

Ethnobotanical survey of the traditional antiparasitic use of medicinal plants in humans and animals in Laghouat (Southern Algeria)

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Abstract

Background and Aim: An ethnobotanical survey was carried out among the inhabitants of the Aflou region of Laghouat (Southern Algeria). This study was considered as a first step toward the identification of new bioactive antiparasitic molecules. The preservation and documentation of this traditional knowledge will ensure its continuity and transmission from one generation to another, especially because of the emergence of resistant parasites and the lack of references caused by the lack of work in this area; therefore, we intended to inventory and collect the maximum amount of information on medicinal plants that are traditionally used by the local population as antiparasitic in humans and animals (small ruminants, cattle, and livestock).

Materials and Methods: The information was collected using open interviews; the ethnobotanical survey was carried out in the area mentioned above from April to July 2021 using a semi-structured questionnaire and a global sample of 200 respondents. The data were analyzed using the System Package for the Social Sciences software and Microsoft Excel 2010 using the following quantitative indices: Relative frequency of citation (RFC), family importance value (FIV), fidelity level, and informant consensus factor (ICF).

Results: The investigation uncovered the antiparasitic use of 58 plant species belonging to 30 families. The family *Asteraceae* had the highest FIV (FIV = 0.23). The pathology with the highest degree of agreement among the informants was genitourinary parasitosis (ICF = 0.930). The species that was most commonly cited by the local population was *Artemisia herba-alba* Asso (RFC = 1), and the foliage was the most commonly used part (46.4%). Infusion (38.8%) was the most-used preparation for remedies.

Conclusion: This investigation revealed a rich ethnopharmacological knowledge in southern Algeria; therefore, the data gathered in this survey may be utilized to create novel antiparasitic compounds with activity in humans and animals.

Keywords: antiparasitic medicinal plants, ethnobotanical survey, human and animal parasitosis, Laghouat.

Introduction

Parasites affecting humans and animals are a severe health complication in developing countries, especially in Africa [1, 2]. More than 1 to 2 billion infections are probably caused by parasites; this causes several million human deaths per year [3]. The appearance of parasitic diseases in humans, such as Chagas disease, malaria, leishmaniasis,

schistosomiasis, trypanosomiasis, lymphatic filariasis, helminthic diseases [4], and gastrointestinal parasitosis, is predominantly caused by parasites such as *Haemonchus contortus* and *Fasciola hepatica* from small ruminants [2]. In addition, several ectoparasites, especially ticks, lice, and mites, have also been reported in cattle [5] and humans. Furthermore, parasites cause a decrease in the productivity of the herds, as they reduce fertility, provoke skin irritation, and suck blood, eventually leading to death [6].

In recent years, parasites have been exhibiting resistance to known conventional treatments, which are costly and out of reach for many impoverished individuals [5]. Therefore, it is necessary to discover novel antiparasitic medicinal compounds. Natural products are a crucial source of novel active

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compounds, because most clinically proven pharmaceuticals are derived from plants [7]. Moreover, traditional knowledge is in danger of extinction. Therefore, the preservation and documentation of this traditional knowledge to revalue this indigenous information are mandatory conditions for maintaining the continuity and transmission of traditional medicine. According to the World Health Organization, traditional medicine is used by 80% of the world's population to meet their primary healthcare needs [8].

In Algeria, the use of medicinal plants is a thousand-year-old tradition, with more than 4000 species and subspecies of plants being used [9]. Unfortunately, very few ethnobotanical studies have focused on the use of medicinal plants against the predominant internal and external parasites, with the former including *Taenia*, *Oscaris*, *Echinococcus*, *Fasciola* (humans/animals), and *Oxyure* (humans) and the latter including skin leishmania, scabies (skin parasites), ticks, and lice (humans/animals) [10].

In the wilaya of Laghouat, particularly in the Daïra of Aflou, to the best of our knowledge, such references are infrequent because of a lack of work in this direction. This ethnobotanical analysis was carried out among the inhabitants of the Aflou region of Laghouat (Southern Algeria) with the aim of inventorying and collecting as much information as possible on the antiparasitic medicinal plants that are traditionally used by the local population in humans and animals (small ruminants).

Materials and Methods

Ethical approval and informed consent

Approval for this study was granted by the Committee for ethical research of the Faculty of Nature and Life Sciences, Department of Biology, Ziane Achour University, with Ref: 012/FSNV/2021. Before starting data collection, oral informed consent was obtained in each case at the site level and then separately before each interview. In addition, informants were made aware that the study's goals were strictly scientific research and not for commercial purposes. Participants gave verbal consent to participate in the study; they were free to withdraw their information at any time. Finally, informants accepted the topic's importance and clearly agreed to have their data published without mentioning their names.

Study period and location

The ethnobotanical survey was conducted in Daïra of Aflou from April to July 2021. The Daïra of Aflou is an Algerian administrative district located in the Wilaya of Laghouat to the west, 110 km and 406 km from Algiers. The region of Aflou is located in a valley in the heart of the Jebel Amour massif. Built at an altitude of 1400 m, it is one of the highest cities in Algeria. This area is located between (34° 07' N Latitude and 02° 06' E Longitude) (Figure-1). The number of inhabitants is 175890 on a total area of 1650 km² [11]. The population density

is 106.6 Hab/km² [11]. Aflou has a semi-arid climate; the annual average temperature is 13.42°C with a maximum temperature of 34.37°C in summer (July) and a minimum of -3.65°C in winter (January), and the rainfall is, on average, 324.38 mm from 2005 to 2014 [12]. The soil is rich in grass and water; it is an area of breeding and grazing, so it is the traditional economic activity of the locality. Aflou, Sebgag, and Sidi Bouzid are the largest municipalities in the Daïra of Aflou, among the three municipalities that compose it. According to the Algerian administrative division and the population density of the commune of Aflou, it is considered an urban area. The other two: Sebgag and Sidi Bouzid are in rural areas; their information is presented in Table-1 [11].

Data collection

Face-to-face interviews were conducted according to the protocol proposed by Mehdioui and Kahouadji [13]. They were based on discussions performed in the local language using a semi-structured questionnaire that included two parts: One containing general information about the respondent (age, school level, and occupation) and the other concerning the antiparasitic plants used (vernacular name, type of plant, and state of the plant). For the inclusion criteria, we generally targeted local people, herders, traditional healers, and herbalists who had an excellent knowledge of plants for antiparasitic use. In turn, the exclusion criteria were individuals who did not have the necessary knowledge to use medicinal plants and did not live in the study area.

Sampling and plant species identification

The municipality of Aflou is urban, whereas the remaining two localities (Sidi Bouzid and Sebgag) are rural. The survey allowed us to interview 200 people (27 herbalists, seven traditional practitioners, 100 citizens, and 66 breeders). These respondents were selected by convenience sampling [14]. The determination of the scientific terminology of the local medicinal species collected during the survey was verified and confirmed by the botanists of the Department of Natural and Life Sciences, Faculty of Sciences, University of Laghouat, and with the help of the following bibliographic support [15]. Furthermore, the scientific names of plant species were checked using internet sources; specifically, the list of plants (<http://www.the-plantlist.org>). The ethical guidelines of the International Society of Ethnobiology were adopted [16].

Data processing

The collected data were entered analyzed by System Package for Social Sciences, version 20 (IBM Corp., NY, USA) and Microsoft Office "Excel 2010" (Microsoft, USA), using descriptive and quantitative statistics of the numbers expressed as percentages. The results of the ethnobotanical survey were analyzed using the relative frequency of citation (RFC), family importance value (FIV), fidelity level (FL), and informant consensus factor (ICF).

