Ethnopharmacological study of medicinal plants used for chronic diseases treatment in Rabat-Sale-Kenitra region (Morocco)

Naoufal El Hachlafi, Abderrahim Chebat, Rachida Soulaymani Bencheikh, Kawtar Fikri-Benbrahim

Research

Abstract

Background: This work aims to the valorization of resources in the provinces of Rabat-Sale-Kenitra region, particularly aromatic and medicinal plants, and to the collection and documentation of the new ethno-medico-botanical information concerning the traditional use of these medicinal plants against chronic disease.

Methods: An ethnobotanical survey was conducted in Rabat-Sale-Kenitra region with traditional herbalists, on one hand, and with subjects suffering from chronic diseases on the other hand, during 5 months from February to June 2019. Data were collected thanks to 581 questionnaire cards based on semi-structured interviews. Relative Citation Frequency (RFC), Family Importance Value (FIV), Plant Part Value (PPV), Fidelity Level (FL), and Informant Consensus Factor (ICF) were used in ethnobotanical data analysis.

Results: A total of 79 medicinal and aromatic plant species were identified, belonging to 74 genera and 39 botanical families, of which Lamiaceae (FIV=0.038) and Asteraceae (FIV=0.015) were the most frequently represented. The most cited plant species were *Nigella sativa* (RFC=0.12), and *Origanum compactum* (RFC= 0.091). Leaves represent the most used plants part with PPV=0.246 and decoction was the major preparation model of remedies (37.7%). Concerning treated diseases, chronic kidney disease has the highest ICF (0.93). Furthermore, 18 cases of side effects related to the use of medicinal species such as *Aristolochia longa* and *Peganum harmala* were recorded.

Conclusion: In light of this work, the population recognizes the effectiveness of medicinal plants in the treatment of chronic diseases, but their use will have to go through extensive phytochemical, pharmacological and toxicological research in order to clarify their effectiveness and innocuousness.

Keywords: Medicinal and aromatic plants, Ethnobotanical surveys, Chronic diseases, Rabat-Sale-Kenitra region.

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Ethnobotany Research & Applications 20:2 (2020)

Résumé

Contexte: Ce travail vise à valoriser les ressources dans les provinces de la région de Rabat-Sale-Kenitra, notamment des plantes aromatiques et médicinales, et à rassembler et documenter de nouvelles informations ethno-médico-botaniques

Manuscript received: 25/04/2020 – Revised manuscript received: 18/05/2020 - Published: 23/05/2020

http://dx.doi.org/10.32859/era.20.2.1-23

concernant l'utilisation traditionnelle de ces plantes médicinales contre les maladies chroniques.

Méthodes: A cette effet des enquêtes ethnobotaniques ont été menées dans la région Rabat-Sale-Kenitra auprès des herboristes, d'une part, et des sujets atteints des maladies chroniques, d'autre part, pendant 5 mois, de février jusqu'à juin 2019. Les données ont été recueillies grâce à 581 fiches questionnaire basées sur des entretiens semi-structurés. La fréquence relative de citation (RFC), l'indice de valeur d'importance des familles (FIV), la valeur d'usage de la partie de plante (PPV), le niveau de fidélité (FL) et le facteur de consensus des interviewés (ICF) ont été utilisés dans l'analyse des données ethnobotaniques.

Résultats: L'analyse des résultats obtenus a permis de révéler 79 espèces végétales qui se répartissent en 74 genres et 39 familles botaniques, dont les Lamiaceae (FIV=0,038) et les Asteraceae (FIV=0,015) sont les plus représentées. Les espèces végétales les plus citées sont *Nigella sativa* (RFC=0,12) et *Origanum compactum* (RFC= 0,091). Les feuilles représentent la partie des plantes la plus utilisée avec PPV=0,246, et la majorité des remèdes sont préparés sous forme de décoction (37,7%). En ce qui concerne les catégories des maladies traitées, les affections rénales chroniques montrent l'ICF le plus élevée (0,93). En outre, 18 cas d'effets secondaires liés à l'utilisation d'espèces médicinales telles que *Aristolochia longa* et *Peganum harmala* ont été enregistrés.

