Ethnopharmacological studies of Medicinal and Aromatic Plants Used in the Treatment of Respiratory System Disorders in the Rif, Morocco

Noureddine Chaachouay, Ouafae Benkhnigue, Mohamed Fadli, Rachida El Ayadi, Lahcen Zidane

Research

Abstract

Background: The aim of these studies was to assess the potential of the Rif (northern Morocco) with regard to medicinal and aromatic plants used in the treatment of respiratory system diseases.

Methods: The ethnobotanical and ethnopharmacological studies were conducted in the Rif region for two campaigns (June 30th, 2016 to June 1st, 2018). In total, 674 local traditional healers were interviewed. Information was collected using open-ended and semi-structured interviews, analyzed and compared by quantitative ethnobotanical indices such as family importance value (FIV), relative frequency of citation (RFC), plant part value (PPV), fidelity level (FL) and informant consensus factor (ICF) were used to analyze the obtained data.

Results: The study identified a total of 41 medicinal plant species belonging to 22 botanical families. The most important family is that of the Lamiaceae represented by 8 species. Concerning the diseases treated, Asthma have the highest ICF (0.97), the leaf was considered the most used part of the plant (PPV=0.482) and the majority of the remedies were prepared in the form of decoction.

Conclusions: The results of these present studies showed the existence of indigenous ethnomedicinal knowledge of medicinal and aromatic plants in the Rif to treat respiratory system diseases. Further research on phytochemical and pharmacological should be considered to discover new drugs from these documented plants.

Keywords: Rif; Morocco; medicinal and aromatic plants; respiratory system diseases, Ethnobotany.

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Background

The respiratory system can be affected by diseases ranging from a simple allergy to chronic asthma or even cancer. Thus, respiratory diseases represent approximately 5.5 million medical consultations per year, of which 3.7 million in the public sector and 1.8 million in the private sector (Ministère de la Santé 2001). It should be noted that diseases have a high cost for families of patients as well as for society in general.

According to the World Health Organization, 80% of the world's population uses traditional medicines to meet primary health care needs (OMS 2003). Humans have always used medicinal and aromatic plants (MAPs) to treat themselves and fight against diseases. In all ancient civilizations and in all continents, one finds traces of this use. Thus, even today, despite the progress of pharmacology, the therapeutic use of plants is very present in some countries, especially in developing countries (Bellakhdar 1997).

Morocco, by its biogeographical position, offers a very rich ecological and floristic diversity constituting a true plant genetic reserve, with about 4,500 species belonging to 940 genera and 135 families, the mountainous regions of Rif and Atlas being the most important areas for endemism (Matuhe 2001). Indeed, traditional medicine has always occupied an important place in the traditions of medication in Morocco and the Rif region is a concrete example. The analysis of the Moroccan medicinal bibliography shows that the data on regional MAPs are very fragmentary and dispersed. We believe that the heritage of the medicinal flora requires regular monitoring and evaluation in terms of quality and quantity.

Accordingly, we conducted these ethnobotanical and ethnopharmacological studies in the Rif, which has a considerable lithological, biological and floristic diversity. The aim of these studies is to contribute to indigenous knowledge of MAPs, to make a catalog of these plants in the study area and to analyze the results concerning the existing relationships between medicinal species and respiratory system diseases. Indeed, it is very important to transform this traditional knowledge into scientific knowledge in order to revalue it, to preserve it and use it rationally.

Materials and Methods

Description of the study area

Tangier Tetouan-Al Hoceima are part of the Rif region, which is one of the twelve regions of Morocco established by the territorial division of 2015 (Bulletin officiel 2015). This region is limited to the north by the Strait of Gibraltar and the Mediterranean Sea, to the west by the Atlantic Ocean, to the south-west by the Rabat-Sale-Kenitra region, to the south-east by the Fez-Meknes region and to the east by the Eastern region. The region has two prefectures (Tangier-Asilah and M'Diq-Fnideq) and six provinces (Al Hoceima, Chefchaouen, Fahs-Anjra, Larache, Ouezzane and Tetouan) and the region's capital, Tangier-Asilah as shown in Fig. 1.

According to the 2014 national census report (HCP 2018), the total area of study area is about 11,570

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km² with an average population density of 222.2/km², and the human population is 3 549512. The study area has Mediterranean climate with maximum temperature beyond 450C during summer (July-August) and below 00C during winter (December-January) and annual rainfall is about 1000 mm.