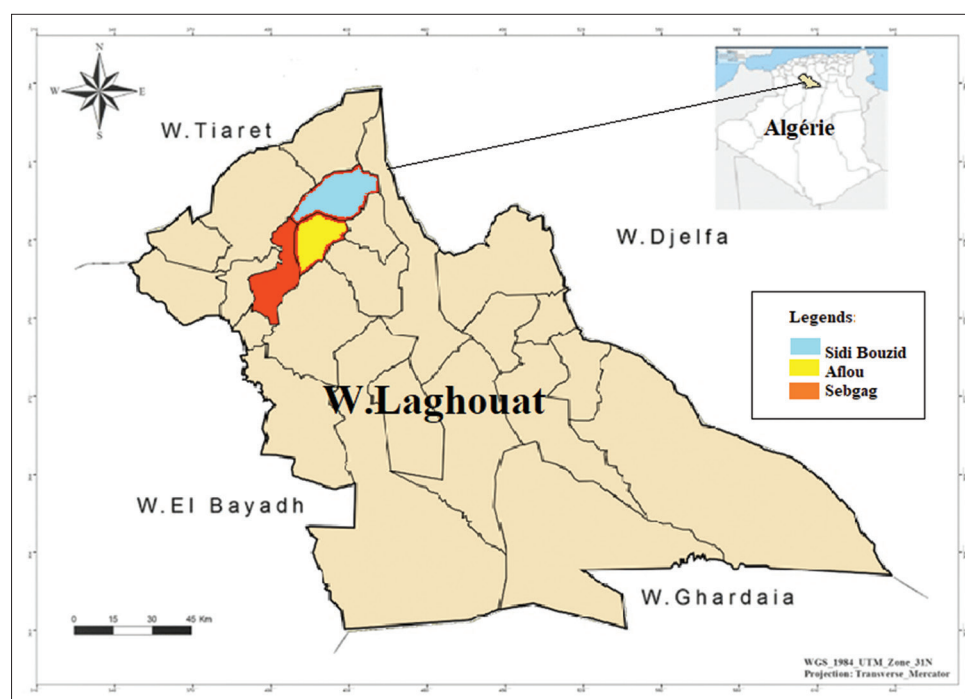


Figure-1: The geographical map of Aflou [Source: https://fr.wikipedia.org/wiki/Da%C3%AFra_d%27Aflou].

Table-1: Distribution of area and density by municipality in the study area [11].

Municipality	Population	Area (km ²)	Density (habitant/km ²)
Aflou	160,131	405	395.39
Sidi Bouzid	7,897	860	9.18
Sebgag	7,862	385	20.42

Relative frequency of citation

The RFC value was calculated using the following formula [17]:

$$RFC = FC/N,$$

Where, FC is the number of respondents who mentioned the use of the species and N is the total number of respondents. The RFC value varied from 0 (when no individual referred to a plant as applicable) to 1 (when all informants mentioned it as an appropriate medicine).

Family importance value

The FIV gives local importance to the families of wild species. It is a culturally important metric that can be used in ethnobotany to define the taxonomic value of a natural plant. To calculate the FIV, we used the following formula:

$$FIV = FC_f/NS,$$

where FC_f is the number of informants who cited the family and NS is the total number of species in each family [18].

Fidelity level

The FL factor was calculated using the following formula:

$$FL (\%) = N_p/N \times 100,$$

Where, N_p is the number of informants who reported the use of the plant species to treat a particular

condition and N is the number of informants who used these plants as medicine to treat a given disease [19].

Informant consensus factor

For data analysis, the ICF was employed to indicate the extent to which the information was homogeneous. Informant consensus factor values will be low (near 0) if plants are chosen randomly, or informants do not exchange information about their use; whereas ICF values will be high (near 1) if there is a well-defined selection criterion in the community and if the information is exchanged among informants. The following formula was used:

$$ICF = Nur - N_t/Nur - 1 [20],$$

Where, Nur is the number of citations for each particular condition and N_t is the number of species used to treat that condition.

Results and Discussion

Socio-demographic profile of the respondents

A total of 200 local informants, including citizen residents, herbalists, traditional practitioners, and other healers, were interrogated using semi-structured surveys and group interviews (Table-1 and Figure-1).

Location of the citizens surveyed

The bulk of the local people interviewed (65%) lived in urban regions (Table-2), and most of them were ordinary citizens; the remainder of the interviewees (35%) were breeders residing in rural areas. These proportions are close to those reported by Zougagh *et al.* [14].

Gender of the citizens surveyed

The results of our investigation indicated that both sexes are involved in herbal medicine. More than half of the informants were men (58%), including

Table-2: Distribution of 200 respondents by habitat municipality.

Municipalities	Respondents	Percentage
Aflou (urban)	130	65.0
Sebgag (rural)	39	19.5
Sidi Bouzid (rural)	31	15.5

mainly herbalists, breeders, and a large proportion of citizens (Table-3). In comparison, women (42%) were traditional practitioners and the remaining portion of citizens, with a male/female sex ratio of 1.38. This suggests that the profession of herbalist and breeder is preferentially reserved for men. Women's vigilance can explain this predominance of males for the balance of the disease and their attachment to all that is traditional; males give sustenance and healthcare to their families in the case of an illness. In turn, women practice herbal medicine (traditional practitioners) in the household, which may be attributed to the customs of the region. These results confirm the findings of another ethnobotanical study performed in the Djelfa region [21].

Age of the citizens surveyed

The findings of this investigation revealed that the use of medicinal species is prevalent across all age classes, with varying percentages. The majority of the respondents were in the age range between 40 and 60 years (31.3%), followed by informants who were older than 60 years (27.5%), informants who were between 36 and 45 years (20.5%), and informants who were between 20 and 35 years (19%). Finally, informants younger than 20 years came in the last position (1.5%) (Figure-2a). The data showed that the elderly acquired therapeutic knowledge from their parents or the experiences of others. The oldest informants offer more credible information because they possess much of the traditional knowledge that is part of the folk tales. As a result, there is a loss of knowledge about medicinal plants, which may be explained by the doubts of some young people who are disinterested in herbal medicine because of modernization and foreign cultural influences. Furthermore, knowledge of the properties and use of medicinal plants is often acquired (70%) through a long-accumulated experience (Figure-2b), and then passed orally from one generation to another [13, 22].

Educational level of the respondents

Regarding educational level, 46.5% of the respondents were illiterate, 24.5% had a primary school level, 17.5% were between a middle and secondary school level, and 11.5% had a university level (Figure-2c). Thus, the use of medicinal plants decreased as the level of education increased [23]. Our results confirmed the findings of the study performed by Bouzid *et al.* [23], who reported that more than half of the users of medicinal plants (64%) were illiterate and 27% of the users had a primary school level. In contrast, very few of those with a university level (9%) used medicinal plants [22].

Marital situation of the respondents

In terms of marital status, married respondents (74%) used medicinal plants much more than did single respondents (19%), with 05 % of widowers versus only 2% of divorced informants using these plants (Figure-2d). The difference between family status and Indigenous knowledge for treating antiparasitic infections was statistically significant ($p = 0.000$). This may be explained by the fact that married individuals may avoid or reduce the material fees used to pay doctors and pharmacists [21, 22].

Occupation of the respondents

Half of the respondents interviewed in the study area were ordinary citizens who used antiparasitic plants to remedy their illnesses. Concomitantly, breeders accounted for only 33% of the respondents, with the remainder of the cohort being distributed between herbalists and traditional practitioners (Figure-2e).

Plants surveyed

Most-used botanical families

The data collected allowed the identification of 58 species of plants belonging to 30 botanical families that were used to treat parasitic diseases in humans and animals (small ruminants). These plants are presented in Table-4 using their family and scientific names, local names, parts used, the form of preparation, mode of administration, and quantitative values (FL, ICF, RFC, and FIV). The most represented families were *Lamiaceae*, with nine species; followed by *Asteraceae* and *Apiaceae*, six species each; and *Myrtaceae*, three species. In comparison, the remaining families were represented by two or only one species (Figure-3). According to research performed in the Mediterranean region, *Lamiaceae* and *Asteraceae* are the most-used plants in traditional medicine [10, 14, 24]. *Asteraceae* (FIV=0.23), *Amaryllidaceae* (FIV=0.188), *Cupressaceae* (FIV=0.11), and *Lamiaceae* (FIV=0.08) (Table-3) were the four families most cited according to the FIV index. This high proportion could be explained by the fact that these families are widely present among the flora of Aflou. This dominance was also observed, albeit with some differences, in the results of other ethnobotanical surveys conducted in other countries [14, 22].

