east by Libya, to the west by the wilaya of Tamanrasset, and to the south by Niger. It shares 1233 km of borders with Tunisia, Libya, and Niger. The climate of the wilaya is arid desert and very dry with extremely irregular rain. June is the hottest month of the year and January the coldest (Abid 2018). The average temperatures in winter vary between 25.7 °C maximum and 8.1 °C minimum, and in summer 41.2 °C maximum and 26.3 °C minimum (NAID 2013). The majority of the population is Berber-speaking Touareg (NAID 2013; Miara et al. 2019).

Identification of *Alhagi maurorum* Medik. from Illizi

The collected plant material was identified using Ozenda's identification keys for Sahara flora (Ozenda 2004), Quézel and Santa (1962, 1963). The perennial plant has rigid and very thorny branches, and its cloves have red-brown color divided by irregular constrictions. Samples of the above-described parts were collected in Belbachir city 26°28 north latitude and 8°28 east longitude (Map GPS) and prepared in specimen indexed of the plant and used during the survey.

Fig. 1 Geographical location of Illizi wilaya (Miara et al. 2019); **a** study area (Illizi town) (Abid 2018)



Collection of ethnobotanical data

The survey was conducted during June and September 2018 in Illizi town with 73 individuals from different areas of Illizi wilaya, traditional practitioners and residents, born and/or living for a long time (more than 10 years) in the district.

For the purpose of this study, an inventory interview method was selected that requires less time to collect ethnobotanical data (Silva et al. 2014) since the presentation of a specimen indexed of *Alhagi maurorum* (Fig. 2) was given and open questions asked in Arabic and Amazigh languages (Fig. 3).

The questionnaire (Fig. 3) was prepared with slight modifications according to Bouallala et al. (2014) that contained eight parameters divided into two sections. The first one depended on the respondent (commune, age, sex, and educational level). The second focused on the plant (local name, used parts, treated diseases, and methods of preparation).

Data analysis

Data collected were analyzed via Statistical Package for Social Science (SPSS) version 16 and Microsoft Excel 2007 for plotting tables and graphs. The association between



Fig. 2 Indexed *Alhagi maurorum* specimen used for the ethnobotanical survey

Fig. 3 Questionnaire paper used for the ethnobotanical survey

Sheet number ()			
Respondent profile			
Commune			
Age (years old)	20-35	36-50	More of 51
Sex	Male	Female	
Educational level	Illiterate	Middle	Secondary University
Medicinal informations about <i>Alhagi maurorum</i>			
Local name	Used parts	Treated diseases	Mode(s) of preparation(s)

categorical variables was determined by Pearson χ^2 test of independence, with conditions of use being no more than 20% of cells in contingency table (cross tabulation) having expected values less than 5 and p value less than chosen significance level $\alpha = 0.05$ (Moore et al. 2013).

Results and discussion

Sociodemographic profile of respondents

Use of plant according to sex

In total, of the 73 people interviewed, 69 declared to know the plant, revealing a widespread medicinal practice in Illizi, especially by women (52.17%—37 interviewees versus 47.83%—32 interviewees for men). No significant relation between sex of interviewees and plant use was revealed ($p = 0.473 > \alpha$, and 50% of cells in cross tabulation have expected count less than 5). This suggests there is information exchange between both sexes.

Ethnobotanical research published recently (Bouasla and Bouasla 2017; Bakiri et al. 2016; Lahsissene and Kahouadji 2010) also reported a dominance of women among the people surveyed. Bouasla and Bouasla (2017) attributed this bias to regional traditions and women’s occupation of preparing plant-based recipes for family members. Knowledge has been passed down through generations by mothers to daughters.

Use of plant according to age and educational level

As demonstrated in Fig. 4, individuals aged over of 51 years old demonstrated the greatest use of *Alhagi maurorum*,

