



Treatment of Urolithiasis: Ethnobotanical Study of Plants Used by the Population Bordering the Forest of Izarène

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Research

Abstract

Background: In order to valorize and safeguard ancestral knowledge of medicinal plants used in traditional pharmacopoeia in the treatment of urolithiasis, an ethnobotanical study was carried out near the riverine population of the forest of Izarène.

Methods: Using 480 questionnaire cards, ethnobotanical field surveys were conducted during three campaigns (2013-2016). The different survey environments were determined using probabilistic stratified sampling techniques. The data were organized and analyzed by descriptive statistics. Ethnobotanical data were analyzed through the calculation of different quantitative indices, such as: Relative Frequency of Citation (RFC), Family Importance Value index (FIV) and Use value of the Plant Part (PPV).

Results: The results showed 53 useful plant species, belonging to 24 botanical families, which have been reported in the treatment of renal lithiasis. The Lamiaceae family was the most represented (10 species, FIV = 0.043). The highest Relative Citation Frequency (RFC) (0.173) was recorded for *Herniaria hirsuta*. The results obtained also showed that leaves are the most used part (PPV = 0.216). The decoction is the dominant method of preparation and the administration is mainly oral.

Conclusions: The results obtained could constitute a database in the perspective of phytochemical, pharmacological and implementation experiments of innovative initiatives that could lead in the future to the manufacture of traditional drugs used in the treatment of renal lithiasis.

Keywords: Medicinal plants, forest of Izarène, ethnobotanical surveys, renal lithiasis.

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Resume

Contexte: Pour valoriser et sauvegarder les connaissances ancestrales sur les plantes médicinales utilisées en pharmacopée traditionnelle dans le traitement de la lithiase rénale, une étude ethnobotanique a été réalisée, auprès de la population riveraine de la forêt d'Izarène.

Méthodes: A l'aide de 480 fiches questionnaires, des enquêtes ethnobotaniques sur le terrain ont été menées pendant trois campagnes (2013 à 2016). La détermination des différents milieux d'enquêtes a été réalisée grâce aux techniques d'échantillonnage stratifié probabiliste. Les données ont été organisées et analysées par des statistiques descriptives. Les données ethnobotaniques ont été analysées via le calcul de différents indices quantitatifs, tels que : la

Fréquence Relative de Citation (RFC), l'indice de valeur d'importance pour la famille (FIV) et la valeur d'usage de la partie de la plante (PPV).

Résultats: Les résultats ont montré 53 espèces végétales utiles, appartenant à 24 familles botaniques, qui ont été signalées dans le traitement de la lithiase rénale. La famille des Lamiaceae était la plus représentée (10 espèces, FIV= 0.043). La Fréquence Relative de Citation (RFC) la plus élevée (0,173) a été enregistrée pour *Herniaria hirsutas*. Les résultats obtenus ont montré aussi que les feuilles sont la partie la plus utilisée (PPV= 0.216). La décoction est le mode de préparation dominant et l'administration se fait majoritairement par voie orale.

Conclusions: Les résultats obtenus pourraient constituer une base de données dans la perspective des expériences phytochimique, pharmacologique et de mise en œuvre des initiatives innovantes pouvant déboucher dans l'avenir sur la fabrication des médicaments traditionnels utilisables dans le traitement de la lithiase rénale.

Mots clés: Plantes médicinales, forêt d'Izarène, enquêtes ethnobotaniques, lithiase rénale.

Background

Urolithiasis is a frequent and recurrent disease, known since ancient times and is inseparable from the history of humanity (El Lekhlifi *et al.* 2014). It is a widespread condition that affects 4 to 20% of the population depending on the country (Doré B. 2004), with a recurrence rate of around 50% over five years (Docti 2013).

In Morocco, it is the second most common cause of hospitalization in urology after prostate adenoma; it is characterized by the formation of crystalline concretions developing in the pelvis and / or the calyces of a kidney causing a total or partial obstruction of normal flow of urine. Calculations have heterogeneous composition in 90 to 95% of cases. Thus, and for reasons of simplification, several publications limit the expression of crystal composition to the majority species (Daudon, 2005). Thus, there are four main types of lithiasis: calcium, uric acid, cystine and phosphate.

In Morocco, fragmentary epidemiological studies have shown that the nature of kidney stones is close to those of industrialized countries with a dominance of calcium oxalate followed by uric acid (Laziri *et al.* 2010; Boumzaoued *et al.* 2015; Bouatia *et al.* 2015). The formation of urinary calculi involves several factors such as sex, dietary intake, genetics, climatic aspects and metabolic disturbances (Badalato *et al.* 2011; Wasserstein 2011).

Today, despite the development of chemical drugs to control urinary diseases, the use of plants is often seen as a source of active substances. In addition, a significant portion of the population, especially in rural areas, prefers medicinal plants for economic reasons and sometimes because of difficulty in accessing medical care.

Morocco occupies a privileged place among the Mediterranean countries which have a long medical tradition and a traditional know-how containing medicinal plants (Scherrer *et al.* 2005). The richness of its traditional medicine has been demonstrated by several studies carried out in the field, which is a legacy of the Arab-Berber civilization and benefited largely from Muslim and Jewish tradition which reigned in this country (Jouad *et al.* 2003).