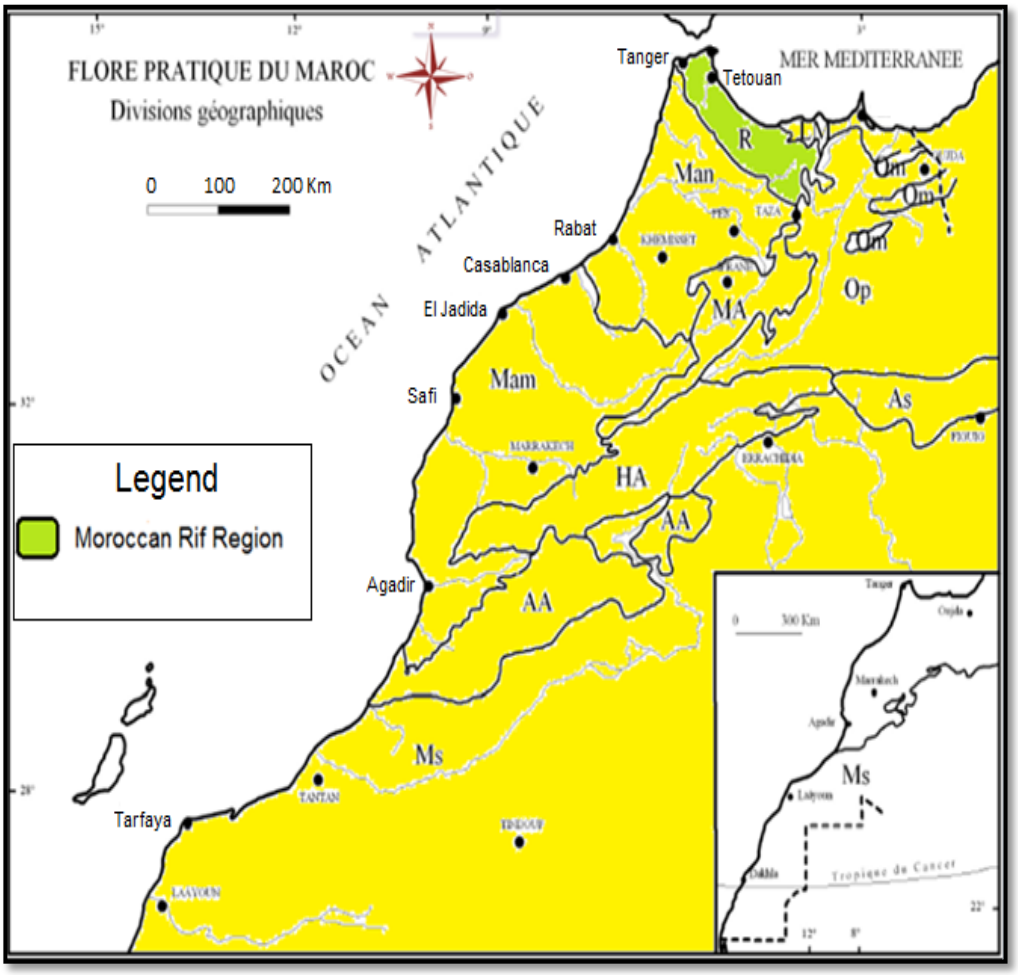

Fig. 1. Map of the study area.

The economy of the local people is mainly based on subsistence agriculture, livestock and to a lesser extent, from forest resources for their livelihood. Traditional medicine is the first choice for the population for health problems, and traditional healers in this area are reputed to have good knowledge on MAPs and disease treatment.

Data collection

In order to gather information on MAPs used for curing respiratory system disorders, an ethnobotanical and ethnopharmacological Surveys were conducted from June 30th, 2016 to June 1st, 2018. Semi-structured questionnaires were administered and open-ended interviews were conducted, through face to face interviews and focus group. The inclusion criteria were people who are knowledgeable about plants used for respiratory system problems, while the exclusion criteria were informants who are not living in the study area. Totally, 674 informants within aged 20 to 83 were randomly selected for interviews (pharmacists, herbalists, practitioners and therapists) in the study area (hospitals, pharmacies, houses, mosques, and weekly markets). Who have been informed about the objective of these studies, after obtaining their trust and were regularly interviewed in Amazigh or Arabic dialects depending on the variety of language spoken by each case, in order to collect and document indigenous knowledge of plants usage against respiratory system diseases. The questionnaire used consists of two parts: the first part deals with the demographic characteristic of the informants and the second one focuses on the MAPs used in the treatment of the diseases (Appendix). The sample is made up of 349 females and 325 males from different socio-economic strata, chosen at random from the Rif's population. In these studies,

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the sample is developed using a stratified random sampling method (Godron 1971) to conduct various surveys from a site to another in the study area. According to this sampling method, we have divided our study area into sites (Sn), so we have 28 sites that correspond to the number of divisions in the study area (Fig. 2).

Plant species collection and identification

Each plant used by our informants was placed in the Herbarium or in a plastic bag with a label indicating its vernacular name. We photographed them and took samples for identification later in the resources and biodiversity laboratory, department of biology faculty of sciences, Ibn Tofail University Kenitra, Morocco, using the following botanical works: the MAPs of the Morocco (Sijelmassi 1993), practical flora of Morocco (Fennane *et al*. 1999) and catalogs of vascular plants of Northern Morocco, including identification keys (Valdés 2002), volumes I and II.

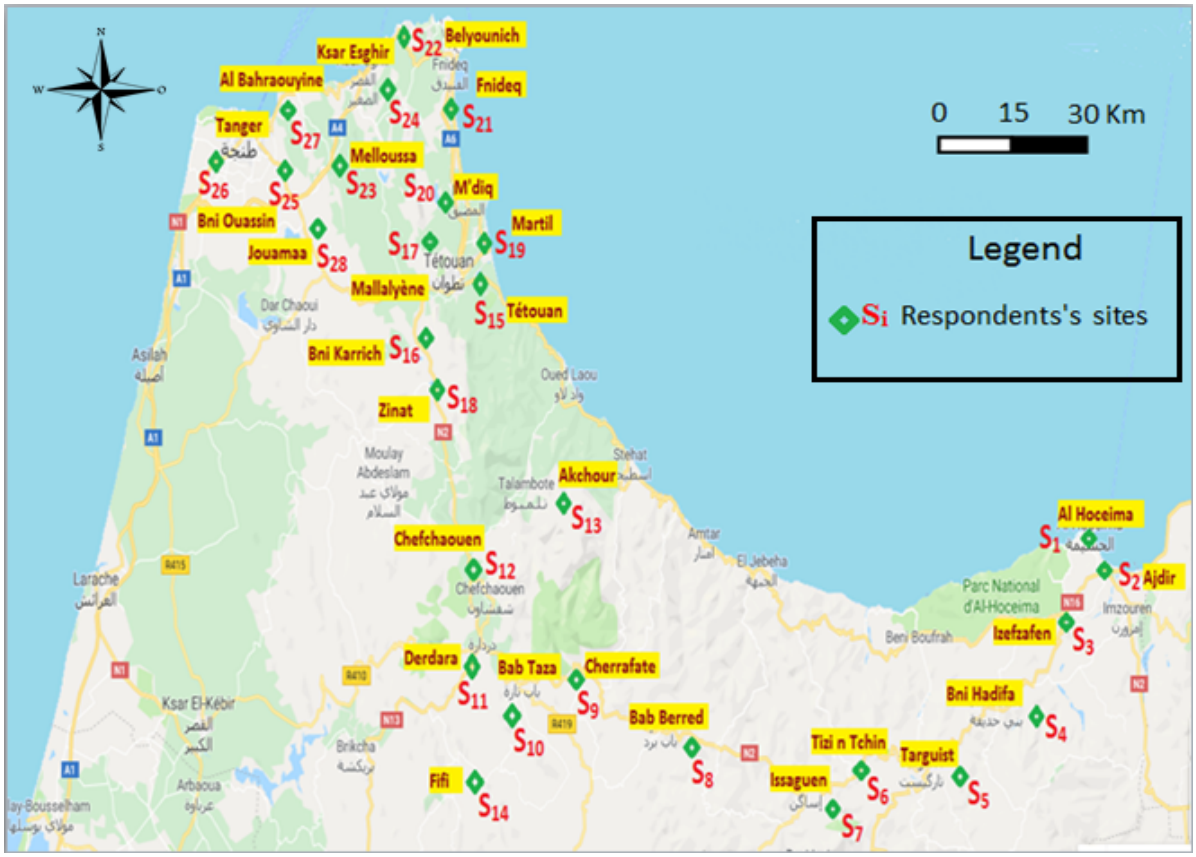

Fig. 2. Distribution of survey points at the study area level.