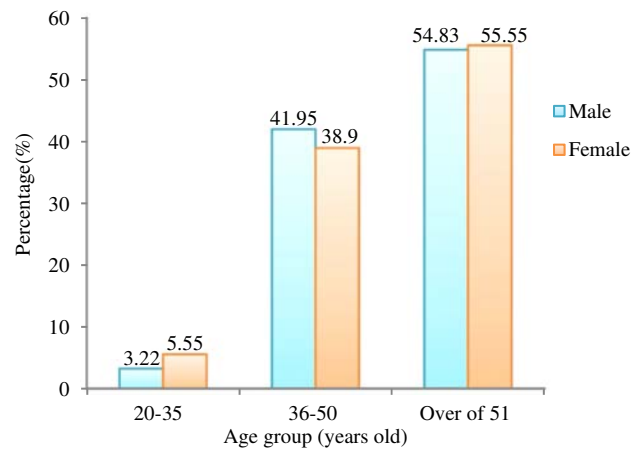


Fig. 4 Repartition of age group respondents according to sex

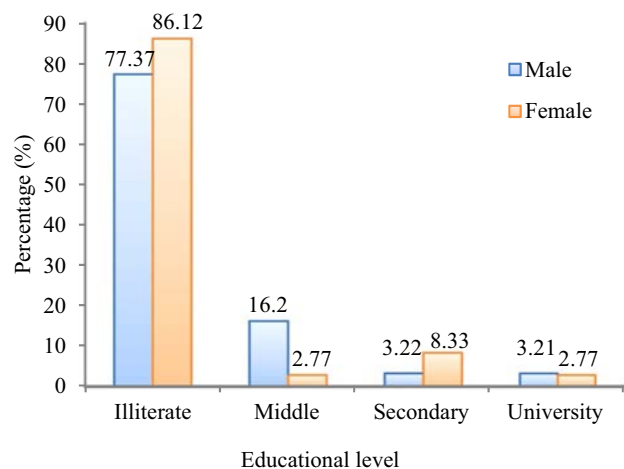


Fig. 5 Educational level of interviewed people

with 56.52%, followed by the age group 36–50 years old at 39.14%. The age class having the lowest use of *Alhagi maurorum* was that of 20–35 years old, with 4.34%.

For both sexes (Fig. 5), 82.6% are illiterate, decreased for middle, secondary, and university levels to 8.7%, 5.8%, and 2.9%, respectively.

Similar results were reported in another ethnobotanical study by Bouasla and Bouasla (2017) about medicinal uses of plants in the northeast of Algeria (Skikda wilaya). The authors concluded that educated people with modern Western lifestyle have little interest in traditional medicine based on the use of plants. Knowledge of the properties and uses of medicinal plants is generally acquired through long experiences accumulated and passed on from one generation to the next (Bammou et al. 2015).

The “study discontinuation” observed among individuals questioned belonging to the middle category was due to families’ economic situations requiring them to leave the classrooms early and help their parents herd sheep, the main source of their livelihood, as well as due to geographic isolation of their cities and poor means of transport in Saharan regions of Illizi wilaya. Consequently, such living conditions certainly create a relationship between herbs and human since childhood, allowing information to be passed down from generation to another, sparing of transportation expenses and care.

Local nomination

The collected plant was presented to local habitants, most of them from the Touareg community of Illizi, for identification. Four common terms were used by the interviewed people. These names, never reported previously to our knowledge, were Atjer (57.98%) and Ahjer (28.98%), both meaning “Something that brings goodness,” Karde (7.24%) “In relation to use it as food Camel,” and Debagh (5.80%) “To leather tanning by local people.”

Used parts

Leaves were the most used plant part for 59.42% of users, mostly as an antihyperglycemic agent, followed by seeds (37.58%) for fever treatment, and roots and gum (1.5% each) for gastrointestinal disorders and hyperglycemia, respectively. Ethnobotanical research conducted in Illizi by Miara et al. (2019) reported leaves (52%), followed by seeds (13%), as the most used parts of plants in Touareg community preparations. Even if the use of specific organs is correlated with treatments of specific pathologies as described above, the majority of leaf usage can be explained by availability and the ease of collecting this part of the plant (Akerreta et al. 2007). They are considered as the site of photosynthesis and sometimes the storage of secondary metabolites responsible

for the biological properties of the plant (Bigendako-Polygenis and Lejoly 1990). Moreover, high total phenolic content and antioxidant activity of 83.5% in free radical scavenging were established by Laghari (2012) for the leaf extract of *Alhagi maurorum*. Active phytochemical compounds were detected in aqueous extract of plant leaves, including several subclasses of flavonoids and phenolic acids such as chrysoeriol, isorhamnetin, chrysoeriol-7-oxylsoid, coumaric, and caffeic and ferulic acids (Ahmed 2019). Diethyl ether and petroleum ether extracts of *A. maurorum* aerial parts were analyzed for their chemical composition by gas chromatography–mass spectrometry (GC–MS) analysis, which characterized fatty acids and coumarins as main constituents (Loizzo et al. 2014). Essential oils from the leaves and stems contain volatile fractions composed of terpenoids, ketones, acid derivatives, and hydrocarbons (Muhammad et al. 2014). Recently, Al-Saleem et al. (2019) isolated from root extract of the plant 14 flavonoids, including quercetin, isorhamnetin, kaempferol, naringenin, and mauritanin.