To document and thus perpetuate the traditional knowledge acquired by the local population, our laboratory tries to undertake floristic, ecological and ethnobotanic research of the medicinal plants on various parts of Morocco. Thus, diverse works were published on the Moroccan ethnobotanic knowledge among which we will cite: El Yahyaoui *et al.* 2015; Orch *et al.* 2015; El Azzouzi *et al.* 2015; Orch *et al.* 2017; Chaachouay *et al.* 2019).

In this context, we carried out an ethnobotanical study which aims to identify and inventory the medicinal plants used for the treatment of urolithiasis among the population bordering the forest of Izarène known for its floristic and ecological diversity, and which offers to the local population a knowledge rather rich in traditional phytotherapy.

Materials and Methods

Description of the study area

The forest massif of Izarène is part of the Tangier-Tétouan-Al Hoceïma area. It is located in the North-western zone of the Kingdom, 12 km to the North-East of the town of Ouezzane and covers an approximate forest surface of 14600 ha between the parallels 34° 45' and 34° 58' N and the meridian lines 5° 25 ' and 5° 32' W. Limited to the southern part by marls of the Cretaceous pre-rifaine nappe, this forest massif is characterized by an uneven relief where the altitudes vary approximately between 350 and 680 m (HCEFLCD 2005).

The zone of study, the Circle of Mokrisset, is a part of the province of Ouezzane and group 3 Caïdats (Zoumi, Mokrisset and Brikcha), and 3 rural districts (Zoumi, AinBaïda and Brikcha) (Figure 1); it contains a population estimated at 25 000 inhabitants (SPEF 2004).

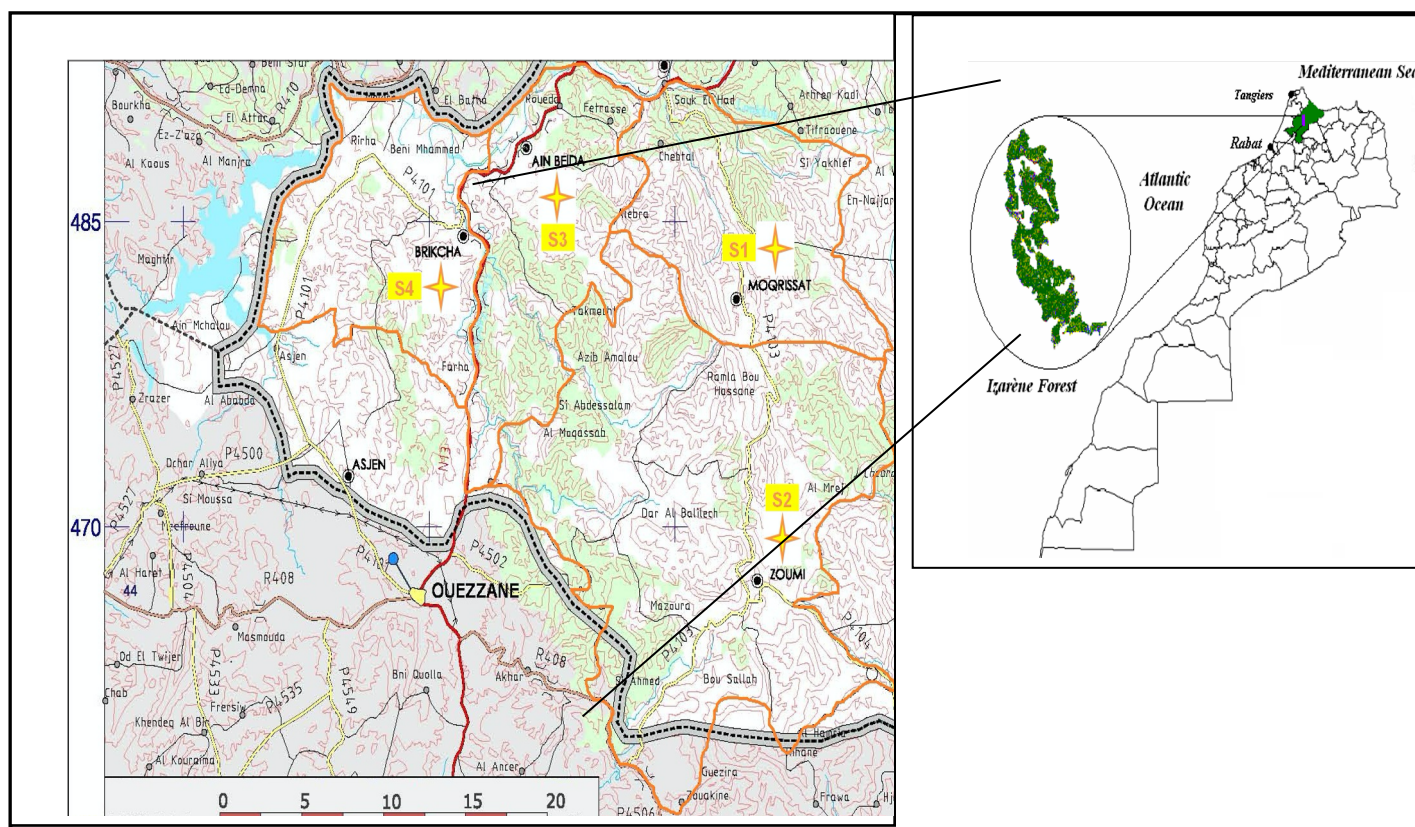


Figure 1. Location map of the study area

The geological formation of the forest massif is characterized by a tormented mountainous area due to the presence of several hills forming the beginning of the mountains of the Rifaine chain of the south side. These hills are characterized by a deep argilo-slaty or argilo-marly soil which can reach in some places more than 3 meters of depth. The climate of the zone is sub-humid at moderate winter, the annual average precipitation would be about 1000mm. These precipitations are distributed over approximately 70 days during all the year (November to April). A mild very rainy winter with almost no frost is followed by a dry and hot season lasting 3 to 4 months (Askarn 1982).