Data Analysis

Descriptive and quantitative statistical methods were used to analyze the socio-demographic data of the informants (ANOVA One-way and Independent Samples T-Test, P-values of 0.05 or less were considered significant). The results of the ethnobotanical and ethnopharmacological surveys were analyzed using the Family Importance Value (FIV), Relative Frequency of Citation (RFC), Plant Part Value (PPV), Fidelity Level (FL) and Informant Consensus Factor (ICF). All statistical analyses were carried out with Statistical Package for Social Science (SPSS) version 21 and Microsoft Excel 2010.

Family Importance Value (FIV)

The FIV identify the significance of plants families. It is as an index of cultural importance which can be applied in ethnobotany to calculate a value of biological plant taxon. To calculate FIV, we use the following formula: $\mathrm{FIV} = \frac{FC_{family}}{\mathrm{Ns}}$. Where $\mathrm{FC_{family}}$ = RFC is the number of informants mentioning the family and Ns = Total number of species within each family (Sreekeesoon and Mahomoodally 2014).

Frequency (FC) and Relative Frequency of Citation (RFC)

Relative frequency of citation (RFC) is obtained by dividing frequency citation (FC) by total number of informants in the survey (N). The value of RFC for

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species of MAPs is based on the citing percentage of informants for every species. RFC was calculated by using the following formula (Tardío and Pardo-de-Santayana 2008): $\mathrm{RFC} = \frac{FC}{\mathrm{N}}$ with (0 < RFC < 1).

Plant Part Value (PPV)

Plant part value (PPV) was calculated using the following formula $\mathrm{PPV} = \frac{\mathrm{RU_{Plant\,part}}}{\mathrm{RU}}$. Where RU is the number of uses reported of all parts of the plant and $\mathrm{RU_{plant\ part}}$ is the sum of uses reported per part of the plant. The part with the highest PPV is the most used by the respondents.

Fidelity Level (FL)

Fidelity level (FL) is the percentage of informants who mentioned the uses of certain plant species to treat a particular ailment in the study area. The FL index is calculated using this formula (Friedman *et al*. 1986): $\mathrm{FL}\,(\%) = \frac{\mathrm{Np}}{\mathrm{N}} \mathrm{x}\,100$. Where Np is the number of informants that claim a use of a plant species to treat a particular disease, and N is the number of informants that use the plants as a medicine to treat any given disease.

Informant Consensus Factor (ICF)

Informant consensus factor was derived in order to seek an agreement between the informants on the reported cures for each group of diseases (Heinrich *et al*. 1998). $\mathrm{ICF} = \frac{\mathrm{Nur-Nt}}{\mathrm{Nur-1}}$. Where Nur is the number of use-reports in each disease category and Nt is number of species used.

Results and Discussion

Socio-demographic features of the informants (N=674)

A total of 674 local informants including 349 females and 325 males (with a sex ratio female/male of 1.07) were interviewed (Table 1). The percentage of MAPs reported by females (51.8%) was greater than males (48.2%) though the difference was not statistically significant (P = 0.375). This predominance of females can be explained by the vigilance of women for the balance of the disease, and their attachment to all that is traditional; indeed, it is women who give sustenance and healthcare to their families in case of an illness. These results confirm the results of other ethnobotanical work carried out at national scale (Jouad *et al*. 2001a; Salhi *et al*. 2010a; Tahraoui *et al*. 2007a; Ziyyat *et al*. 1997).

The majority of respondents were with the age range between 40 and 60 (47.3%) followed by informants who were more than 60 years (36.2%), informants who were between 20 and 40 years (13.1%). Finally informants with an age less than 20 come in last position (3.4%). The difference between age groups and indigenous knowledge was significant (P = 0.000). The highest age respondents provide more reliable information because they hold much of the ancestral knowledge that is part of the oral tradition. So there is a loss of information on MAPs, which can be explained by the mistrust of certain young people, who tend not to believe this herbal medicine due to the influence of modernization and exotic culture influence. At present, the traditional medical knowledge transmitted from generation to generation is in danger, because transmission between old people and younger generation is not always assured (Anyinam 1995). These values confirm the results obtained in other regions of Morocco (Aribi 2013; Benlamdini *et al*. 2014a; El Hafian *et al*. 2014a).

The analysis of the collected data shows that, MAPs are much more used by married (72.3%) than by divorced (14.4%), knowing that widowers have a percentage of 8% and only 5.3% for singles, because the married people can avoid or minimize the material charges required by the doctor and the pharmacist. The difference between family status and indigenous knowledge for the treatment of respiratory system diseases was statistically significant (P = 0.000). Those findings coincide with those of similar study conducted by (El Hilah *et al*. 2015) in the central plateau of Morocco (Table 1).

Regarding the level of education, 70.5% of the informants were illiterate, the 29.5% of the remaining informants were divided between primary schooling (21.32%), secondary schooling (7.18%), and only 1% with higher education. Thus, the difference between educational level and indigenous knowledge was significant (P = 0.000). We can therefore see that the use of MAPs decreases as the level of study increases. This result is similar to the findings reported by (Bouzid *et al*. 2017; El Hilah *et al*. 2015a; Lahsissene *et al*. 2009).

In our studies, 25.5% of the interviewees had a low socio-economic level, (60.1%) were unemployed, (12.1%) with average level, and only 2.3% with higher level. The difference between income/month and indigenous knowledge was significant (P = 0.000). The high cost of modern medical treatments and their side effects are among the main reasons why respondents used herbal medicine. We can therefore see that the use of MAPs increases with the increase in monthly income of these informants. These results are similar to those obtained in Moyen Moulouya of Morocco by (Douiri *et al*. 2007a).