Traditional preparations

As shown in Fig. 6, to facilitate the administration of the active ingredient for many medicinal purposes, the maceration of seeds (34.78%) and leaves (8.69%) in warm water is the most frequently mode of plant preparation (43.47%), followed by dried powder with 30.45% of plant preparations (swallow with milk/cold water), infusion (13.04%) of leaves (11.59%) and seeds (1.45%) in hot water, and dried root decoction in water (1.45%). In addition, new modes of preparation were reported, such as application of leaf powder during roasting of meat (5.8%) or leather tanning (4.34%) as well as pounding gum (1.45%) added to fenugreek seeds (*Trigonella foenum-graecum*) against hyperglycemia. Ethnobotanic research has been carried out by Hammiche and Maiza (2006) in Tassili N'ajjer (Illizi), who

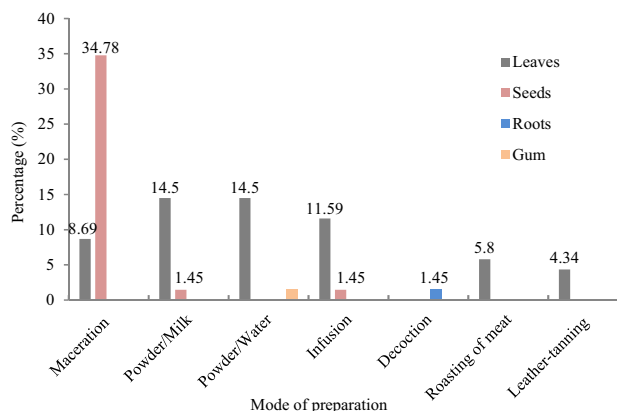


Fig. 6 Different modes of preparation for different parts of *Alhagi maurorum*

reported the fresh or dried uses by the practitioners of plants, essentially in the form of decoction, maceration, and infusion in water. Sometimes oils and rarely milk are used. Infusion and decoction were reported also as major methods of preparation in Illizi (Miara et al. 2019).

Treated diseases

Interviewees used different parts of *Alhagi maurorum* to treat various illnesses and ailments, mainly fever (28.99%) and gastrointestinal disorders (26.08%). New therapeutic uses were also reported for treatments of hyperglycemia (18.84%), genitourinary infections in women (11.60%), diarrhea (8.7%), leather tanning (4.34%), and external hemorrhoids (1.45%) (Table 1). Statistically, no significant correlation related all treated diseases to used parts since 82.1% cells in contingency table have an expected count of less than 5 and $p=0.175 > \alpha$. The independence of used parts (notably both of leaves and seeds) to treated diseases indicates the effectiveness of *A. maurorum* parts and their chemical content in the treatment of common illnesses mentioned above. This result is supported by studies of Ahmed (2019) and Al-Saleem et al. (2019). Indeed, these authors have reported the presence of flavonoids in the leaves and roots of the plant.

Some ethnomedicinal uses have been reported in different countries around the world, such as Egypt (Srivastava et al. 2014), Palestine (Ali-Shtayeh et al. 2000), or Saudi Arabia (El-Shabasy 2016). Preparation methods of *A. maurorum* mentioned above (maceration, infusion, and decoction in water) facilitate the liberation of active ingredients described