The vegetation cover is characterized by a rich and diversified forest formation, consisting mainly of vegetation that shows a degradation of the climatic formation of the cork oak (Borgniet *et al.* 2009). The forest of Izarène has a vital economic, ecological and social importance for the bordering population. It assures the needs of the population for the firewood and for work and constitutes the principal source of fodder for the cattle (SPEF 2004). Beyond its paramount functions, it also plays a role in traditional medicine thanks to the use of the medicinal plants as means of subsistence among the bordering population.

Data collection

In order to gather information about the use of medicinal plants used for the treatment of kidney stones, ethnobotanical surveys were carried out in different localities, villages and douars, bordering the forest of Izarène, during a period from 2013 to 2015.

The determination of the various mediums of inquiries was achieved thanks to the techniques of probabilistic stratified sampling (Godron 1971 & 1982). In this study, the sample is divided into 4 homogeneous strata (S1, S2, S3 and S4), of which 3 correspond to the numbers of the rural communes of the Circle of Mokrisset (Table 1).

Table 1. Distribution of the surveys by strata

Strata	Names of strata	Number of inquiries
Strata 1	Mokrisset	120
Strata 2	Zoumi	120
Strata 3	Ain Baïda	120
Strata 4	Brikcha	120
Echantillon 480		

The investigation was carried out on 480 inhabitants of villages and douars of the studied zone. By adopting a random stratified sampling, samples of 120 people are then formed for each of the 4 strata

and they are put together to constitute the total sample (480 people).

The field studies required us to deal with two groups: those who knew and/or used plants for medicinal goals and those who used plants and products for commercial purposes (plant collectors, herbalists, traditional practitioners). The interviews with the informants were conducted in the Arabic dialect of the region. A questionnaire was prepared from the preliminary surveys in the study area and validated by a team from the botanical laboratory of the Faculty of Sciences of Kenitra. The questionnaire used consisted of two parts: The first part dealt with the demographic characteristics of the informants and the second focused on the plants used in the treatment of diseases (Appendix 1). The time devoted to each interview was approximately two hours, and the oral and written consent of the informants was collected for each interview. All persons who shared their traditional knowledge were informed about the principle of the study, its interest, and the procedure used while respecting the anonymity of the information collected.

Identification and conservation of plant species

The taxonomic identification of the samples collected in the field was carried out, thanks to the following documents: The medicinal plants of Morocco of Sijelmassi (1993); Practical flora of Morocco of Fennane *et al.* (1999) and Catalogs of Vascular Plants of Northern Morocco, including identification keys, Valdés *et al.* (2002), Volumes I and II.

The botanical and ethnobotanical characteristics as well as the local name of the plants were noted on the samples deposited in the Laboratory of Biodiversity and Natural Resources, Department of Biology, Faculty of Sciences, Kenitra.

Data Analysis

The data recorded on the survey sheets were then transcribed into a database and processed by SPSS version 21 and the Excel spreadsheet (version 2010). Descriptive statistical methods were used to analyze the socio-demographic data of informants. To determine the socio-demographic parameters influencing the orientation of the riverside population towards traditional medication, an analytical study using logistic regression was conducted. Analysis of ethnobotanical data was carried out using the Relative Frequency of Citation (RFC), the Family Importance Value (FIV) and the Plant Part Value (PPV).

Relative frequency of citation (RFC)

RFC is calculated to appreciate the local importance of each species. The RFC is the result of the citation

frequency (F_c), that is the number of informants who mentioned the use of the species, divided by the total number (N) of respondents (Tardio & Pardo-de-Santayana, 2008), with ($0 < RFC < 1$).

$$RFC = F_c / N$$

Family Importance Value (FIV)

The Family Importance Value (FIV) identifies the importance of medicinal plant families. It is calculated using the method proposed by Cadena-González *et al.* (2013).

$$FIV = FC_{family} / N_s$$

where FC_{family} : RFC is the number of informants mentioning the family and N_s : total number of species in each family. Family use value is a culturally significant index that can be applied to ethnobotany to calculate the biological value of the plant taxon (Gakuubi & Wanzala 2012).

Plant Part Value (PPV)

The PPV is calculated to appreciate the importance of each used part of the plant by the respondents, it is obtained by the following formula:

$$PPV = RU_{plant\ part} / RU$$

with $RU_{plant\ part}$ is the sum of reported uses per part of the plant and RU = the number of reported uses of all parts of the plant.

Results and Discussion

Sociodemographic profile of the respondents

This ethnobotanical study was carried out in a sample of 480 people, the results obtained show that the female predominates with 360 women (75%), compared with 120 men (25%) (Table 2), which corresponds to the sex ratio of 3.