Most frequently cited medicinal plants

Some of the antiparasitic medicinal plants that were inventoried during the investigations were more frequently cited in the Aflou region. The RFC of the medicinal plants cited ranged from 0.005 to 1 (Table-3). The highest values were observed for *Artemisia herba-alba* Asso (RFC = 1), followed by *Allium sativum* L. (RFC = 0.305), *Rosmarinus officinalis* L. (RFC = 0.165), *Lavandula officinalis* L. (RFC = 0.165), *Cotula cinereum* Delile (RFC = 0.16), *Thymus guyonii* Noë (RFC = 0.145), *Artemisia campestris* L. (RFC=0.14), *Juniperus phoenicea* L. (RFC = 0.125), *Zingiber officinale* Roscoe

Table-3: List of medicinal plants for human and animal parasites in the region of Afrou (Laghouat).

Scientific name and family	Local name	Part used	Preparation form	Administration mode	Traditional uses	FL%	FC	RFC	FIV
Anacardiaceae <i>Pistacia atlantica</i> Desf.	Butom	Leaves/Galls/ Fruit	Infusion/Oil/ Decoction	Oral/Swabbing	RA, DA, (H) SP (leish) (H)	50	6	0.03	0.03
Apiaceae <i>Ferula foetida</i> (Bunge) Regel	Hentit	Latex	Maceration	Oral	PD (H)	100	12	0.06	0.029
<i>Scorodosma poetidium</i> L.	Kamoun	Seeds	Decoction/powder	Oral	PD (H)	100	8	0.04	
<i>Cuminum cyminum</i> L.	Fasoukh	Latex	Other	Swabbing	SP (leish) (A)	100	6	0.03	
<i>Ferula veseritensis</i> Coss.	El-Karwia	Seeds	Decoction/powder	Oral	PD (H)	100	2	0.01	
<i>Carum carvi</i> L.	Tal-ghouda	Tuber	Powder	Oral	PD, GD (H)	50	6	0.03	
<i>Bunium mauritanicum</i> L.	Habet lehla	Seeds	Decoction	Oral	PD (H)	100	1	0.005	
<i>Foeniculum vulgare</i> Mill.	Berrostom	Roots	Powder	Swabbing	SP (leish) (A)	100	7	0.035	0.035
Aristolochiaceae <i>Aristolochia baetica</i> L.	Defla	Leaves/Whole	Infusion/Powder	Swabbing/Rinsing	DA, SP (leish, sca, tic) (A/H)	63.6	11	0.055	0.055
Apocynaceae <i>Nerium oleander</i> L.	Chih	Leaves/Whole	Infusion/Decoction/ Powder	Oral/Rinsing/Swabbing	PD, GP, DA, BP, SP (leish, sca) (A/H)	39.5	200	1	0.23
Asteraceae <i>Artemisia herba-alba</i> Asso	Dgouft	Leaves	Infusion	Oral	PD (H)	100	28	0.14	
<i>Artemisia campestris</i> L.	Babounje	Flowers/ Whole	Infusion	Rinsing/ Oral	DA (H)	100	10	0.05	
<i>Anthemis nobilis</i> L.	Guertoufa	Whole	Infusion/Decoction	Oral/Rinsing	PD, DA (H)	93.7	32	0.16	
<i>Chamaemelum nobile</i> L.	Redbakia	Leaves	Infusion	Oral	GP (H)	100	3	0.015	
<i>Cotula cinereum</i> Delle	Chiba	Leaves	Infusion	Oral	PD (A/H)	100	10	0.05	0.035
<i>Echinacea purpurea</i> (L.) Moench.	Chabrag	Whole	Decoction	Rinsing/ Oral	DA, SP (leish) (H)	71.4	7	0.035	0.017
<i>Artemisia absinthium</i> L.	Remth	Whole	Decoction	Rinsing	SP (leish, sca) (A/H)	80	5	0.025	
Brassicaceae <i>Zilla macroptera</i> Coss.	Gtaf	Whole	Infusion	Oral	GP (H)	2	2	0.01	0.02
Amaranthaceae <i>Hammada scoparia</i> (Pomel) Ijijn	Kabouya	Seeds	Raw	Oral	PD (H)	100	2	0.01	
<i>Atriplex halimus</i> L.	Hadja	Fruit	Powder	Swabbing	SP (leish, sca) (A/H)	100	7	0.035	
Cucurbitaceae <i>Cucurbita pepo</i> L.	Arar	Whole	Oil/vegetable tar	Swabbing/ Oral/Swabbing/	DA, AL (A/H) SP (leish, sca, tic) (A/H)	60	25	0.125	0.11
<i>Colocynthis vulgaris</i> (L.) schrad.	Essarw	Whole	Oil/vegetable tar	Oral/Swabbing/	DA, RA, AL, SP (leish, sca) (A/H)	57.9	19	0.095	
Cupressaceae <i>Juniperus phoenicea</i> L.	Lebina	Stems	Latex	Swabbing/	SP (leish, sca) (H)	100	2	0.01	0.017
<i>Cupressus sempervirens</i> L.									
Euphorbiaceae <i>Euphorbia guyoniana</i> Boiss. and Reut.									

(Contd...)

Table-3: (Continued).

Scientific name and family	Local name	Part used	Preparation form	Administration mode	Traditional uses	FL%	FC	RFC	FIV
<i>Ricinus communis</i> L. Fabaceae	Kharoua	Seeds	Oil	Swabbing	AL (H)	100	1	0.005	
<i>Retama raetam</i> Webb.	Retam	Whole	Decoction/Powder	Oral/Swabbing	SP (leish,sca) (A/H)	100	5	0.025	0.025
Plantaginaceae									
<i>Globularia alypum</i> L.	Tasselgha	Leaves	Infusion	Rinsing	SP (sca) (A/H)	100	1	0.005	0.005
Juglandaceae									
<i>Juglans regia</i> L.	El-djouz	Leaves	Infusion	Oral	PD (H)	100	1	0.005	0.005
Lamiaceae									
<i>Thymus guyonii</i> Noë	Zaatar	Leaves/Whole	Infusion/Decoction	Oral/Rinsing	PD, RA, AL (H) SP (leish) (H)	48.3	29	0.145	0.08
<i>Thymus ciliatus</i> Lam.	Djertil	Leaves/Whole	Infusion/Decoction	Oral	PD (A/H)	100	12	0.06	
<i>Teucrium polium</i> L.	Djaïda	Leaves	Infusion	Oral	PD, BP (H)	58.3	12	0.06	
<i>Rosmarinus officinalis</i> L.	Lazir	Leaves	Infusion/Decoction	Oral Swabbing	PD, GP, RA (A/H) AL (H)	45.4	33	0.165	
<i>Lavandula officinalis</i> L.	Khzama	Flowers/ Leaves	Oil/Infusion	Swabbing/Rinsing	GP, AL (A/H)	90.9	33	0.165	
<i>Salvia officinalis</i> L.	Miramia	Leaves	Infusion	Oral	GD (H)	100	8	0.04	
<i>Origanum majorana</i> L.	Bardakouch	Leaves	Infusion	Oral	GD (H)	100	12	0.06	
<i>Mentha spicata</i> L.	Naanaa	Leaves	Infusion/Oil	Oral	RA, PD (H)	66.7	3	0.015	
<i>Mentha pulegium</i> L.	Feliou	Leaves	Infusion	Oral	PD (H)	100	2	0.01	0.01
Lauraceae									
<i>Cinnamomum verum</i> J.Presl Amaryllidaceae	Qarfa	Bark of trunk	Decoction	Oral	RA (H)	100	2	0.01	0.188
<i>Allium sativum</i> L.	Toum	Clove	Raw	Oral/Swabbing	PD, AL, SP (leish, sca) (A/H)	42.6	61	0.305	
<i>Allium cepa</i> L.	Basla	Clove	Raw/Maceration	Oral/Swabbing	PD, AL (A/H)	71.4	14	0.07	
Xanthorrhoeaceae									
<i>Aloe vera</i> (L.) Burm.f. Linaceae	Mor -sebar	GÈLE/suc	Powder	Oral/Swabbing	PD, SP (leish, sca) (A/H)	66.7	3	0.015	0.015
<i>Linum usitatissimum</i> L. Lythraceae	Zereat-ketane	Seeds	Decoction	Oral	AL (H)	100	1	0.005	0.005
<i>Lawsonia inermis</i> L.	Elhénna	Leaves	Powder	Swabbing	SP (leish, sca) (A/H)	100	4	0.02	0.02
Meliaceae									
<i>Melia azedarach</i> L.	Méïia/ Sébahiya	Leaves/Fruit	Decoction/Oil/ Lotion	Oral/Swabbing/Rinsing	SP (leish, sca) PD, AL (A/H) Insecticid	60	10	0.05	0.05
Myrtaceae									
<i>Eugenia caryophyllus</i> L.	Lekrounfel	Flower bud	Decoction/Oil	Oral/Swabbing	SP (leish, sca) (H) PD, AL (H)	50	6	0.03	0.038
<i>Eucalyptus globulus</i> Labill.	Kalitousse	Leaves	Infusion/Decoction	Oral/Rinsing	DA, RA (H) AL, BP (H)	46.7	15	0.075	
<i>Myrtus communis</i> L.	Rihane	Leaves	Infusion	Oral	PD (H)	100	2	0.01	