Conclusion: À la lumière de ce travail, la population marocaine reconnait l'efficacité des plantes médicinales dans le traitement des maladies chroniques, mais leur utilisation devra passer par des multiples recherches phytochimiques, pharmacologiques et toxicologiques afin de préciser leurs efficacités et innocuités.

Mots-clés: Plantes aromatiques et médicinales, Enquêtes ethnobotaniques, Maladies chroniques, Région de Rabat-Sale-Kénitra.

Background

Chronic diseases, also known as non-communicable diseases (NCDs), are defined by the World Health Organization as long-term disorders, which usually progress slowly and are not transmissible between people (WHO 2014). The risk factors of chronic diseases are complex and results of a combination of different genetic, physiological, behavioral and environmental factors (WHO 2014). Chronic diseases such as hypertension, diabetes, cancer, asthma, and chronic kidney diseases are increasingly becoming a major problem of health care systems worldwide due to their considerably increasing prevalence. In 2008, around 36 million (63%) of all global deaths were caused by chronic diseases (Alwan et *al*. 2010), this number increased to 39 million (72%) of all global deaths in 2016 (Naghavi et *al*. 2016)

Morocco constitutes a veritable floristic reserve with 5200 species and subspecies, including 900 endemic (Fennane & Ibn Tattou 2012) and the Moroccan medicinal flora is estimated to 600 species (Rejdali 1996). In addition, Morocco has a very special place among the Mediterranean countries that have a long medical tradition and traditional expertise based on medicinal plants (Scherrer et *al*. 2005). This is an Arab-Berber heritage, mostly influenced by the Islamic religion.

In Morocco, as everywhere else in the world, plants continue to meet an important need despite the increase in the modern sanitary system. The use of medicinal plants in the treatment of chronic diseases such as diabetes, Hypertension, asthma, chronic kidney diseases and cancer is part of the traditional Moroccan pharmacopoeia (Tahri et al. 2012). Many research works focused on these practices, and the studies conducted in different regions of Morocco have shown that the use of plants to treat these chronic diseases is widespread (Barkaoui et *al*. 2017, Benkhnigue et *al*. 2010, Bousta et *al*. 2014, Chebat et *al*. 2014, Eddouks et *al*. 2002, Ghourri et *al*. 2013, Hachi et *al.* 2016, Khouchlaa et *al*. 2017, Mechchate et *al*. 2020, Salhi et *al.* 2010, Skalli et *al*. 2019, Tahraoui et *al*. 2007).

Phytotherapy and traditional medicine studies are especially interesting, because few researches focused on specific aspects such as spontaneous plant species used in traditional medicine. Moreover, the Moroccan medicinal pharmacopeia analysis shows that the information on regional medicinal plants remains fragmentary and scattered (Lahsissene & Kahouadji 2010). Furthermore, the overexploitation of some species can cause their extinction in several regions (Ouziki & Taiqui 2016). Hence, ethnopharmacology is important for the conservation and preservation of biological resources, mainly aromatic and medicinal plants; because it enables to maintain the indigenous knowledge of each population through the documentation of this ancestral knowledge (Cakilcioglu & Turkoglu 2010, Heywood 2011).

Accordingly, we conducted an ethnobotanical and ethnopharmacological study in Rabat-Sale-Kenitra region to inventory and identify medicinal and aromatic plants used by the local population and to document the new ethno-medico-botanical

information and traditional use of these medicinal plants against chronic disease. It should be noticed that the study region was chosen for its floristic, ecological and climatic diversity and for the great traditional knowledge of its local population.

Materials and Methods

Study area

Rabat-Sale-Kenitra is an administrative region, created by the last territorial division (in 2015), enclosing the capital of the Kingdom of Morocco (Rabat). It covers an area of 17,569 km² representing 2.4% of the total Moroccan area (HCP Morocco 2015), and it is divided into three prefectures (Rabat, Sale and Skhirat-Temara) and four provinces (Sidi Kacem, Kenitra, Khemisset and Sidi Slimane) (Fig. 1).