The predominance of women can be justified by the fact that women are always looking for natural herbal remedies, to improve their knowledge of these plants and to maintain their health as well as those of their families, since they are closer to the plants either in the medication of their children or in use in cooking. These results confirm the results of other ethnobotanical work carried out at the national level (Ziyyat *et al.* 1997; Hmamouchi 2001; Jouad *et al.* 2001; Eddouks *et al.* 2002; Tahraoui *et al.* 2007; Mehdioui & Kahouadji 2007; Salhi *et al.* 2010; Benkhniq *et al.* 2010).

The use of medicinal plants concerns all age groups at the scale of the riparian population of the forest massif of Izarène. Our results show a predominance of the elderly, so those with an age over 60 represent 36.5%. The age groups of [50-59], [40-49], [30-39],

[18-29] have a percentage of 16.7%, 17.9%, 15% and 14%, respectively. Indeed, older persons are expected to provide more reliable information on the traditional use of medicinal plants, because they hold much of the ancestral knowledge that is transmitted orally. The transmission of this knowledge is currently in danger because it is not always ensured (Weniger 1991; Anyinam 1995). The relative transmission of traditional practices from one generation to the next may explain the mistrust of some people, particularly young people, who tend not to believe too much in this traditional medicine. Concerning the level of education of the respondents

Table 2. Socio-demographic characteristics of the participants in the study area.

	Distribution	Number of informants	Percentages (%)
Gender	Male	120	25.0
	Female	360	75.0
Age groups	[18-30[67	14.0
	[30-40[72	15.0
	[40-50[86	17.9
	[50-60[96	20.0
	> 60	159	33.1
Educational level	Illiterate	234	48.8
	Primary	128	26.7
	Secondary	81	16.9
	University	37	7.7
Family situation	Married	407	84.8
	Single	73	15.2
Monthly income	Without income	204	42.5
	Low income	217	45.2
	Average income	59	12.3

The residents surveyed in this region are mostly married with a percentage of 85% against 15% for single people.

Concerning the socio-economic level, 45.2% of respondents have a low socio-economic level, 42.5% are unemployed and 12.3% have an average level. The high level of poverty, the high cost of modern medical treatments and their side effects are the essential factors that push the local population to make extensive use of herbal medicine as reported in El Hassani's work in Middle Moulouya (El Hassani *et al.* 2013).

According to the logistic regression model, it appears that the variables: gender, age, and least expensive use are predictors influencing the orientation of the riverside population towards traditional medication, pointing out that the least expensive use factor represents an influence of 12 times more than the other factors (Table 3). The high cost of modern medical treatments, their side effects and the unfavorable socio-economic conditions of our

in the study area, the results obtained show that the majority of users are illiterate with a percentage of 48.8%. This relatively high percentage is directly correlated with the education level of the local population. Nevertheless, people with primary and secondary education have a significant percentage (27% and 17% respectively), while those with a university level have a percentage of 8%. Other studies have shown that people's knowledge about the use of medicinal plants is held by illiterate people (Lahsissene *et al.* 2009; Omer *et al.* 2012).

population, are the essential factors that push the local population to make extensive use of herbal medicine. These results confirm the results achieved by El Hassani in Middle Moulouya (El Hassani *et al.* 2013).

Floristic analysis

Botanical families most represented in the study area

Ethnobotanical field surveys have identified 53 species belonging to 24 families and divided into 50 genera. These plants are presented in alphabetical order in Table 4. For each plant listed, we give the scientific name, the family, the local name, the part used, the preparation method adopted by the local population, as well as the CF, RFC and FIV data.

The number of species and the FIV index revealed 6 families with high values of importance and which, as a result, are predominant in the treatment of urolithiasis (Figure 2). These are Lamiaceae (10 species with FIV= 0.043), Apiaceae (6 species with FIV= 0.042), Asteraceae (4 species with FIV=

0.017), Brassicaceae (3 species with FIV= 0.024), Fabaceae (3 species with FIV= 0.075), Poaceae (3 species with FIV= 0.072). The other remaining families have only one or two species. Indeed, these results have been confirmed by similar studies carried out in the Tan-Tan region of Morocco (Ghourri *et al.* 2013), and those carried out in the city of Oran in Algeria (Khitri *et al.* 2016).

Relative Frequency of Citation

Some species are more recommended by the local population than others; this results in a high citation frequency (CF). We calculated the citation frequency (RFC) as numerical representatives in the quantitative ethnobotanical survey to highlight the importance of traditional knowledge. Species with a

very significant relative frequency of citation are those with a high level of use.

Among these plants, seven species belonging to seven botanical families are frequently used by the riparian population in the treatment of renal lithiasis. These are: *Herniaria hirsutas* (RFC=0.173), *Ziziphus lotus* (RFC=0.166), *Zea mays* (RFC=0.154), *Petroselinum sativum* (RFC=0.127), *Glycyrrhiza glabra* (RFC=0.125), *Opuntia ficus-indica* (RFC=0.116) and *Crocus sativus* (RFC=0.10). This representativeness has also been observed, with some differences, in similar ethno-medicinal surveys conducted in other regions of Morocco (Hseini *et al.* 2007; Lahsissene *et al.* 2009; Ghourri *et al.* 2013; Khouchlaa *et al.* 2017).