(Contd...)

Table-3: (Continued).

Scientific name and family	Local name	Part used	Preparation form	Administration mode	Traditional uses	FL%	FC	RFC	FIV
Oleaceae <i>Olea europaea</i> L.	Zitoun	Fruit/Leaves	Oil/Infusion	Oral/Swabbing	DA (A/H)	100	10	0.05	0.05
Piperaceae <i>Piper nigrum</i> L.	Felfel-akhal	Seeds	Powder	Swabbing	AL (H)	100	1	0.005	0.005
Punicaceae <i>Punica granatum</i> L.	Romane	Bark of the fruit	Raw/Decoction	Oral	PD (A/H)	100	15	0.075	0.075
Renonculaceae <i>Nigella sativa</i> L.	Sanoudj	Seeds	Decoction/Oil	Oral/Swabbing	PD (A/H) BP (H) GP (H)	66.7	3	0.015	0.015
<i>Hydrastis canadensis</i> L.	Khatem-dehab	Rhizom	Decoction	Oral	GP (H)	100	3	0.015	
Rhamnaceae <i>Zizyphus lotus</i> (L.) Lam.	Sedra	Leaves	Powder	Swabbing	SP (leish, sca) (H) DA (A/H)	80	10	0.05	0.05
Rutaceae <i>Citrus limon</i> (L.) Osbeck <i>Ruta graveolens</i> L.	Laymoune Fidjel	Fruit Whole	Maceration Infusion/Powder	Oral Oral/Swabbing	PD (A/H) PD (H) AL (H)	100 50	14 4	0.07 0.02	0.045
Theaceae <i>Camellia sinensis</i> (L.) Kuntze	Latay	Leaves	Decoction	Oral	PD (A)	100	5	0.025	0.025
Zingiberaceae <i>Zingiber officinale</i> Roscoe	Zandjabil	Rhizom	Raw/Powder	Oral	PD, RA (A/H) GP (H) PD (H)	41.6	24	0.12	0.072
<i>Curcuma longa</i> L. Zygophyllaceae <i>Peganum harmala</i> L.	Kourkoum Harmal	Rhizom Seeds	Powder/Maceration Powder/Decoction	Oral Oral Swabbing	SP (leish, sca) (H) AL (H) BP (H)	100 54.5	5 11	0.025 0.055	0.055

PD=Parasites of the digestive tract, SP (sca)=Skin Parasites (scabies), SP (leish)=Skin Parasites (leishmaniasis), SP (tic)=Skin Parasites (ticks), DA= Dermatologic Affection; GP=Genetourinary Parasites, RA=Respiratory ailments, GD=Gland Disorders, BP=Blood Parasites (malaria), A/H=Animals/humans, AL=Affection by Lice, FL=Fidelity level, FC=Frequency citation, RFC=Relative frequency of citation, FIV=Family importance value

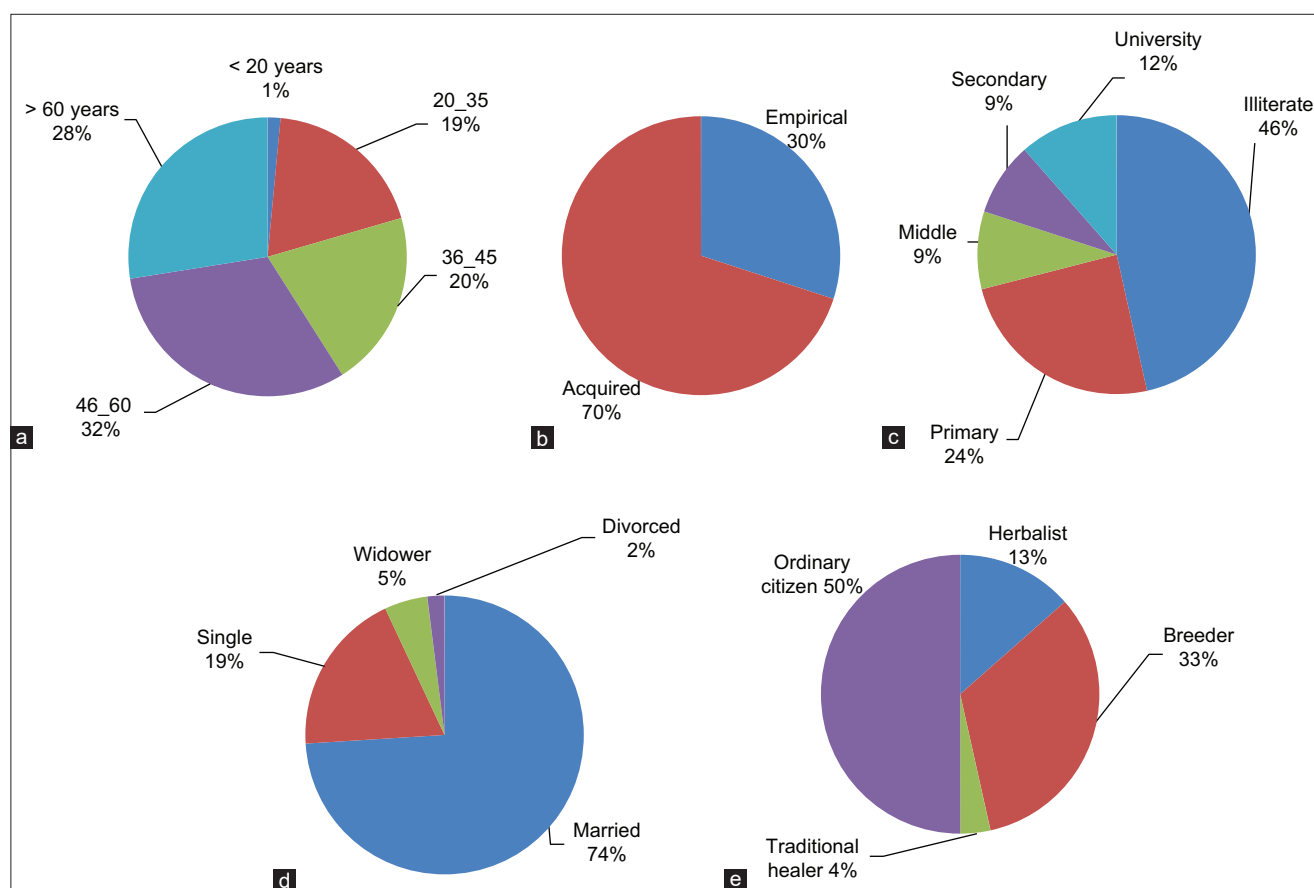


Figure-2: Socio-demographic profile of the informants; (a) Age of the citizens surveyed (b) Origin of information of the respondents (c) Educational level of the respondents (d) Marital status of the respondents and (e) Occupation of the respondents.