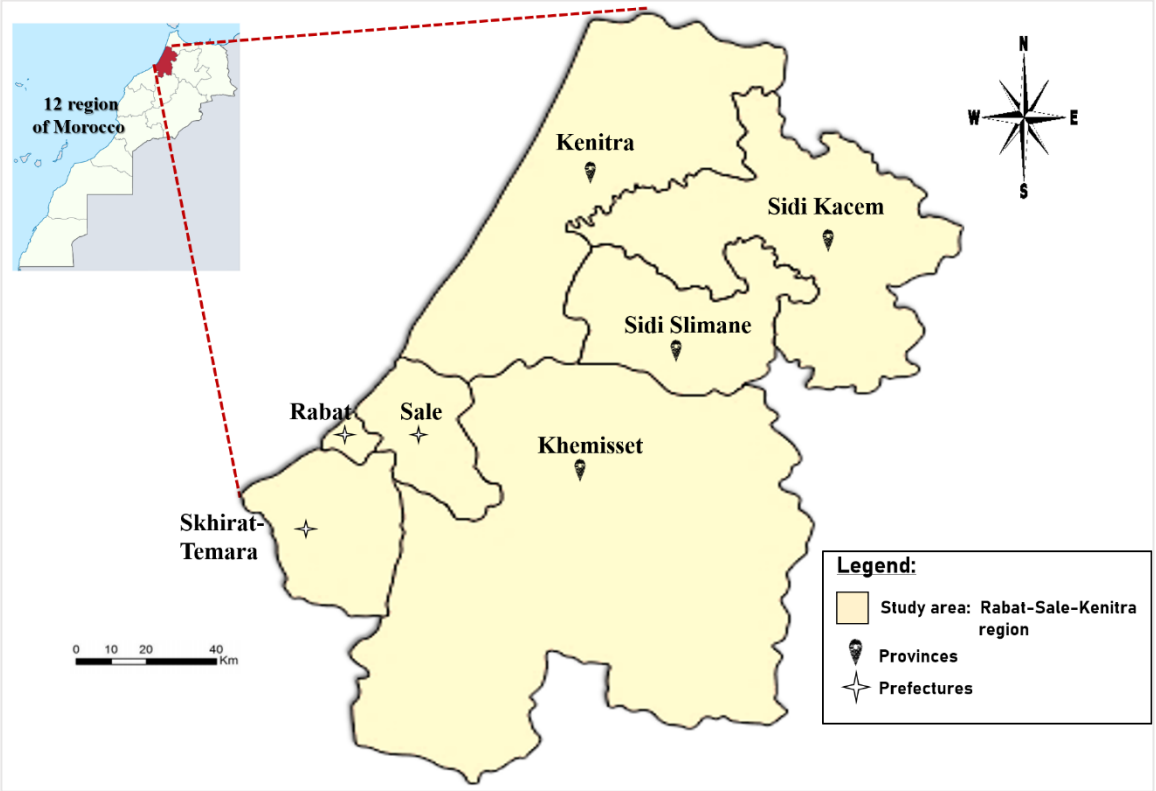

Figure 1. Geographical description of study area (Map of Rabat-Sale Kenitra region).

Its population is estimated at 4,580,866 people corresponding to 13.5% of the Moroccan population (HCP Morocco 2015). Its climate is a Mediterranean type characterized by precipitations concentrated in the cold months of the year (from autumn to spring) with hot and dry summers. Indeed, maximal temperatures average 22 - 23 °C, and minimal ones 14 - 17 °C (HCP Morocco 2015).

Moreover, it has a rich forest cover (125,000 ha where 28% is natural forest) and contains very important natural and biological reserves such as Maamora forest, Merja Zerka, and Sidi Boughaba (Bouayyadi et *al.* 2015). Indeed, the forest of Maamora is one of the principal national ecological reserves, known as the largest suberia (of *Quercus suber*) in the world. Finally, the study area contains more than 408 species and subspecies of vascular plants belonging to 261 genera and 62 botanical families, which represents 9.3% of Moroccan vascular flora (Benabid 2000).