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Floristic Analysis

Diversity of MAPs in the study area

In total, 674 respondents were interviewed in these studies and 41 species and subspecies of MAPs belonging to 22 botanical families were used to treat respiratory system diseases in the study area. These plants are presented in alphabetical order. For each plant listed, we give the scientific name, the family, the local name, the part used, the method of preparation adopted by the local population, as well as the data of FIV, RFC and FL are shown in Table 2.

The most importnat botanical family of MAPs, used to treat respiratory system diseases based on the number of species and FIV index, was Lamiaceae (8 species with FIV 0.048), the other most represented families were: Brassicaceae (07 species with FIV 0.009), Poaceae (03 species with FIV 0.002) and Zingibiraceae (03 species with FIV 0.054), while other families were represented by two or one species only (Fig. 3). Scientific studies on these plant families could provide insights into their rich phytoconstituents and understandings of the pharmacological actions of their active compounds (Ramana 2008). The dominance of these families is mainly due to some especial properties such as secondary metabolites. This representation has also been observed, with some differences, in other ethnomedicinal surveys conducted in other regions of the country (Benlamdini *et al*. 2014b; Eddouks *et al*. 2002; Jouad *et al*. 2001b; Tahraoui *et al*. 2007b).

Table 1. Socio-demographic details of the respondents in the study area.

Variables	Catrgories	Number of informants	Percentages (%)	P-values
Gender	Female	349	51.8	.0645
	Male	325	48.2	
Age groups	< 18 years	23	3.4	0.000
	20-40	88	13.1	
	40-60	319	47.3	
	> 60 years	244	36.2	
Family situation	Married	487	72.3	0.000
	Divorced	97	14.4	
	Widower	96	8.8	
	Single	36	5.3	
Educational level	Illiterate	475	70.5	0.000
	Primary	144	21.32	
	Secondary	48	7.18	
	University	7	1	
Income/month	Unemployed	405	60.1	0.000
	250 - 1500 DH	172	25.5	
	1500 - 5000 DH	82	12.1	
	> 5000 DH	15	2.3	

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Table 2: List of medicinal and aromatic plants actives on the respiratory system diseases in the Moroccan Rif region.

Family and Scientific name	Local name	Parts used	Preparation	Medicinal uses	FL %	FC	RFC	FIV
Aizoaceae								0.001
Mesembryanthemum acinaciforme L.	Bousbayeaa	Leaf	Other	CG	100	01	0.001	
Anacardiaceae								0.001
Schinus molle L.	Foulfol kadib	Fruit	Decoction	TB	100	01	0.001	
Apiaceae								0.003
Thapsia garganica L.	Deryas	Whole plant	Cataplasm	CG	100	02	0.003	
Araliaceae								0.003
Hedera helix L.	Louwaya	Leaf	Cooked	AT,	100	02	0.003	
Asteraceae								0.001
.*Sonchus oleraceus* (L.) L.	Tilfaf	Whole plant	Cooked	LC	100	01	0.001	
Brassicaceae								0.009
Brassica rapa L.	Left Lbeldi	Root	Raw	CL	100	06	0.009	
Lepidium sativum L.	Habb Rchad	Seed	Cooked	AT,	100	21	0.031	
Sinapis alba L.	Karkaz	Seed	Cooked	CG	100	01	0.001	
Brassica rapa var. *annua* W.D.J.Koch.	Left	Leaf	Raw	TB	100	07	0.010	
Sinapis arvensis L.	Khardal	Leaf	Cooked	CL	100	01	0.001	
Brassica fruticulosa Cirillo.	Harchae	Seed	Decoction	LC	100	01	0.001	
Brassica nigra (L.) K.Koch.	Khrdal, Bohamo	Leaf	Infusion	CL	100	06	0.009	
Cupressaceae								0.018
Juniperus oxycedrus L.	Taqqa	Leaf	Infusion	AT,	100	12	0.018	
Cuscutaceae								0.001
Cuscuta approximata Bab.	Lhamoul	Whole plant	Infusion	TB	100	01	0.001	

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Cyperaceae								0.001
Cyperus alternifolius L.	Saad	Whole plant	Infusion	TB	100	01	0.001	
Fabaceae								0.041
Vicia faba L.	Elfûl, Ibaouèn	Seed	Cooked	AT,	100	51	0.076	
Medicago sativa L.	Fessa	Leaf	Decoction	LC	100	05	0.007	
Lamiaceae								0.048
Lavandula pedunculata (Mill.) Cav.	Lakhzama	Leaf	Decoction	LC	100	03	0.004	
Lavandula stoechas L.	Halhal	Leaf	Decoction	AT,	100	56	0.083	
Mentha suaveolens Ehrh.	Marseta, Timersad	Leaf	Decoction	CL, CG	89	46	0.068	
Mentha saturejoides R.Br.	Menta, Nadgh	Whole plant	Infusion	AT,	100	11	0.016	
Lavandula multifida L.	Kohhyla, Tiguizte	Leaf	Decoction	AT,	100	23	0.034	
Lavandula dentata L.	Lakhzama	Other combination	Infusion	AT, CL	75.5	53	0.078	
Mentha × *citrata* Ehrh.	Nana Elmeska	Whole plant	Infusion	CL	100	04	0.006	
Mentha × *rotundifolia* (L.) Huds.	Mchichtrou	Leaf	Infusion	AT, CL, CG	49.3	67	0.100	
Lauraceae								0.003
Cinnamomum camphora (L.) J.Presl.	Kafour	Leaf	Infusion	CL	100	02	0.003	
Myrtaceae								0.051
Eucalyptus globulus Labill.	Kalitûs	Leaf	Cataplasm	AT, CL	93.8	65	0.096	
Eucalyptus camaldulensis Dehnh.	Kalitûs	Leaf	Decoction	AT, LC	60	05	0.007	
Oleaceae								0.009
Fraxinus angustifolia Vahl.	Lsan Ettir	Other combination	Infusion	CG	100	06	0.009	
Platanaceae								0.001
Platanus orientalis L.	Delb Machriqi	Bark	Infusion	LC	100	01	0.001	
Poaceae								0.002
Avena sativa L.	Khortal	Seed	Decoction	CG	100	02	0.003	