(RFC = 0.12), *Punica granatum* L. (RFC = 0.075), *Allium cepa* L. (RFC = 0.07), *Artemisia absinthium* L. (RFC = 0.05), and *Olea europea* L. (RFC = 0.05). Their high RFC values indicate that these plants are the most known and used by most respondents to treat parasitic diseases.

Many investigations aimed at testing their biological and phytochemical activity have been carried out for these plants. In India, Singh *et al.* [25] reported that *Allium sativum* L. is used against amoebiasis and as a dewormer in animals [26]. *Artemisia herba-alba*, *T. guyonii* Noë, *J. phoenicea* L., and *A. campestris* L. are used as antiparasitic plant remedies in Algeria, as reported by Boudjelal *et al.* [10]. Kpabi *et al.* [27] found that *Zingiber officinale* Roscoe is used against amoebiasis in northern Togo. Several studies have mentioned the use of *L. officinalis* L. to control lice and other external parasites [28]. In Morocco, El Rhaffari and Zaid [29] proved the anti-leishmania activity of *R. officinalis* L., and veterinarians continue using it as a pulmonary antiseptic in animals [26]. Regarding *J. phoenicea* L., the most-used form of preparation of this plant is juniper oil, which is obtained after the distillation of the wood of old trees. This oil is also known as cade oil, vegetable tar, or by the Arabic name of Gatran. It is mainly a veterinary product that is used to treat specific animal diseases in the study area: fasciolosis and as a deworm for

sheep [26]. It was associated with *Olea europea* L. for use in humans and particularly to remove external parasites on domestic animals [30]. Root macerations of *P. granatum* L. are used to control tapeworms in small ruminants [26] and against roundworms [31]. *Allium cepa* L. and *Artemisia absinthium* L. are also used as anthelmintics in humans and animals [26]. The medicinal properties of *Artemisia herba-alba* Asso and *A. campestris* L. remain of interest to researchers [32].

Fidelity level index

According to our results, most plants had a high FL, with a value of 100% recorded for 25 plant species (Table-3). Most of them were used by several informants to treat a single pathology, and we ignored the plants that were mentioned only once for better accuracy [22]. The high FL of a species indicates the presence of a specific disease in a given area and the use of plant species to treat it by its citizens [33]. Therefore, the plant species with the highest FL that had not been previously researched should be suggested for future clinical-practice-related investigations.

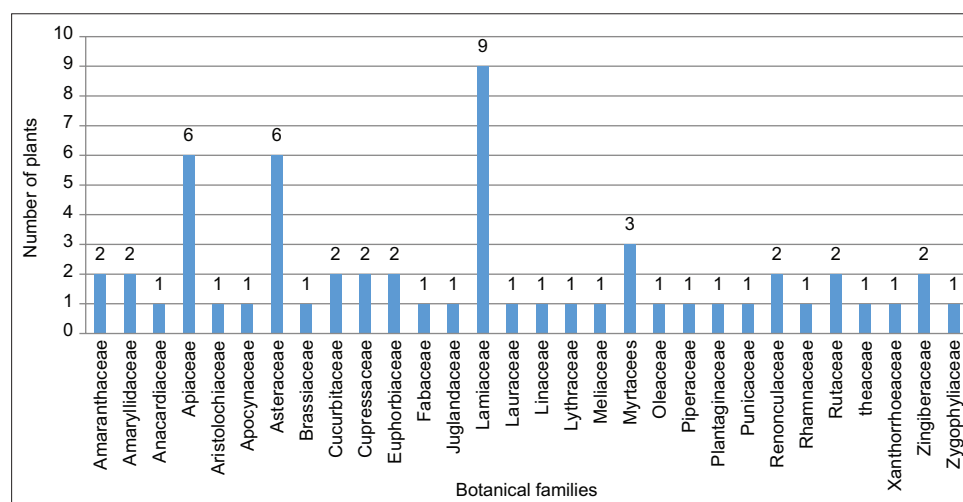
Pathologies and their ICF values

The ICF ranges from 0 to 1. A high ICF indicates agreement regarding plant species selection among informants, whereas a low value indicates disagreement. Recently, a consensus ratio analysis was used as an important factor for ethnobotanical data

Table-4: Informant consensus factor values by category for treating parasitosis.

Pathology	Plants species and number of uses	Nt	Nur	ICF
Genitourinary parasites	<i>Artemisia herba-alba</i> Asso. (29), <i>Echinacea purpurea</i> (L.) Moench (3), <i>Hydrastis canadensis</i> L. (3), <i>Cupressus sempervirens</i> L. (11), <i>Rosmarinus officinalis</i> L. (15), <i>Lavandula officinalis</i> L. (30), <i>Zingiber officiale</i> Roscoe. (8), <i>Atriplex halimus</i> L. (2).	8	101	0.930
Blood parasites	<i>Artemisia herba-alba</i> Asso. (45), <i>Teucrium polium</i> L. (5), <i>Eucalyptus globulus</i> Labill. (4), <i>Nigella sativa</i> L. (2), <i>Peganum harmala</i> L. (1).	5	57	0.929
Gland disorders	<i>Bunium mauritanicum</i> L. (3), <i>Origanum majorana</i> L. (12), <i>Salvia officinalis</i> L. (8).	3	23	0.909
Dermatological affection	<i>Pistacia atlantica</i> (Desf). (3), <i>Nerium oleander</i> L. (7), <i>Artemisia herba-alba</i> Asso. (12), <i>Anthemis nobilis</i> L. (10), <i>Cotula cinereum</i> Delile (30), <i>Eucalyptus globulus</i> Labill. (7), <i>Zilla macroptera</i> Coss. (5), <i>Olea europea</i> L. (10), <i>Zizyphus lotus</i> (L.) Lam. (8), <i>Peganum harmala</i> L. (6), <i>Cupressus sempervirens</i> L. (3), <i>Juniperus phoenicea</i> L. (6).	12	107	0.896
Parasites of the digestive tract	<i>Ferula foetida</i> (Bunge) Regel (12), <i>Cuminum cyminum</i> L. (8), <i>Carum carvi</i> L. (2), <i>Bunium mauritanicum</i> L. (3), <i>Artemisia herba-alba</i> Asso. (79), <i>Foeniculum vulgare</i> Mill. (1), <i>Artemisia campestris</i> L. (28), <i>Cotula cinereum</i> Delile (2), <i>Artemisia absinthium</i> L. (10), <i>Cucurbita pepo</i> L. (2), <i>Juglans regia</i> L. (1), <i>Allium sativum</i> L. (10), <i>Allium cepa</i> L. (4), <i>Camellia sinensis</i> (L.) Kuntze (5), <i>Aloe vera</i> (L.) Burm.f. (1), <i>Thymus guyonii</i> Noë (14), <i>Thymus ciliatus</i> (Desf). (12), <i>Teucrium polium</i> L. (7), <i>Mentha spicata</i> L. (2), <i>Mentha pulegium</i> L. (2), <i>Rosmarinus officinalis</i> L. (5), <i>Melia azedarach</i> L. (1), <i>Eugenia caryophyllus</i> L. (1), <i>Myrtus communis</i> L. (2), <i>Punica granatum</i> L. (15), <i>Nigella sativa</i> L. (1), <i>Citrus limon</i> (L.) Osbeck (14), <i>Zingiber officiale</i> Roscoe. (6), <i>Curcuma longa</i> L. (5), <i>Ruta graveolens</i> L. (2).	30	257	0.887
Affections by Lice	<i>Juniperus phoenicea</i> L. (15), <i>Cupressus sempervirens</i> L. (3), <i>Ricinus communis</i> L. (1), <i>Allium sativum</i> L. (25), <i>Allium cepa</i> L. (10), <i>Thymus guyonii</i> Noë (8), <i>Lavandula officinalis</i> L. (3), <i>Linum usitatissimum</i> L. (1), <i>Melia azedarach</i> L. (6), <i>Eugenia caryophyllus</i> L. (3), <i>Eucalyptus globulus</i> Labill. (2), <i>Piper nigrum</i> L. (1), <i>Ruta graveolens</i> L. (2), <i>Rosmarinus officinalis</i> L. (10), <i>Peganum harmala</i> L. (2).	15	92	0.846
Skin parasite	<i>Pistacia atlantica</i> (Desf). (2), <i>Ferula vesceritensis</i> Coss. (6), <i>Artemisia herba-alba</i> Asso. (35), <i>Hammada scoparia</i> (Pomel) Iljin. (5), <i>Colocynthis vulgaris</i> (L.) schrad. (7), <i>Juniperus phoenicea</i> L. (4), <i>Euphorbia guyoniana</i> Boiss. & Reut. (2), <i>Zilla macroptera</i> Coss. (2), <i>Retama raetam</i> Webb. (5), <i>Globularia alypum</i> L. (1), <i>Allium sativum</i> L. (26), <i>Aloe vera</i> (L.) Burm.f. (2), <i>Thymus guyonii</i> Noë (5), <i>Melia azedarach</i> L. (3), <i>Eugenia caryophyllus</i> L. (1), <i>Zizyphus lotus</i> (L.) Lam. (2), <i>Lawsonia inermis</i> L. (4), <i>Peganum harmala</i> L. (2), <i>Cupressus sempervirens</i> L. (2), <i>Nerium oleander</i> L. (4), <i>Aristolochia baetica</i> L. (7).	21	127	0.841
Respiratory ailments	<i>Pistacia atlantica</i> (Desf). (1), <i>Thymus guyonii</i> Noë (2), <i>Rosmarinus officinalis</i> L. (3), <i>Cinnamomum verum</i> J.Presl. (2), <i>Eucalyptus globulus</i> Labill. (2), <i>Zingiber officiale</i> Roscoe. (10), <i>Mentha spicata</i> L. (1), <i>Eugenia caryophyllus</i> L. (1).	8	22	0.666