Previous studies in some different parts of this region showed an interesting traditional knowledge of its population (Bouayyadi et *al*. 2015, Chebat et *al*. 2014, Khouchlaa et *al*. 2017, Hseini & Kahouadji 2007, Salhi et *al*. 2010, Skalli et *al*. 2019).

Data collection

The ethnobotanical study lasted over a period of five months, from February to June 2019. It was carried out using 581 questionnaire cards used to survey traditional herbalists on one hand and patients affected by chronic diseases on the other hand.

Concerning traditional herbalists, the location of ethnobotanical survey sites has been identified using the stratified sampling technique (Kahouadji 1986). This method aims to have a floristic inventory as exhaustive as possible and to conduct varied ethnobotanical surveys from one area to another in the study region. Thus, 12 stations were identified,

including nine urban communes and three rural ones and covering the traditional city neighborhoods, villages, douars and traditional markets (souks) of the studied region (Table 1). The Arabic language was used to collect data. The traditional herbalists were individually interviewed using semi-structured interviews in the 12 points studied.

Table 1. Distribution of traditional herbalists interviewed by stratum in the study area

Name of location	Number of traditional herbalists interviewed
Sidi Kacem city	21
Sidi Slimane city	26
Souk Elarbaa Gharb	11
Dar Gueddari	11
Sidi Yahya EL Gharb	14
Mechra Bel ksiri	10
Dar Bel amri	14
Souk El Haoufate	16
OuledOuejih Kenitra	7
Old Medina Kenitra	20
Tabriquet (city of Sale)	10
The medina of Rabat	18
Total	**178**

Concerning patients suffering from chronic diseases, the surveys were carried out at Moulay El Hassan hospital in Kenitra, National Institute of Oncology in Rabat, pulmonology department of Moulay Youssef hospital in Rabat, old people's home in Sidi Slimane and at the Moroccan association to aid help of patients with chronic respiratory pathology in Rabat (ANFAS) (Table 2). The data were collected with respect to confidentiality, anonymity and consent. All respondents were informed about the aim of this investigation.

Table 2. Localities of surveys conducted with patients affected by chronic diseases

Names of localities	Number of surveys
Moulay El Hassan hospital in Kenitra	122
NIO of Rabat	109
DPMYH of Rabat	101
Old People's Home Sidi Slimane	32
ANFAS	39
Total	**403**

NIO of Rabat: National Institute of Oncology, DPMYH: department of pulmonology Moulay Youssef hospital, ANFAS: Moroccan association for the help of patients with chronic respiratory pathology.

The data collected during surveys are related to the informant (age, gender, academic level) on one hand and to the medicinal plants on the other hand. These later concern: vernacular name, scientific name, the chronic disease treated (asthma, high blood pressure, diabetes, cancer, rheumatism), plant parts used (stems, roots, leaves, grains, aerial part), preparation methods, administration mode as well as dosage recommendations, treatment duration and side effects associated with these medicinal plants use. The time devoted to each interview varies between 10 and 40 min.

Species identification

The species taxonomic identification was subsequently carried out using standard Moroccan floras: Traditional Moroccan pharmacopoeia of Bellakhder (1997), Practice flora of Morocco by Fennane *et al*. (1999), Vascular Flora of Morocco: inventory and chorology by Fennane and Ibn Tattou (2005), Practice flora of morocco by Fennane *et al*. (2007) and Moroccan medicinal and aromatic plants by Hmamouchi (2001).

Moreover, the taxonomic names of plant species were confirmed at pharmacovigilance department of Moroccan poison control and pharmacovigilance center, Rabat, from online botanical databases, namely: The Plant List (http://www.theplantlist.org/) and encyclopedia of Life (https://eol.org/).