Table 3. Statistical analyses of the influence of socio-demographic parameters on confidence in plant use.

	Odds-Ratio	IC for 95%		p-value
		Inferior	Superior	
Gender	0.189	0.08	0.445	0.000
Age groups	0.294	0.208	0.415	0.000
Educational level	1.147	0.893	1.474	0.282
Family situation	1.203	0.340	4.254	0.774
Monthly income	1.018	0.572	1.709	1.812
least expensive use	12.403	5.915	26.009	0.000

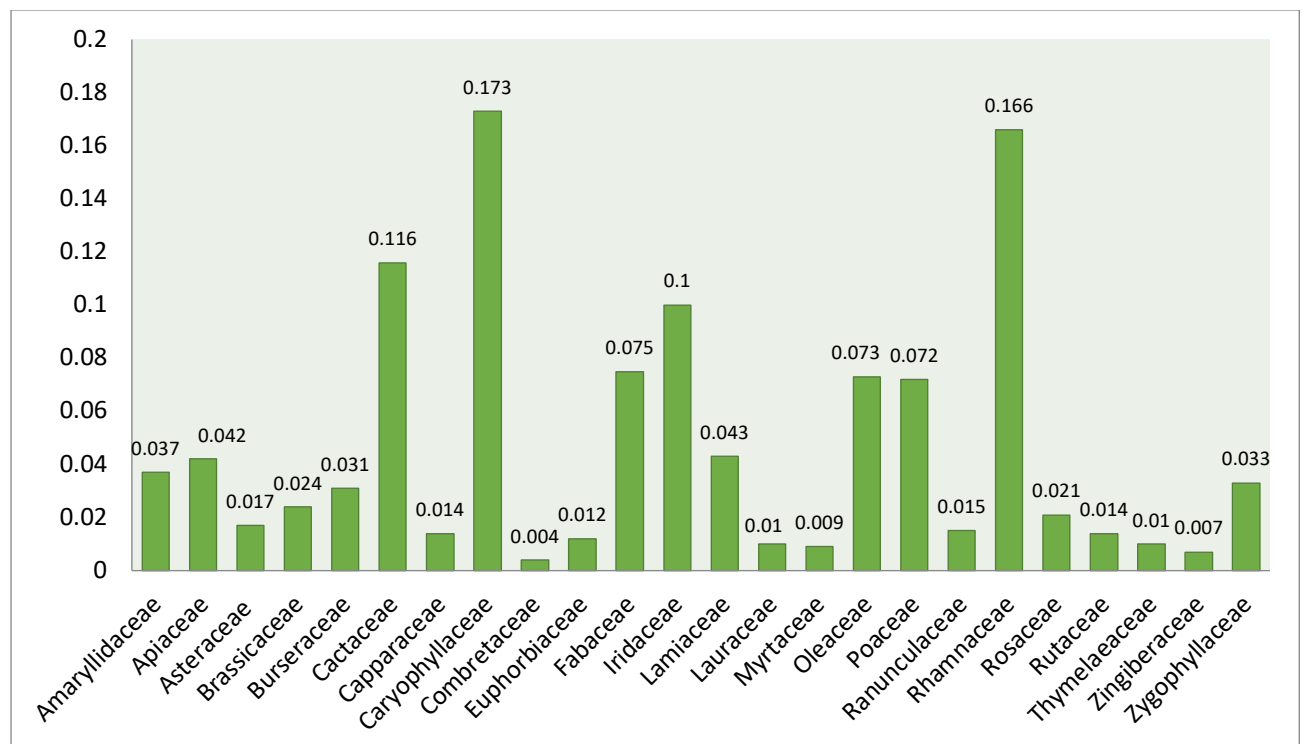


Figure 2. Distribution of medicinal plants according to the family importance value (FIV) in the study area.

Table 4. List of medicinal plants used for the treatment of renal lithiasis in the study area.