ICF=Informant consensus factors, Nur=Number of citations for each particular condition, Nt=Number of species used to treat that condition.

**Figure-3:** The most-used botanical families.

analysis [22, 34]. The ICF values in this study ranged from 0.666 to 0.930, depending on the pathology treated (Table-4). The condition with the highest level of agreement among informants was genital-urinary parasites (0.930), followed by blood parasites (0.929), glandular conditions (0.909), dermatological

conditions (0.896), digestive tract parasites (0.887), lice-associated conditions (0.846), skin parasites (0.841), and respiratory diseases (0.666). These high ICF values indicate reasonable reliability in the use of medicinal plant species by citizens [35]. Moreover, they demonstrate the most significant agreement

between medicinal plants and parasitic diseases because the informants often utilized certain plant species to treat antiparasitic disorders.

Parts of plants used, method of preparation, and routes of administration of recipes

Parts of plants used

Our results showed that the foliage is the most-used plant part, with a percentage of 46.4%, followed by whole plants (20.9%), bulbs (9.7%), fruits (7.5%), rhizomes (5.7%), and seeds (3.8%). The least used parts are barks (2.2%), stems (0.5%), and flowers (0.4%) (Figure-4a). We also found that other parts of plants, such as gels, juices, or latex, were used at a percentage of 2.9% in total. Thus, the leaves are the most-used plant organs in the preparation of remedies in the Aflou region. Similar results indicated that leaves were the most dominant plant parts [36, 37]. This could be because the leaves are sites of photo-chemical reactions [38] and are characterized by ease and speed of harvesting [39]. The fight against overgrazing can be promoted by applying the technique of prohibiting plowing in pastoral areas. The census of endangered plants and the encouragement of specialized state nurseries to produce plants and distribute them to environmental protection associations for planting should be promoted.

Form of preparation

The parts of antiparasitic plants in the study area were prepared in the form of infusion (38.8%), followed by decoction (27.4%), powder (11.8%), raw (6.9%), maceration (2.5%), and other forms of

preparation (6.7%) (Figure-4b). The predominant use of the infusion form can be explained by the fact that this technique allows the extraction of the greatest number of active principles and attenuates or cancels the toxic effects of specific traditional recipes. Several other ethnobotanical studies have shown that most respondents prepared the remedies by infusion [22, 40].

Method of administration

The route of administration is related to the type of pathology to be treated and the form of preparation of the plants used. In general, the traditional recipes prepared were administered through the oral route (56.4%), because it is the most straightforward, most effective, and quickest route, followed by brushing (22.8%), rinsing (19.1%), and massage in only 1.7% of cases. Most ethnobotanical studies conducted in Africa [41–43] agree with our results regarding the predominance of oral administration (Figure-4c).

Type of disease treated

The ethnobotanical investigation conducted in Aflou listed some parasitic diseases treated by medicinal plants, with the most frequent being (in descending order): Parasites of the digestive tract and its annexes (32.7%), cutaneous parasites (16.2%), dermatological affections (13.6%), genital–urinary parasites (12.8%), affections caused by lice (11.7%), and blood parasites (7.2%). The other diseases treated, such as respiratory and glandular disorders, did not exceed 3% (Figure-4d). Diseases of the digestive tract were the most widely treated by medicinal plants. These results are similar to those reported in Africa [36, 44].