Data analysis

The data collected on survey sheets were entered in computer, processed and statistically analyzed using SPSS (System Package for Social Sciences, version 21) and Microsoft Office "Excel 2016". The respondent socio-demographic data were analyzed by a simple descriptive statistical method using percentages and frequencies. While ethnobotanical and ethnopharmacological data were analyzed using the Relative citation frequency (RFC), Family Importance Value (FIV), Plant part value (PPV), Fidelity level (FL) and Informant Consensus Factor (ICF).

Relative citation frequency (RFC)

The Relative Citation Frequency (RFC) is determined by dividing the citation frequency (FC) by the total number of people surveyed (N).The RFC value for medicinal plant species is based on the percentage of respondents who cited each plant species. This index shows the relative importance for each species in the study area. It was calculated

according to the following formula (Tardio & Pardo-de-Santayana 2008):

$$RFC = FC/N$$

With (0 < RFC < 1)

Family Importance Value (FIV)

Family Importance Value (FIV) is used to demonstrate the significance of plant families. It is designed to assess the biological taxon value of plants and is calculated according to the following method (Sreekeesoon & Mahomoodally 2014):

$$FIV = FC family\ /NS$$

Where FC_{family} = RFC: is the number of informants citing the family and Ns: is the total number of species within each family.

Plant part value (PPV)

Plant part value (PPV) is used to show use frequency of each plants part. The part with the highest PPV is the most used part by respondents. It is calculated as follows:

$$PPV = RU\ plant\ part/RU$$

With, RU: the number of uses reported for all plant parts, and, $RU_{plant\ part}$: the sum of uses reported per plants part (Gomez-Beloz 2002).

Fidelity level (FL)

Fidelity level (FL) shows a plant species effectiveness against a given disease. It corresponds to the percentage of respondents citing the use of a plant species to treat a particular ailment in the study area.

FL is calculated according to Alexiades & Sheldon (1996) and Sreekeesoon & Mahomoodally (2014):

$$FL = Ip/Lu \times 100$$

Where Ip = the number of citations of the species used in a particular disease treatment, and Lu = the total number of citations of the species used in the treatment of any disease.

Informant Consensus Factor (ICF)

The Informant Consensus Factor (ICF) shows homogeneity of knowledge in the use of a plant species in each disease category. It is calculated according to Heinrich *et al*. (1998):

$$ICF = Nur - Nt/Nur - 1$$

Where Nur = is the number of use citations for a disease category and Nt = is the number of species used by informants in a given use category.

Results and Discussion

Socio-demographic data of respondents

Use of medicinal plants according to age

The use of medicinal plants concerns all age groups, especially those between 45 and 60 years old (53.35%) and over 60 years old (27.79%). Older people have a better knowledge of medicinal species due to the accumulated experience and the popular know-how transmission (Anyinam 1995, Weniger 1991).

For young people (less than 30 years), a low percentage of this practice has been reported compared to other age groups (7.94%). This may be justified by the lack of traditional medicine knowledge by young people, the low transmission of knowledge from elderly to young people, and the development of conventional medicine (Table 3).

In a similar study in Turkey, the average age of medicinal plants users was about 54 years old, which consolidates the results obtained in our study (Yilmaz *et al*. 2007). Similar results were also obtained in two previous studies carried out in Mali (Samake 2012) and Great Britain (Skinner & Rangasami 2002), where people more than 46 and between 40 - 60 years old were respectively the most frequent consumers of traditional remedies.

Concerning traditional herbalists, the age ranges varied between 26 and 81 years, with an average age of 50.5 years and with 35.95% being over 60 years (Table 3). This can be explained by an accumulation of daily knowledge and experiences, through the lives of this group and by its transmission to the young population, from father to son. Moreover, it demonstrates a great responsibility sense shown by this older generation for this empirical knowledge that must be preserved. Same results were obtained in a study among traditional herbalists of the economic capital of Morocco, Casablanca (Zougagh *et al*. 2019).

Use of medicinal plants according to Gender

Data analysis shows that medicinal plants are used by women as well as by men. However, women have slightly more knowledge of traditional medicine compared to men, with a frequency of 59.05% compared to 40.94% for men (Table 3).