Family	Scientific name	Local name	Parts used	Preparation mode	Fc	RFC	FIV
Amaryllidaceae	<i>Allium cepa</i> L.	Lbesla	Other part	Raw	30	0.062	0.037
	<i>Allium sativum</i> L.	Toum	Other part	Raw	6	0.012	
Apiaceae	<i>Ammi visnaga</i> (L.) Lam.	Bachnikha	Seeds	Decoction	26	0.054	0.042
	<i>Apium graveolens</i> L.	Krafèss	Aerial parts	Decoction	2	0.0041	
	<i>Daucus carota</i> L.	Khizzu	Seeds	Decoction	12	0.025	
	<i>Foeniculum vulgare</i> Gaertn.	Nafaâ	Seeds	Infusion	13	0.027	
	<i>Petroselinum sativum</i> Hoffm.	Maâdanous	Aerial parts	Decoction	61	0.127	
	<i>Pimpinella anisum</i> L.	Habbethlawâ	Seeds	Decoction	9	0.0187	
Asteraceae (Composées)	<i>Artemisia herba alba</i> Assac.	Chih	Leaves	Infusion	8	0.0166	0.017
	<i>Inula viscosa</i> (L.) Ait.	Terrahlâ	Leaves	Decoction	12	0.025	
	<i>Echinops spinosus</i> L.	Tassekra	Roots	Decoction	10	0.02	
	<i>Matricaria chamomilla</i> L.	Mansaniya	Flowers	Infusion	3	0.006	
Brassicaceae (Cruciferae)	<i>Anastatica hierochuntica</i> L.	âkarbâ	Aerial parts	Decoction	12	0.025	0.024
	<i>Brassica oleracea</i> L.	Krumb	Leaves	Infusion	8	0.0166	
	<i>Lepidium sativum</i> L.	HabRchad	Seeds	Decoction	15	0.031	
Burseraceae	<i>Boswellia carterii</i> Birdw.	Salabân	Other part	Infusion	20	0.041	0.031
	<i>Commiphora africana</i> (A. Rich) Engl.	Oumm-en-nâs	Other part	Infusion, powder	11	0.022	
Cactaceae	<i>Opuntia ficus-indica</i> (L.) Mill.	NouwaratIhandi ya	Flowers	Infusion	56	0.116	0.116
Capparaceae	<i>Capparis spinosa</i> L.	Al'Kabbar	Fruits	Decoction	7	0.014	0.014
Caryophyllaceae	<i>Herniaria hirsuta</i> L.	Herrastlahjar	Whole plant	Decoction	83	0.173	0.173
Combretaceae	<i>Terminalia chebula</i> Retz.	Hiliije	Fruits	Powder	2	0.004	0.004
Euphorbiaceae	<i>Euphorbia falcata</i> L.	Hayyat en-nufûs	Whole plant	Decoction	6	0.012	0.012
Fabaceae	<i>Glycyrrhiza glabra</i> L.	ârqsûss	Roots	Decoction	60	0.125	0.075
	<i>Medicago sativa</i> L.	Fessa	Seeds	Powder, decoction	45	0.093	
	<i>Senna alexandrina</i> Mill.	Sannâharam	Leaves	Infusion	4	0.0083	
Iridaceae	<i>Crocus sativus</i> L.	Za'âfranelhor	Flowers	Decoction	48	0.1	0.1
Lamiaceae	<i>Ajuga iva</i> (L.) Schreb.	Chendgûra	Aerial parts	Powder	31	0.064	0.043
	<i>Lavandula dentata</i> L.	Lakhzama	Flowers	Decoction, infusion, powder	15	0.0312	
	<i>Lavandula multifida</i> L.	Kohayla	Leaves	Decoction	37	0.077	
	<i>Marrubium vulgare</i> L.	Merriwta	Leaves	Infusion	12	0.025	
	<i>Mentha rotundifolia</i> L.	Mchichtrô	Leaves	Infusion	9	0.0187	
	<i>Origanum compactum</i> Benth.	Zaâtar	Leaves	Infusion	27	0.056	
	<i>Origanum majorana</i> L.	Merededouch	Leaves	Infusion	29	0.06	
	<i>Rosmarinus officinalis</i> L.	Aazir	Leaves	Decoction	14	0.03	
	<i>Salvia officinalis</i> L.	Assalmiya	Leaves	Decoction	18	0.0375	

	<i>Thymus vulgaris</i> L.	Zaïtra	Aerial parts	Decoction	13	0.027	
Lauraceae	<i>Cinnamomum zaylanicum</i> Nees.	Qorfa	Other part	Powder	5	0.01	0.01
Myrtaceae	<i>Eucalyptus globulus</i> Labill.	Al' Kalitūs	Leaves	Decoction	8	0.016	0.009
	<i>Eugenia caryophyllata</i> Thunb	Qronfel	Flowers	Decoction, powder, and maceration	1	0.002	
Oleaceae	<i>Olea europaea</i> var. <i>sativa</i>	Zitoun, Zabbouj	Leaves	Decoction, infusion	35	0.073	0.073
Poaceae	<i>Cynodon dactylon</i> L. Pers.	Njem	Roots	Decoction	11	0.023	0.072
	<i>Hordeum vulgare</i> L.	Chaâir	Seeds	Decoction	20	0.041	
	<i>Zea mays</i> L.	LahyatAdra	Flowers	Decoction	74	0.154	
Ranunculaceae	<i>Nigella sativa</i> L.	Assânûj	Seeds	Decoction	12	0.025	0.015
	<i>Ranunculus muricatus</i> L.	Wdene l'halûf	Roots	Powder	3	0.006	
Rhamnaceae	<i>Ziziphus lotus</i> (L.) Lam.	Nbeg	Fruits	Decoction	80	0.166	0.166
Rosaceae	<i>Cydonia oblonga</i> Mill.	Ssferjel	Leaves	Decoction	6	0.0125	0.021
	<i>Prunus domestica</i> L.	Barkuk	Fruits	Infusion	14	0.03	
Rutaceae	<i>Citrus limon</i> (L.) Brum.	Lhâmed	Fruits	Other	7	0.014	0.014
Thymelaeaceae	<i>Thymelaea lythroides</i> L.	L'metnâne	Leaves	Decoction	5	0.010	0.010
Zingiberaceae	<i>Alpinia officinarum</i> Han.	khdenjâl	Other part	Powder	2	0.004	0,007
	<i>Zingiber officinal</i> Rosc.	Sekinjbîr	Other part	Decoction, powder, and maceration	5	0.01	
Zygophyllaceae	<i>Zygophyllum gaetulum</i> Emb. & Maire	Al'âggaya	Aerial parts	Infusion	16	0.033	0.033

In addition, some of the identified plants are recognized by their toxic potential, such as *Nigella sativa* (Zaoui *et al.* 2000; Bnouham *et al.* 2002), *Zygophyllum gaetulum* and *Artemisia herba-alba* (Eddouks *et al.* 2002; Tahraoui *et al.* 2007). Indeed, the majority of the herbalists are unaware of the toxicity of the plants used as well as the methods of their use, in particular the methods of preparation and the recommended doses. The use of medicinal plants must be rationalized and the benefit/risk determined. Studies on these objectives are therefore necessary.