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Cynodon dactylon (L.) Pers.	N'jem	Rhizome	Infusion	TB	100	02	0.003	
Festuca glauca Vill.	Aguzmir	Whole plant	Decoction	TB	100	01	0.001	
Pontederiaceae								0.024
Eichhornia crassipes (Mart.) Solms.	Sounbel	Whole plant	Cooked	CL	100	16	0.024	
Ranunculaceae								0.115
Nigella sativa L.	Sanûj	Seed	Infusion	CL	100	78	0.115	
Rutaceae								0.003
Citrus sinensis (L.) Osbeck.	Limoun	Fruit	Other	TB	100	02	0.003	
Solanaceae								0.053
Mandragora autumnalis Mill.	Bid Al Ghol, Taryâla	Leaf	Other	AT	100	36	0.053	
Styracaceae								0.007
Styrax officinalis L.	Jawi	Bark	Other	TB	100	05	0.007	
Zingiberaceae								0.054
Alpinia officinarum Hance.	khodenjal	Rhizome	Decoction	AT	100	02	0.003	
Zingiber officinale Roscoe.	Skinjbir	Rhizome	Infusion	AT, CL, TB	89.6	106	0.157	
Elettaria cardamomum (L.) Maton.	Qaaqella	Seed	Decoction	TB	100	01	0.001	

AT: Asthma; CL: Cold; CG: Cough; TB: Tuberculosis; LC: Lung Cancer.

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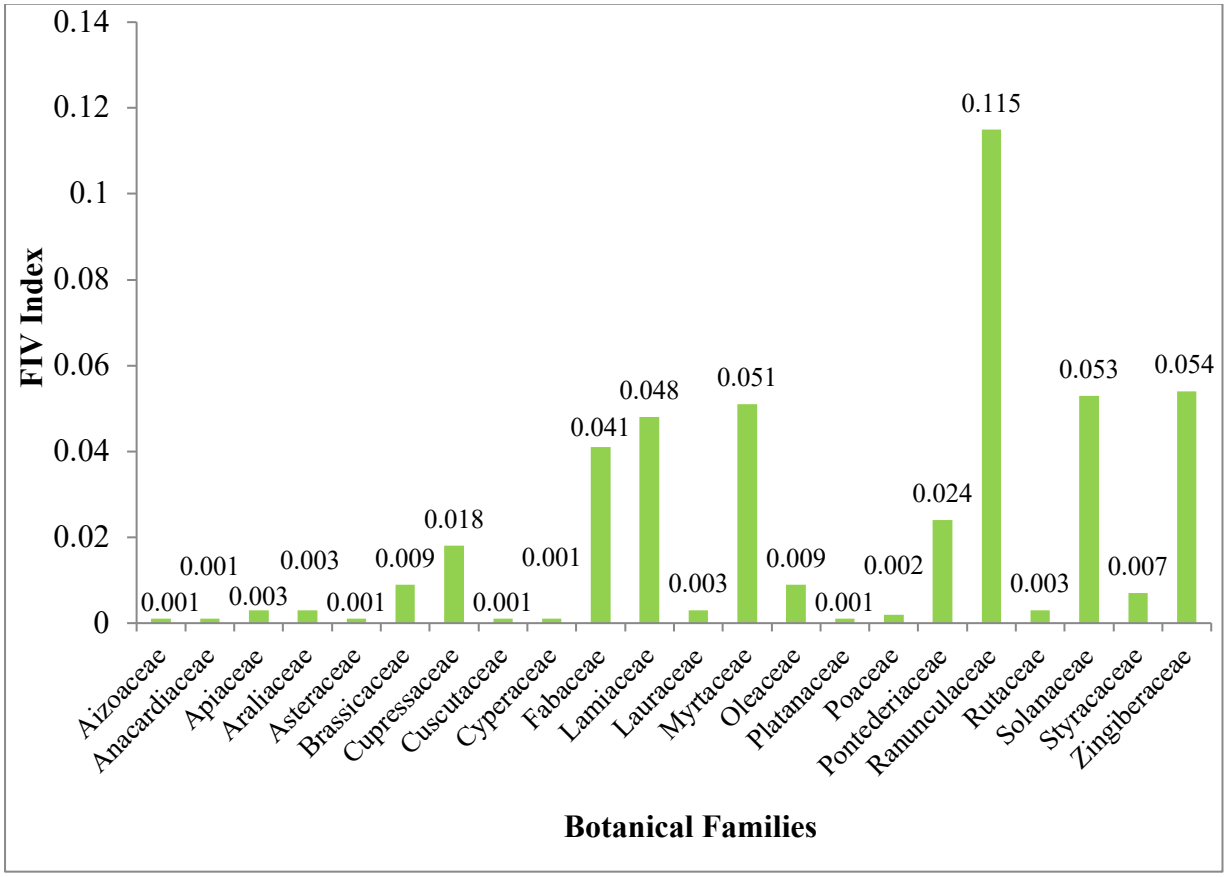

Fig.3. Family Importance value (FIV) of medicinal plants.

Informant consensus factor and fidelity level of MAPs.

To evaluate the relative importance of reported MAPs, relative frequency of citation (RFC) were calculated based on the informants' citations for specific under study plant, its value ranged from 0.001 to 0.157. The most commonly used species were Zingiber officinale Roscoe. (RFC = 0.157), Nigella sativa L. (RFC 0.115), Mentha × rotundifolia (L.) Huds. (RFC = 0.1), Eucalyptus globulus Labill. (RFC = 0.096), Lavandula Stoechas L. (RFC = 0.083) and Lavandula dentata L. (RFC = 0.078) (Table 2). These species had the highest RFC index, because these plants were mentioned by a large number of informants and RFC directly depends on the number of informants mentioning the use of a specific plant. Those MAPs having high RFC must be further assessed for phytochemical and pharmaceutical analysis to identify their active constituents for any drug extraction (Vitalini et al. 2013).

Fidelity Level (FL) is one of the quantitative tools used to select MAPs from ethnopharmacological field studies for further pharmacological screening. In our studies, the majority of the plants had high FL, and the highest FL of 100% was recorded for 39 plant species (Table 2). The MAPs with high fidelity level are considered as having better healing potential in the Rif region. Only 2 species show low fidelity values (FL < 60). Low fidelity levels of the used plants are indicative of the popular character of Rif's medicine, where home remedies rather than plants prescribed by specialists are used.