This result is consistent with several studies carried out in many regions of Morocco: Settat province (Nabih 2002) and Fez-Boulmane prefecture (Jouad 2001) as well as the oriental region (Ziyyat 1997). At the international level, similar results have also been obtained in several surveys conducted in Mali (Samake2012), France (Baillard *et al*. 2007) and in the United States (Tsen *etal*. 2000) with respective

women use frequencies of 63%, 54% and 55.14%. In the Moroccan context, this result can be justified by a continuous search, by women, for natural remedies based on aromatic and medicinal plants and by the ease with which this expertise can be transmitted from one generation to another.

The majority of traditional herbalists (88.20%) were male, while females represent only 11.79% (Table 3). These data confirm the results of other national ethnobotanical studies, which have shown that majority of herbalists in Morocco are usually managed by men (Ait Ouakrouch 2015, Hamdani 1984, Jouad *et al*. 2001). The male predominance in the detention and exercise of this traditional practice is associated with primacy given to men in our society with regard to inheritance.

Use of plants according to education level

Most of the aromatic and medicinal plants users are illiterate (44.91%) or have primary education (29.77%), while those having secondary or university education use medicinal plants infrequently (13.64% and 11.66% respectively) (Table 3). This is explained by the increase of vigilance level about potential adverse effects of medicinal plants, with an individual's education level. This result is concomitant with other studies which showed that traditional knowledge is held by illiterate (El Yahyaoui *et al*. 2015, Lahsissene *et al*. 2009). In our study, 54.49% of traditional herbalists have never been in school, 19.10% and 23.03% have primary and secondary schooling respectively and only 3.37% of herbalists had higher levels of education (Table 3). These results are concordant with several other national studies and confirm that the use of medicinal plants remain the prerogative of people who do not attend school (Hamdani 1984, Jouad *et al*. 2001).

Table 3. Socio-demographic profile of respondents

Data	Traditional herbalists		Patients affected by chronic diseases	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Gender				
Female	21	11.797	238	59.05
Male	157	88.20	165	40.94
Age				
<30 years	9	5.05	32	7.94
30-45	46	25.84	44	10.91
45-60	59	33.14	215	53.35
>60 years	64	35.95	112	27.79
Educational status				
Illiterate	97	54.49	181	44.91
Primary	34	19.10	120	29.77
Secondary	41	23.03	55	13.64
University	6	3.37	47	11.66

Floristic analysis

The ethnobotanical and ethnopharmacological surveys carried out in Rabat-Sale-Kenitra region enabled to identify 79 species of medicinal and aromatic plants used for chronic diseases treatment, belonging to 74 genera and 39 botanical families. All the plants listed are reported in Table 4 where are given: the scientific name, botanical family, vernacular name, part used, preparation method followed by the local population and FC, RFC and FIV data; for each of them. All the plants listed are reported in Table 4 giving: the scientific name, botanical family, vernacular name, part used, preparation method followed by the local population and FC, RFC and FIV data; for each of them. Among the 39 botanical families recorded in the study area, the most representative are Lamiaceae (10 species, with FIV=0.038), Asteraceae (8 species, with FIV=0.015), Apiaceae (7 species, with FIV=0.068) and Fabaceae (6 species, with FIV=0.028) (Fig. 2). The dominance of the Lamiaceae and Asteraceae families can be explained by the ubiquity and wide distribution of these two families in Morocco.

This representativeness is also observed, with few differences, during ethnobotanical surveys previously carried out in some parts of the same region (Hseini & Kahouadji 2007). Other studies carried out at different points in the country have confirmed that Moroccan population mostly uses the families: Lamiaceae, Asteraceae and Apiaceae, in the treatment of different disease types (Bouyahya *et al*. 2017, Eddouks *et al*. 2002, Eddouks *et al*. 2017, El Hilah *et al*. 2015, Fakchich & Elachouri 2014, Ouakrouch *etal*. 2015, Tahraoui *et al*. 2007). Moreover, the Lamiaceae family is characterized by essential oils having an important position in therapy due to their interesting chemical composition and their wide spectrum of biological activities (Cimanga *et al*. 2002, Lamiri *et al*. 2001).