Frequency of Use of the Medicinal Plants According to their Origin

The ethnobotanical study identified 53 antilithiasic medicinal plants. Among them, 28 species are imported from other parts of the country, while 17 species are cultivated and 8 species collected from the forest of Izarène. Among these last species, four medicinal plants, *Mentha rotundifolia*, *Origanum compactum*, *Ajuga iva* and *Euphorbia falcata* are scarce in the region and may disappear from the forest if no protective measures are taken by the services concerned, due to the intensive collection of these species.

Ethnobotanical analysis

Parts used

To prepare therapeutic recipes used in the treatment of urolithiasis, various parts of the listed plants are exploited by the local population (leaves, flowers, fruit, seed...). The calculation of the PPV use index revealed that the leaves are the most used parts with a PPV index = 0.216, followed by flowers with a PPV= 0.185 index, then the seeds (PPV = 0.142). The other parts are used to a lesser degree (Figure 3). Indeed, these results have been confirmed by similar ethnobotanical studies carried out in other regions of Morocco (Ghourri *et al.* 2013; ElYahyaoui *et al.* 2015; Sbaj-Jouilil *et al.* 2017). The leaves are the most used because they are at the same time central to the photochemical reactions and reservoirs of organic matter derived from them, and therefore rich in active ingredients, and because they are parts that are easy to collect.

Method of preparation and administration

In order to administer the active ingredients contained in medicinal plants, the population bordering the forest of Izarène uses several methods of preparation for the treatment of renal lithiasis (decoction, infusion, powder, raw...). Decoction is the most commonly used method of administration with

a percentage of 50% (Figure 4), followed by Infusion preparation with a percentage of 25.8% and the use of powdered plant with a percentage of 16.2%, the other methods of preparation, namely the use of raw plant, maceration and others, represent 8%. The high percentage of the decoction preparation shows that the local population believes in this type of preparation and finds it adequate to warm the body and disinfect the plant to cancel the toxic effect of some recipes, but decoction can destroy some active ingredients of the species used.

In the study area, the oral route is the most widely used for most plants. However, the majority of respondents do not know the weights, dose, and precise measures to be prescribed in the preparation and dosage of herbal medicines.

Origin of information on medicinal plants

Concerning the therapeutic use of medicinal plants, the majority of respondents collected information through the experience of people around them (62.8%), which reflects the image of the relative transmission of traditional practices from one generation to the next. Herbalists are ranked as the second most important source of information (20.6%) and a small minority (16.6%) through their own experience via television programs

Conclusions

Renal lithiasis is a genuine public health problem. The use of medicinal plants for therapeutic purposes has received renewed attention and interest

throughout Morocco and in developing countries in general.

The level of poverty and the high cost of treatment provided by modern medicine, in addition to annoying side effects, are the main factors that drive the population bordering the forest of Izarène to use the medicinal plants of the traditional pharmacopoeia in the treatment of renal lithiasis.

The study carried out in the region of Izarène, showed the potential richness of the medicinal flora used in the treatment of urolithiasis diseases. Indeed, 53 medicinal species have been identified among the actors of traditional medicine in the study area; they belong to 24 families and are divided into 53 genera. Depending on the number of species and the FIV index, the most represented families are Lamiaceae, Apiaceae and Asteraceae.

Decoction is the most common method of use, while leaves are the plant's most commonly used plant organs in phytotherapeutic treatment, and the study identified threatened species.

This work is a source of information that contributes to a knowledge of the medicinal flora and a safeguard of local popular knowledge. It can also constitute a database for phytochemists and pharmacologists for the valorization of medicinal plants used in urinary lithiasis diseases in order to discover new active ingredients that can be used in pharmacology.