Plant parts used for remedy preparation

The plant parts of MAPs used to cure respiratory system disorders, varied from species to species. Based on the plant part value PPV index, leaf was reported as the dominant plant part for respiratory system diseases remedy preparation in the study area (PPV 0.482), followed by seed (PPV 0.224), rhizome (PPV 0.162), other combination (PPV 0.086), whole plant (PPV 0.024), root and bark (PPV 0.009 each) and fruit (PPV 0.004) respectively (Fig. 4). The preference of leaves was due to its easy availability, easy harvesting and simplicity in remedy preparation. In addition, the leaves are the center of phytochemical reactions, making them rich in metabolites. Similar findings indicated leaf as a

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major dominant plant part in Morocco (Daoudi *et al*. 2016; Douiri *et al*. 2007b; Hachi *et al*. 2015) or in World (Asnake *et al*. 2016; Mukungu *et al*. 2016; Nouri 2016; Ranganathan *et al*. 2012; Rhazi *et al*. 2017) for herbal medicine preparation.

Methods of preparations

The preparations are divided into 5 categories including raw, cooked, decoction, infusion and other forms of preparations (Fig. 5). The majority of the remedies in the study area were prepared by decoction (46.3%) followed by infusion (38.5%) cooked (7.6%), other forms of preparations (4.4%) and raw (3.2%). The frequent use of the decoction can be explained by the fact that the decoction makes it possible to collect the most active ingredients and attenuates or cancels out the toxic effect of certain recipes. Ethnobotanical research surveys conducted elsewhere in Morocco showed the majority of the interviewees prepared the remedy by decoction (El Hilah *et al*. 2015b; Salhi *et al*. 2010b; Slimani *et al*. 2016). This confirms that there is a perpetual exchange of information on the use of MAPs between the people of Morocco. Decoction mentioned as the major method of preparation at the continental level (Okello *et al*. 2010; Stangeland *et al*. 2011; Yetein *et al*. 2013).

Routes of administration

Concerning the route of administration people in the Rif area preferred the administration of their herbal medicines through oral (85.1%) followed by swabbing (8.04%), rinsing (3%), massage (2%). The percentage of the other modes of administration grouped (Inhalation, parenteral) does not exceed 1.86%. The predominance of oral administration may be explained by a high incidence of internal ailments in the region (Polat and Satıl 2012). On the other hand, it's thought that oral route is the most acceptable for the patient. The predominance of oral administration of the different MAPs in the Rif is in total agreement with most of the carried out ethnobotanical studies in Africa (Benarba *et al*. 2014; Chermat and Gharzouli 2015; El Hafian *et al*. 2014b).

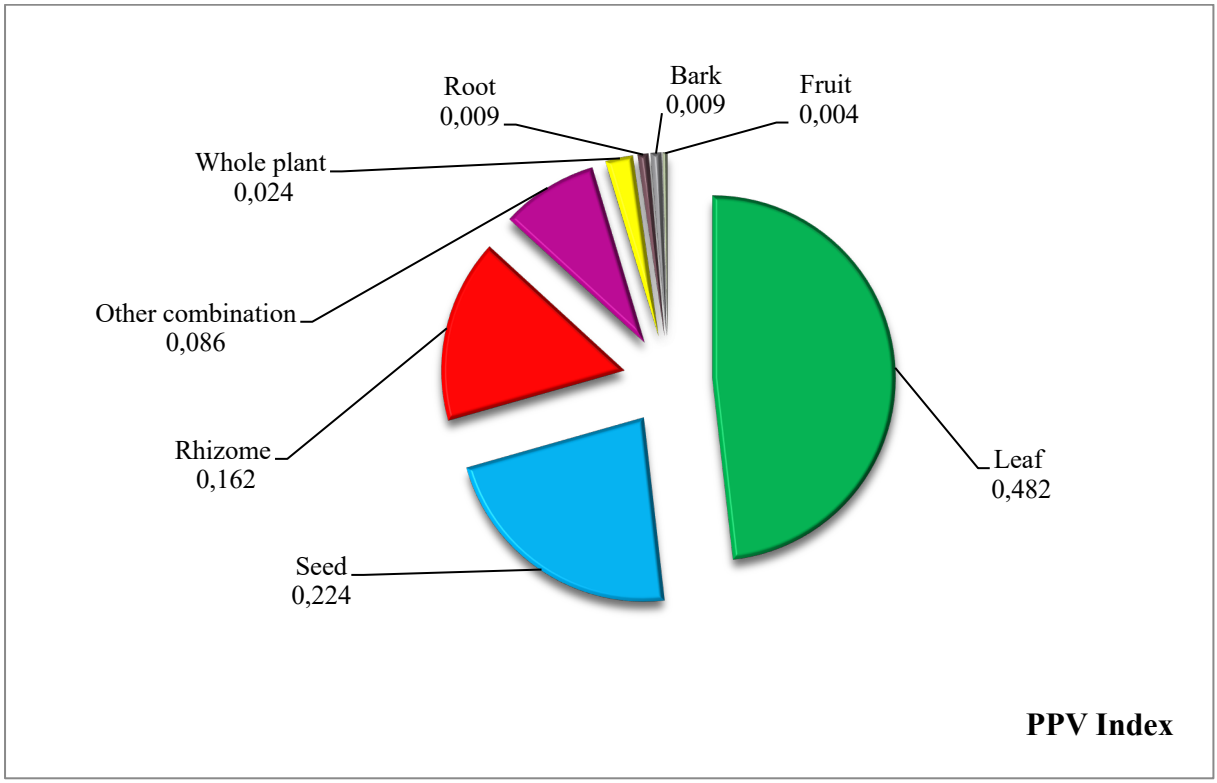

Fig.4. Plant part used in the treatment of respiratory system diseases.