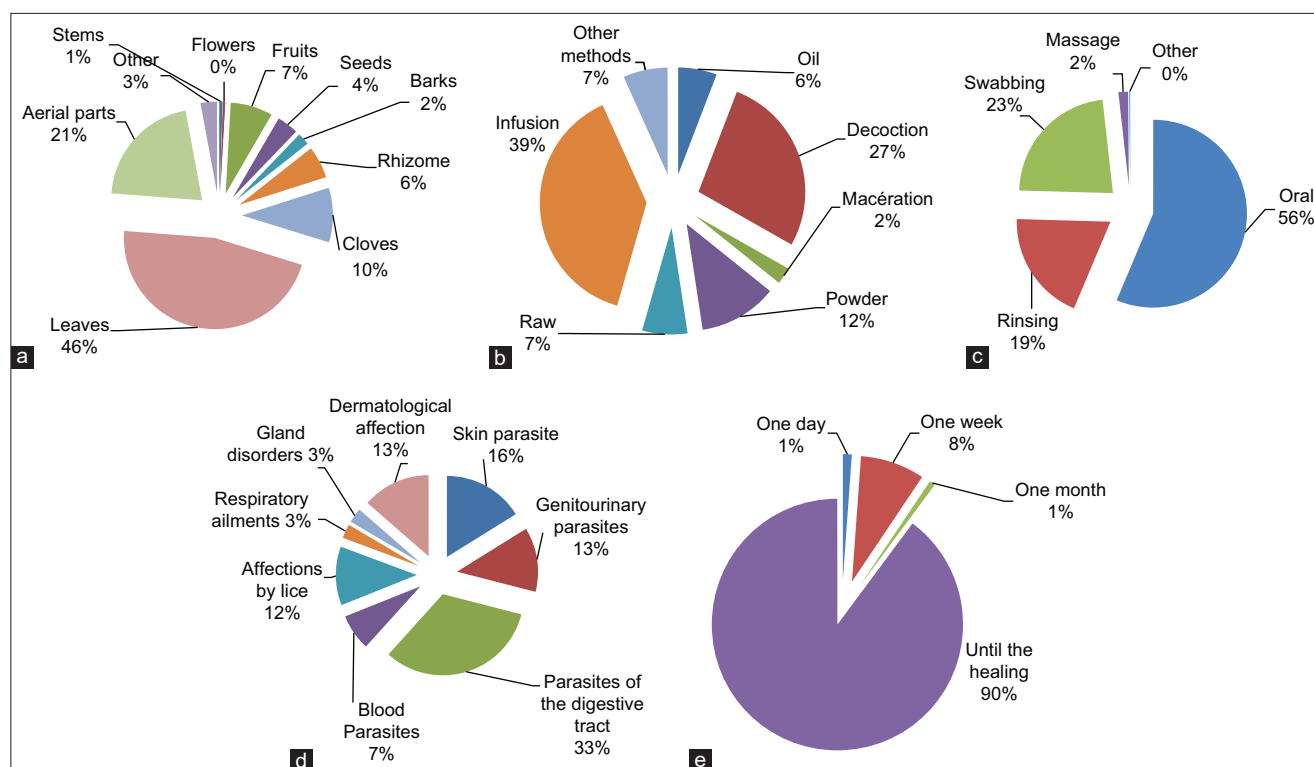


Figure-4: Antiparasitic medicinal plants and their different criteria; (a) Parts of plants used (b) Forms of treatment preparations (c) Modes of administration (d) Diseases treated and (e) Duration of treatment.

Duration of treatment

The treatment duration varied according to the pathologies to be treated and the plants used. This duration can be indefinite and will continue until the patient is cured; thus, it can be limited to 1 day or will extend to 1 week or even 1 month. Our results were similar to those of Slimani *et al.* [44] and Yabrir *et al.* [21], who reported that the duration of treatment continued until the illness was cured (89.8%) (Figure-4e).

Conclusion

The present study was the first of its kind, revealing that 58 plant species were employed for treating parasitosis in humans and animals (small ruminants) among the inhabitants surveyed in the region of Aflou in Southern Algeria. Moreover, 18 of these species were introduced species that were imported from other regions or countries, such as *Ferula foetida* (Bunge) Regel, *Cuminum cyminum* L., *Ferula vesceritensis* Coss, *Carum carvi* L., *Foeniculum vulgare* Mill., *Aristolochia baetica* L., *Echinacea purpurea* (L.) Moench, *Salvia officinalis* L., *Origanum majorana* L., *Cinnamomum verum* J. Presl, *Linum usitatissimum* L., *Eugenia caryophyllus* L., *Piper nigrum* L., *Nigella sativa* L., *Hydrastis Canadensis* L., *Camellia sinensis* (L.) Kuntze, *Zingiber officinale* Roscoe, and *Curcuma longa* L.; however, the majority of the species reported in this survey were native plants. The ethnobotanical survey revealed the incredible biodiversity of the medicinal and aromatic antiparasitic plants used in the region. These plants are prevalent and widely used. We also observed that the information collected through this survey regarding traditional medicine was mainly restricted to the elderly. There is a risk that this knowledge will be lost before it is passed on to future generations. Therefore, the preservation and documentation of this traditional knowledge are necessary for maintaining the continuity and transmission of traditional medicine. Our survey was considered as a first step toward the completion of the research and evaluation of the actual efficiency of the mentioned plants. This could lead to the development of new antiparasitic molecules that are active in humans and animals.

Authors' Contributions

FB, RS, KS, and NC: Conceptualization, investigation, methodology, and writing - original draft. NM and MRM: Visualization, supervision, and interpretation of the data. RK, RS, and MHB: Supervision, methodology, and writing - review and editing. All authors have read, reviewed, and approved the final manuscript.

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Competing Interests

The authors declare that they have no competing interests.

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References

1. Idowu, O., Soniran, O.T., Ajana, O. and Aworinde, D.O. (2010) Ethnobotanical survey of antimalarial plants used in Ogun state, Southwest Nigeria. *Afr. J. Pharm. Pharmacol.*, 4(2): 55–60.
2. Lindberg, A.F. and Vattaa, A.L.E. (2006) Managing anthelmintic resistance in small ruminant livestock of resource-poor farmers in South Africa. *J. S. Afr. Vet. Assoc.*, 77(1): 2–8.
3. Mabey, D. (2009) Atlas of Tropical Medicine and Parasitology. In: Peters, W. and Pasvol, G. Elsevier Mosby, CD-ROM Royal Society of Tropical Medicine and Hygiene, London, 2007. p448.
4. Wink, M. (2012) Medicinal plants: A source of antiparasitic secondary metabolites. *Molecules.*, 17(11): 12771–12791.
5. Sanhokwe, M., Mupangwa, J., Masika, P.J., Maphosa, V. and Muchenje, V. (2016) Medicinal plants used to control internal and external parasites in goats. *Onderstepoort J. Vet. Res.*, 83(1): a1016.
6. Molefe, N.I., Tsoetsi, A.M., Ashafa, A.O.T. and Thekiso, O.M.M. (2012) *In vitro* anthelmintic effects of *Artemisia afra* and *Mentha longifolia* against parasitic gastro-intestinal nematodes of livestock. *Banglad. J. Pharmacol.*, 7(3): 157–163.
7. Danton, O., Somboro, A., Fofana, B., Diallo, D., Sidibé, L., Rubat-Coudert, C., Marchand, F., Eschalié, A., Ducki, S. and Chalard, P. (2019) Ethnopharmacological survey of plants used in the traditional treatment of pain conditions in Mali. *J. Herb. Med.*, 17–18: 100271.
8. World Health Organization. (2003) Resolutions and Decisions of Regional Interest adopted by the Fifty-sixth World Health Assembly and by the Executive Board at its 111th and 112th sessions. World Health Organization, Geneva. p2003.
9. Dobignard, A. and Chatelain, C. (2010) Index Synonymique de la Flore d'Afrique du Nord. Vol. 4. CJBG, Genève. p283–286.
10. Boudjelal, A., Henchiri, C., Sari, M., Sarri, D., Hendel, N., Benkhaled, A. and Ruberto, G. (2013) Herbalists and wild medicinal plants in M'Sila (North Algeria): An ethnopharmacology survey. *J. Ethnopharmacol.*, 148(2): 395–402.
11. DPSB (2021) Direction of the Programming and follow-up Budgetary, Monograph of the Wilaya of Laghouat. DPSB, p322.
12. Amrani, O. and Chehma, A.E. (2020) Plantation of *Atriplex canescens* for the restoration of degraded courses in the Algerian steppe. *Rev. Elev. Med. Vet. Pays Trop.*, 73(2): 113–121.
13. Mehdioui, R. and Kahouadji, A. (2007) Ethnobotanical study at the population nearby the Amsittène forest; case of Imi n'Tlit township (Essaouira Province, Morocco) [Etude ethnobotanique auprès de la population riveraine de la forêt d'amsittene: Cas de la commune d'imi n'tlit (province d'Essaouira)]. *Bull. Inst. Sci. Rabat Sec. Sci. Vie*, 29: 11–20.
14. Zougagh, S., Belghiti, A., Rochd, T., Zerdani, I. and Mouslim, J. (2019) Medicinal and aromatic plants used in traditional treatment of the oral pathology: The ethnobotanical survey in the economic capital Casablanca, Morocco (North Africa). *Nat. Prod. Bioprospect.*, 9(1): 35–48.
15. Chehma, A. (2019) Catalogue Des Plantes Spontanées du Sahara Septentrional Algérien: Éditions Universitaires Européennes. Université Kasdi Merbah Ouargla, Algeria.
16. International Society of Ethnobiology. (2006) International Society of Ethnobiology Code of Ethics (with 2008 Additions). International Organization for Standardization, Geneva, Switzerland.
17. Tardío, J. and Pardo-de-Santayana, M. (2008) Cultural importance indices: a comparative analysis based on the