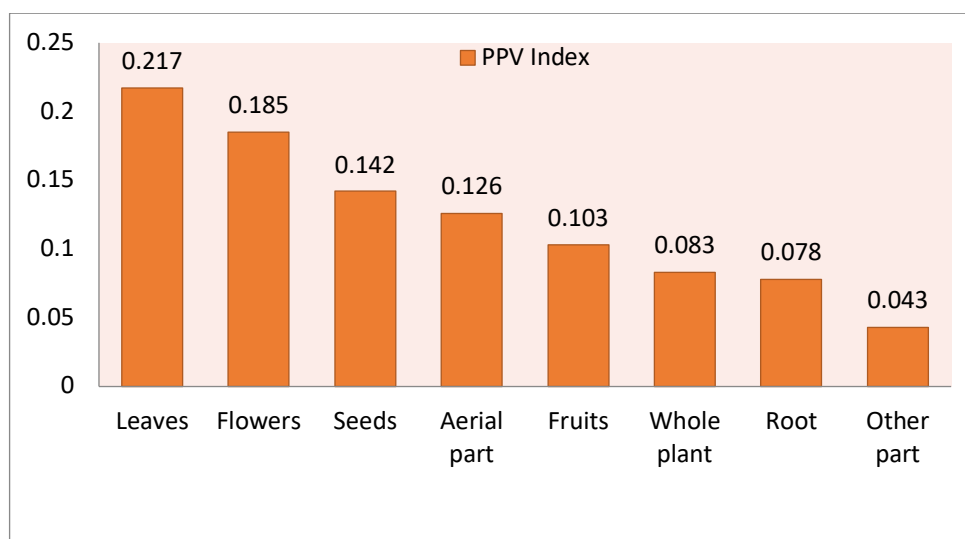


Figure 3. Percentages of Different parts used for the treatment of renal lithiasis diseases in the zone of study.

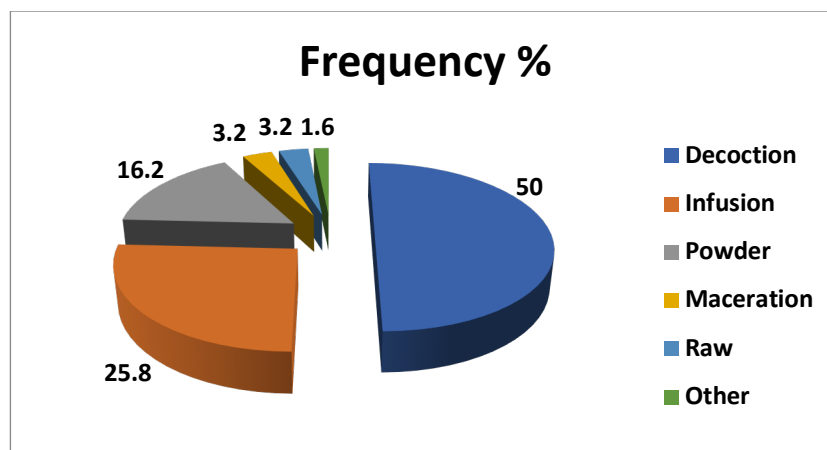


Figure 4. Percentages of different modes of remedies preparation used in the zone of study.

Declarations

List of Abbreviations: **SPSS:** statistical package for social science, **F_c:** frequency of citation **RFC:** relative frequency of citation, **FIV:** family importance value, **PPV:** plant part value

Ethics approval and consent to participate: Before conducting interviews, all participants gave their prior consent knowing the reason for the study.

Authors contributions: HO: Compiled the literature sources, data analysis, and interpretation and wrote the manuscript. OB: Helped in data, LZ, MF and AD: supervised the work and improved the manuscript. All authors read, reviewed and approved the final version of the manuscript.

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Appendix 1. Questionnaire sheets: Medicinal plants and phytotherapy.

Date.....	Commune.....
Caïdat	Survey number.....

Age	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
[18-30[
[30-40[
[40-50[
[50-60[
> 60					
Job	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Sex	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Male					
Female					
Family situation	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Single					
Married					
Level of study	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Illiterate					
Primary					
Secondary					
University					
Locality	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Village					
Douar					
Income / month (MAD)	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
No income					
Low income					
Average income					
When you feel sick, you address:	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Traditional medicine					
Modern medicine					
Traditional medicine and Modern medicine					
To traditional medicine, why?	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Effective					
Cheapest					
Acquisition					
Ineffective medication					
Plant Type	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Spontaneous					
Cultivated					
Introduced					
Use of the plant	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Therapeutic					
Cosmetic					
Other					
Harvesting technique	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Manual					
Mechanical					

Appendix 1. Questionnaire sheets: Medicinal plants and phytotherapy. (continued...)

Harvest Time	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Summer					
Fall					
Winter					
Spring					
Any year					
If desiccated, drying method	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Sun exposure					
In the Shade					
Use of the plant	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Fresh					
Desiccated					
After treatment					
Used part	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Fruit					
Stem					
Whole plant					
Seed					
Rhizome					
Other combination					
Root					
Bark					
Leaf					
Flower					
Bulb					
Form of employment	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Tisane					
Powder					
Essential oil					
Oily oil					
Tincture					
Method of preparation	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Decoction					
Infusion					
Cataplasm					
Raw					
Cooked					
Powder					
Maceration					
Others					
Dose used	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Pinch					
Handle					
Spoonful					
Administration mode	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Oral					
Massage					
Rinse					
Brushing					
Inhalation					
Others					

Dosage for children	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
1time/day					
2time/day					
3time/day					
Other					
Dosage for adults	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
1time/day					
2time/day					
3time/day					
Other					
Dosage for older people	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
1time/day					
2time/day					
3time/day					
Other					
Length of Use	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
One day					
A week					
One month					
Until healing					
Conservation method	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Sheltered from the light					
Exposed to light					
Other					
Diagnosis By	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Himself					
Doctor					
Herbalist					
Other					
Results	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
Healing					
Improvement					
Ineffective					
Side effects	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
No					
Yes					
Toxicity	Mokrisset (S1)	Zoumi (S2)	Ain Baïda (S3)	Brikcha (S4)	Total
No					
Yes					