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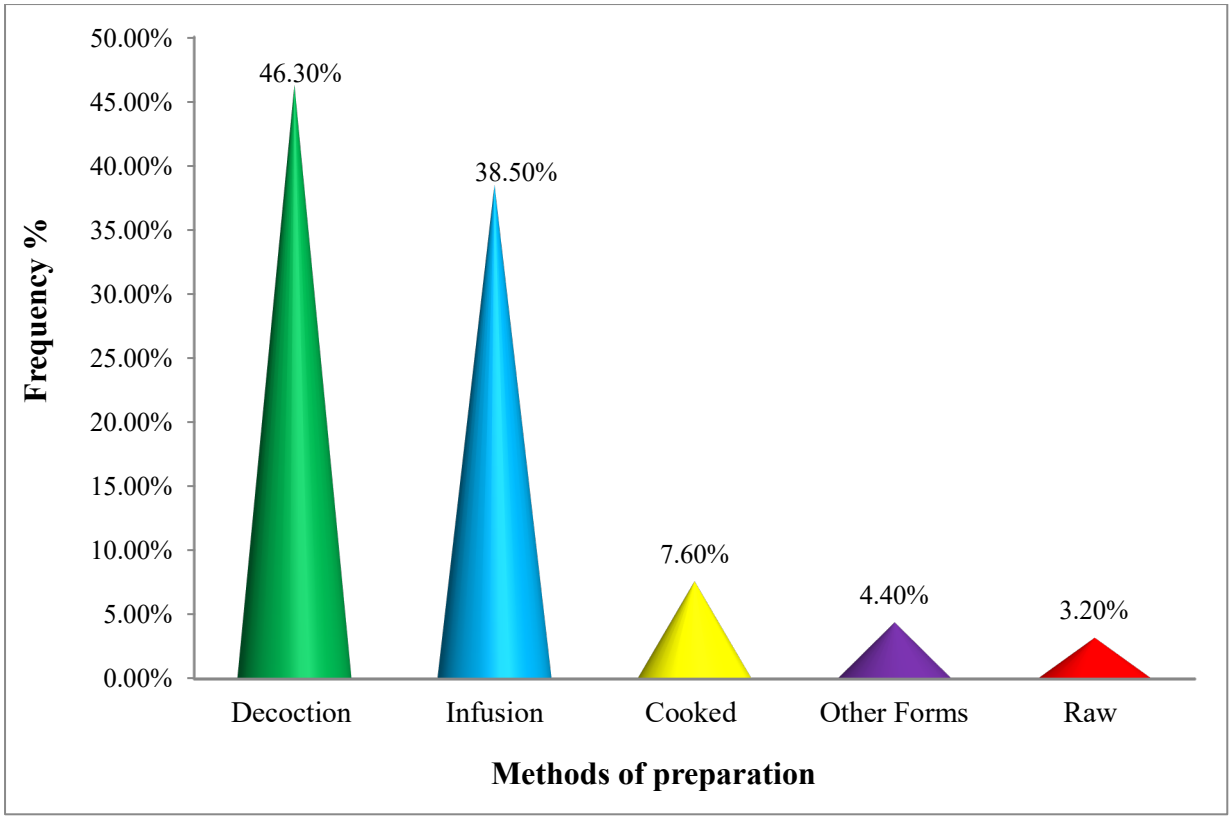

Fig. 5. Frequency of different methods of preparation.

Conditions of medicine preparation

Most commonly, the local people asserted that they prefer the fresh plant part than the dried part for remedy preparation. The majority of the remedies (83%) in the study area were prepared from fresh parts of MAPs followed by dried form (10%) and (7%) prepared either from dry or fresh plant parts. The study conducted by (Abdurhman 2010) indicated that 86% of preparations were in fresh form and (Getahun 1976) reported that most of (64%) MAPs were used in fresh form and 36% in dried from. The dependency of Rif's people on fresh materials is mostly due to the effectiveness of fresh MAPs in treatment as the contents are not lost before use compared to the dried forms.

Source of knowledge about MAPs

In our study, 71.2% of the population acquired knowledge about medicinal use of plants as remedy for respiratory system diseases through others' experiences. This reflects the relative transmission of traditional practices from a generation to the next one. 16% practice herbal medicine according to herbalists' advices, (9.3%) of respondents their information is reflected from pharmacist and only 3.5% had built this knowledge by reading books about traditional Arab medicine, by watching television programs or by their own experience with a large number of MAPs in their surroundings. The environment and others' experience remain therefore the most effective means to transmit knowledge about medicinal purposes of plants (Fig. 6).

Treated ailments and informant consensus factor (ICF)

The informant consensus factor (ICF) reflects homogeneity of information provided by different informants regarding MAPs used to treat a category of ailments. The ICF values obtained for the categorized uses are presented in Table 3. Five categories were reported, namely, asthma, cold, cough, tuberculosis and lung cancer. ICF values obtained for the reported categories indicate the degree of shared knowledge for the uses of medicinal herbs. The ICF's factors ranging from 0.54 to 0.97 per uses categories. The ICF (0.97) was registered for the use asthma category with 14 species, which may indicate a high incidence of this type in this region. This high ICF values indicated reasonable reliability of informants on the use of MAPs (Lin *et al*. 2002). Therefore, species with high FIC are to be prioritized for further pharmacological and phytochemical studies.