- useful wild plants of Southern Cantabria (Northern Spain) 1. *Econ. Bot.*, 62(1): 24–39.
18. Sreekeesoon, D.P. and Mahomoodally, M.F. (2014) Ethnopharmacological analysis of medicinal plants and animals used in the treatment and management of pain in Mauritius. *J. Ethnopharmacol.*, 157: 181–200.
 19. Alexiades, M.N. and Sheldon, J.W. (1996) Selected Guidelines for Ethnobotanical Research: A Field Manual. New York Botanical Garden, United States.
 20. Miara, M.D., Bendif, H., Hammou, M.A. and Teixidor-Toneu, I. (2018) Ethnobotanical survey of medicinal plants used by nomadic peoples in the Algerian steppe. *J. Ethnopharmacol.*, 219: 248–256.
 21. Yabrir, B., Guit, B., Houari, S., Tenoum, H., Touati, M., Adli, B., Bezini, E. and Khader, M. (2019) Ethnobotany of the spontaneous medicinal flora of an extreme environment (rock of salt) of the region of Djelfa-Algeria. *Phyto. Chem. BioSub. J.*, 13(1): 46–57.
 22. Chaachouay, N., Benkhigui, O., Fadli, M., El Ibaoui, H. and Zidane, L. (2019) Ethnobotanical and ethnopharmacological studies of medicinal and aromatic plants used in the treatment of metabolic diseases in the Moroccan Rif. *Heliyon*, 5(10): e02191.
 23. Bouzid, A., Chadli, R. and Bouzid, K. (2017) Ethnobotanical study of the medicinal plant *Arbutus unedo* L. in the region of Sidi Bel Abbes in western Algeria. *Phytothérapie*, 15(6): 373–378.
 24. Benítez, G., González-Tejero, M.R. and Molero-Mesa, J. (2010) Pharmaceutical ethnobotany in the western part of Granada province (southern Spain): Ethnopharmacological synthesis. *J. Ethnopharmacol.*, 129(1): 87–105.
 25. Singh, A., Mishra, A., Chaudhary, R. and Kumar, V. (2020) Role of herbal plants in prevention and treatment of parasitic diseases. *J. Sci. Res.*, 64(1): 50–58.
 26. Blancou, J. and Vin-Niveaux, P. (2006) Historical and anecdotal activity regarding ancient plant therapy of infectious and parasitic animal diseases [Relations historiques et anecdotiques sur les anciens traitements par les plantes des maladies infectieuses et parasitaires des animaux]. *Phytothérapie*, 4(2): 74–82.
 27. Kpabi, I., Agban, A., Hoekou, Y., Pissang, P., Tchacondo, T. and Batawila, K. (2020) Ethnobotanical study of plants with antiparasitic activities used in traditional medicine in Doufelgou in northern Togo [Etude ethnobotanique des plantes à activités antiparasitaires utilisées en médecine traditionnelle dans la préfecture de Doufelgou au nord du Togo] *J. Appl. Biosci.*, 148: 15176–15189.
 28. Candy, K., Akhouni, M., Andriantsoanirina, V., Durand, R., Bruel, C. and Izri, A. (2020) Essential oils as a potential treatment option for pediculosis. *Planta Medica.*, 86(9): 619–630.
 29. El Rhaffari, L. and Zaid, A. (2002) Pratique de la phytothérapie dans le sud-est du Maroc (Tafilalet): Un savoir empirique pour une pharmacopée rénovée. In: Des Sources du Savoir Aux Médicaments du Futur. Vol. 1. Inland Revenue Department, New Zealand, p293–318.
 30. Bellakhdar, J., La, P. and Marocaine, T. (1997) Médecine Arabe Ancienne et Savoirs Populaires. La Pharmacopée Traditionnelle. Ibis Press, Paris, France.
 31. Williams, A.R., Soelberg, J. and Jäger, A.K. (2016) Anthelmintic properties of traditional African and Caribbean medicinal plants: Identification of extracts with potent activity against *Ascaris suum* in vitro. *Parasite*, 23: 1–6.
 32. Kadi, I., Ouinten, M., Gourine, N. and Yousfi, M. (2019) Synergistic antinociceptive activity of combined aqueous extracts of *Artemisia campestris* and *Artemisia herba-alba* in several acute pain models. *Nat. Prod. Res.*, 33(6): 875–878.
 33. Bibi, T., Ahmad, M., Tareen, R.B., Tareen, N.M., Jabeen, R., Rehman, S.U., Sultana, S., Zafar, M. and Yaseen, G. (2014) Ethnobotany of medicinal plants in district Mastung of Balochistan province-Pakistan. *J. Ethnopharmacol.*, 157: 79–89.
 34. Uprety, Y., Asselin, H., Boon, E.K., Yadav, S. and Shrestha, K.K. (2010) Indigenous use and bio-efficacy of medicinal plants in the Rasuwa district, Central Nepal. *J. Ethnobiol. Ethnomedicine.*, 6(1): 3.
 35. Chaachouay, N., Benkhigui, O. and Zidane, L. (2020) Ethnobotanical study aimed at investigating the use of medicinal plants to treat nervous system diseases in the Rif of Morocco. *J. Chiropr. Med.*, 19(1): 70–81.
 36. Miara, M.D., Bendif, H., Rebbas, K., Rabah, B., Hammou, M.A. and Maggi, F. (2019) Medicinal plants and their traditional uses in the highland region of Bordj Bou Arreridj (Northeast Algeria). *J. Herb. Med.*, 16: 100262.
 37. Khan, M.T., Ahmad, L. and Rashid, W. (2018) Ethnobotanical documentation of traditional knowledge about medicinal plants used by indigenous people in Talash valley of Dir lower. Northern Pakistan. *J. Intercult. Ethnopharmacol.*, 7(1): 8–24.
 38. Ariyo, O.C., Usman, B.M., Adelani, O.D. and Ariyo, O.M. (2021) Assessments of medicinal plant usage for the traditional treatment of skin diseases in Akinyele local government area, Ibadan, Oyo state, Nigeria. *Ethnobot. Res. Appl.*, 21(37): 1–18.
 39. Obouayeba, A.P., Koffi, A.E., Akéré, D.S.A., N'guessan, K.A., Ackah, B.A.A.J., Kouakou, T.H. and N'Guessan, J.D. (2019) Ethnopharmacological study of medicinal plants sold in some markets in Haut-Sassandra (Central-West, Côte d'Ivoire). *J. Med. Plants Stud.*, 7(5): 13–22.
 40. El Hilah, F., Ben Akka, F., Dahmani, J., Belahbib, N. and Zidane, L. (2015) Ethnobotanical study of medicinal plants used in the treatment of respiratory tract infections in the central Moroccan Plateau. *J. Anim. Plant Sci.*, 25(2): 3886–3897.
 41. Benarba, B., Meddah, B. and Touil, A.T. (2014) Response of bone resorption markers to *Aristolochia longa* intake by Algerian breast cancer postmenopausal women. *Adv. Pharmacol. Sci.*, 2014: 820589.
 42. Chermat, S. and Gharzouli, R. (2015) Ethnobotanical study of medicinal flora in the northeast of Algeria—an empirical knowledge in Djebel Zdim (Setif). *J. Mater. Sci. Eng.*, 5(1–2): 50–59.
 43. Ali, H.H., Souidi, Z., Benarba, B. and Belhouala, K. (2022) An ethnobotanical study of the traditional uses of medicinal and aromatic plants of the regions of Relizane (North-west Algeria). *Int. J. Environ. Stud.*, DOI: 10.1080/00207233.2022.2099103.
 44. Slimani, I., Najem, M., Belaidi, R., Bachiri, L., Bouiamrine, E.H., Nassiri, L. and Ibjibijen, J. (2016) Étude ethnobotanique des plantes médicinales utilisées dans la région de Zerhoun-Maroc. [Ethnobotanical survey of medicinal plants used in Zerhoun region-Morocco]. *Int. J. Innov. Appl. Stud.*, 15(4): 846.