as flavonoids, glycosides, alkaloids, tannins, saponins, and steroids (Rahman et al. 2011; Al-Snafi et al. 2019). Their presence in plant extracts may explain their curative potential as described for leave infusions prepared for gastrointestinal disorders. Moreover Amani et al. (2006) have reported very promising antiulcerogenic activity of ethanolic extracts (200, 300, and 400 mg/kg) of the plant containing six active flavonoids against ulceration in rats. The macerate extract of leaves used for fever and genitourinary infections in women contained antioxidant agents as described by Ahmed (2019). Moreover, aqueous extract of plant leaves administrated at 300 mg/kg to rats exposed to oxidative stress induced by tetrachloride revealed its positive action on count, vitality, normality of spermatozoids, and antioxidant status (glutathione). Another study has also reported the antioxidant and antiproliferative properties of *A. maurorum* aerial parts in diethyl and petroleum ethers extracts against a panel of human cancer cell lines using the sulforhodamine B assay. Diethyl ether extract composed of fatty acids and coumarins as main constituents showed the strongest activity against C32 melanoma cell line (IC50 value of 2.7 µg/ml) and the highest radical scavenging activity against ABTS radical (IC50 4.7 g/ml). Petroleum ether extract composed mainly of fatty acids exhibited lower antiproliferative activity against C32 melanoma cell line (IC50 of 62.3 µg/ml) and reduction of ABTS radical (IC50 5.9 g/ml) (Loizzo et al. 2014).

Leaves and seeds used for diarrhea and decocted roots for gastrointestinal disorders were reported in the present study, and phenolic extracts of green parts of *Alhagi maurorum* were confirmed to have antibacterial effects against

Table 1 Treated diseases and modes of preparation using *Alhagi maurorum* in Illizi

Ailment/object	Used part	Modes of preparation
Fever	Leaves	Mac: 1–2 glasses per day Pow: take a teaspoon with a glass of water or milk
	Seeds	Mac: 1–2 glasses per day
Gastrointestinal disorders	Leaves	Inf: 1 cup per day Pow: with glass of water
	Seeds	Mac: 1 cup per day
	Roots	Dec: 1–2 glasses per day
Hyperglycemia	Gum	Pow: taken mixed with powder of fenugreek with water after meal
	Leaves	Inf: 1 cup after meal Mac: 1 cup after meal
		Pow: during roasting of meat Pow: small quantity taken between the fingers with cup of water after meal
Genitourinary infections in women	Leaves	Mac: external uses
	Seeds	Mac: external uses
Diarrhea	Leaves	Pow: small quantity taken between the fingers with milk or water
	Seeds	Mac: 1–2 glasses per day
Leather tanning	Leaves	Pow: place on animal leather
External hemorrhoids	Leaves	Inf: use vapor infusion after it cools down

Mac maceration, Pow powder, Inf infusion, Dec decoction

E. coli, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus* (Al-Kamel and Al-Snafi 2019). Here, we report also the use of exsudate gum and seeds of *Alhagi maurorum* plant as treatment against hyperglycemia. To date, no scientific study has focused on chemical composition and biological activities of *Alhagi maurorum* with the objective to make clear its medicinal uses by people from Illizi.

Conclusion

The present ethnobotanical survey conducted in Illizi (south of Algeria) firstly highlights the relative importance given to *Alhagi maurorum* Medik. in traditional medicine of this area. Traditional knowledge of interviewed people about the plant revealed four local appellations (Atjer, Ahjer, Karde, and Debagh), and uses to treat notably gastrointestinal disorders, diarrhea, hyperglycemia, genitourinary infections in women, and external hemorrhoids., Aerial parts (seeds and leaves) of the plant prepared mainly by maceration but also as dried powder water, infusion, and decoction were the most used. Correlations of sociodemographic origins of informants with uses of *A. maurorum* revealed the independence of the plant uses from sex, age groups, and treated diseases that should be investigated in further experimental studies.

The exploration of the rich indigenous knowledge of the Illizi population, always poorly documented, led to the exploitation and investigation of the pharmacological potential of *A. maurorum* plant. Consequently, future ethnopharmacological studies will aim to establish relationships between the traditional uses of the plant and its chemical content.

Acknowledgements The authors would like to thank the people of the Illizi region who generously agreed to share their knowledge, and Prof. Amar Eddoud (Assistant Professor, Department of Biology, Kasdi Merbah University, Ouargla, Algeria) for his help in botanic identification of the plant.

Funding This work was funded by the French Ministry of Europe and Foreign Affairs and the Algerian, Moroccan, and Tunisian Ministries of Higher Education and Scientific Research, within the framework of the Hubert Curien Program (PHC Maghreb), grant number 18MAG36.

Declarations

Conflict of interest No conflicts of interest to declare.

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