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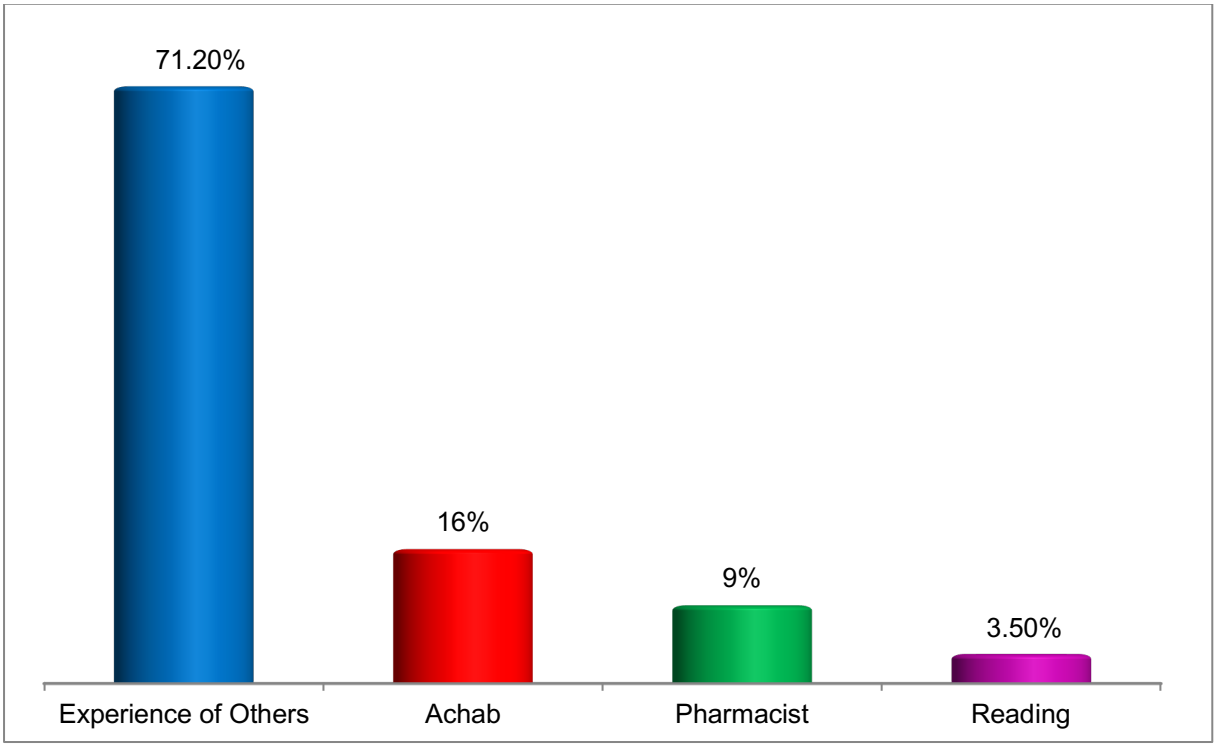

Fig. 3. Traditional knowledge acquisition modes.

Table 3. ICF values by categories for treating respiratory system disorders.

Categories	List of plant species used and number of citations	Total number of		ICF
		Species	Use citations	
Asthma (AT)	*Hedera helix* L. (2), *Lepidium sativum* L. (21), *Juniperus oxycedrus* L. (12), *Vicia faba* L. (51), *Lavandula stoechas* L. (56), *Mentha saturejoides* R.Br. (11), *Lavandula multifida* L. (23), *Mentha* × *rotundifolia* (L.) Huds. (30), *Eucalyptus globulus* Labill. (61), *Mandragora autumnalis* Mill. (36), *Alpinia officinarum* Hance. (2), *Zingiber officinale* Roscoe. (95), *Lavandula dentata* L. (13), *Eucalyptus camaldulensis* Dehnh. (3).	14	416	0.97
Cold (CL)	*Brassica rapa* L. (6), *Sinapis arvensis* L. (1), *Brassica nigra* (L.) K.Koch. (6), *Mentha suaveolens* Ehrh. (41), *Lavandula dentata* L. (40), *Mentha* × *citrata* Ehrh. (4), *Cinnamomum camphora* (L.) J.Presl. (2), *Eichhornia crassipes* (Mart.) Solms. (16), *Nigella sativa* L. (78), *Zingiber officinale* Roscoe. (5), *Mentha* × *rotundifolia* (L.) Huds. (4), *Eucalyptus globulus* Labill.. (4).	12	207	0.94
Cough (CG)	*Mesembryanthemum acinaciforme* L. (1), *Thapsia garganica* L. (2), *Sinapis alba* L. (1), *Fraxinus angustifolia*	7	50	0.86

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	Vahl. (6), *Avena sativa* L. (2), *Mentha* × *rotundifolia* (L.) Huds. (33), *Mentha suaveolens* Ehrh. (5).			
Tuberculosis (TB)	*Schinus molle* L. (1), *Brassica rapa* var. *annua* W.D.J.Koch. (7), *Cuscuta approximata* Bab. (1), *Cyperus alternifolius* L. (1), *Cynodon dactylon* (L.) Pers. (2), *Festuca glauca* Vill. (1), *Citrus sinensis* (L.) Osbeck. (2), *Styrax officinalis* L. (5), *Elettaria cardamomum* (L.) Maton. (1), *Zingiber officinale* Roscoe. (6).	10	27	0.63
Lung Cancer (LC)	*Sonchus oleraceus* (L.) L. (1), *Brassica fruticulosa* Cirillo. (1), *Medicago sativa* L. (5), *Lavandula pedunculata* (Mill.) Cav. (3), *Eucalyptus camaldulensis* Dehnh. (2), *Platanus orientalis* L. (1).	6	13	0.54

Conclusions

The ethnobotanical and ethnopharmacological surveys revealed that, the study area has a great biodiversity with a variety of MAPs and still needs more explorations. This rich floral indicates the high potential of traditional knowledge to serve for the development of natural product-derivate as affordable medicines. These plants still play a crucial role for people in the Rif, but MAPs used to treat respiratory system disorders in this region lack ethnomedicinal evidence. Unfortunately, medicinal flora of Rif region is under threat to the extinction as people are unaware of the conservation strategies for future uses. Deforestation, overgrazing, agricultural expansion, and extensive eradication of medicinal herbs from root, threatened the flora. On the basis of results of the present studies, MAPs scoring high relative frequency of citation, informant consensus factor and fidelity level values should be further tested for their pharmaceutical, phytochemical and biological studies to explore their potential to discover new drugs with limited side effects. In this respect, attention should be drawn to the conservation of traditional MAPs and associated indigenous knowledge in the Rif's area to sustain them in the future.

Declarations

Conflicts of interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

List of Abbreviations

FIV: family importance value
RFC: relative frequency of citation
PPV: plant part value
FL: fidelity level
ICF: informant consensus factor
MAPs: medicinal and aromatic plants
SPSS: statistical package for social science
FC: frequency of citation.

Ethics approval and consent to participate

Before conducting interviews, prior informed consent was obtained from all participants. No further ethics approval was required.

Author's contributions

Noureddine Chaachouay: Compiled the literature sources, data analysis, and interpretation and wrote the manuscript. Ouafae Benkhnigue: Helped in data, Lahcen Zidane: identification of plant species Mohamed Fadli: conceptualization of work, Rachida El Ayadi: realization and manuscript evaluation.

Consent for publication

Not applicable

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