Table 4. List of aromatic and medicinal plants used for the treatment of chronic diseases in the Rabat-Sale-Kenitra region.

Family and Scientific name	Vernacular name	Part used	Mode of Preparation	Therapeutic uses	FC	RFC	FIV	Revised literature
Aloaceae							**0.012**	
Aloe succotrina Lam.	Sebbar	Whole plant	Powder, Infusion	DT, CN	7	0.012		(Bellakhdar 1997, Fennane& Ibn Tattou 2005, Orch et *al.* 2015)
Amaryllidaceae							**0.054**	
Allium cepa L.	Elbessla	Bulbs, Seeds	Infusion	CN, DT, ASH	36	0.061		(Barkaoui et *al.* 2017, Benkhnigue et *al.* 2014, Bouayyadi et *al.* 2015, Chebat et *al.* 2014, Ghourri et *al.* 2013, Youbi et *al.* 2016)
Allium sativum L.	Toma	Bulbs	Maceration, Infusion	AHT, DT, ASH	28	0.048		(Barkaoui et *al.* 2017, Benkhnigue et *al.* 2014, Bouayyadi et *al.* 2015, Eddouks et *al.* 2002, Orch et *al.* 2015)
Apiaceae							**0.068**	
Ammi visnaga (L.) Lam.	Bachnikha	Seeds	Decoction, Infusion	DT	3	0.005		(Barkaoui et *al.* 2017, Bellakhdar 1997, Bousta et *al.* 2014, Salhi et *al*. 2010)
Ammodaucus leucotrichus Coss.	Kamoun Es-sofi	Fruits	Powder	DT	5	0.008		(Barkaoui et *al.* 2017, Benkhnigue et *al*. 2014, Eddouks et *al*. 2002)
Apium graveolens L.	Krafess	Leaves	Decoction, Infusion	DT, CKD	6	0.01		(Bellakhdar 1997, Mechchate et al. 2020, Tahraoui et *al*. 2007)
Carum carvi L.	EL kerwia	Seeds	Decoction	DT	3	0.005		(Bellakhdar 1997, Eddouks et *al.* 2002, Mechchate et *al.* 2020)
Foeniculum vulgare Mill.	Naafaabeldi	Seeds	Decoction, Powder	DT, ASH	13	0.022		(Bellakhdar 1997, Chebat et *al.* 2014, Mechchate et *al.* 2020)
Petroselinum sativum Hoffm.	Màadnous	Leaves	Infusion, Decoction	CKD, DT	8	0.013		(Bellakhdar 1997, Benkhnigue et *al.* 2014, Mechchate et *al.* 2020, Tahraoui et al. 2007)
Pimpinella anisum L.	Habbathlawa	Seeds	Decoction, Powder	CN, DT	6	0.01		(Benkhnigue et *al.* 2014, Bouayyadi et *al.* 2015, Tahraoui et *al.* 2007)
Aristolochiaceae							**0.041**	
Aristolochia longa L.	Bereztem	Roots	Powder, Decoction	CN	24	0.041		(Bellakhdar 1997, Chebat et *al.* 2014)
Asparagaceae							**0.0017**	
Asparagus officinalis L.	Seckoum	Rhizome	Decoction	RHD	1	0.0017		(Bellakhdar 1997)

Asteraceae						**0.015**	
Artemisia absinthium L.	Chiba	Leaves, Whole plant	Decoction, Infusion	DT	9	0.015	(Benkhnigue et *al.* 2014, Bouayyadi et *al.* 2015, Eddouks et *al.* 2002, Mechchate et *al.* 2020)
Artemisia herba-alba Asso	Chih	Leaves	Decoction	DT	17	0.029	(Bellakhdar 1997, Benkhnigue et *al.* 2014, Eddouks et *al.* 2002, Mechchate et *al.* 2020, Mehdioui&Kahouadji 2007, Tahraoui et *al.* 2007)
Calendula arvensis L. subsp. arvensis	Jemra	Leaves, Flower	Decoction	DT	6	0.01	(Bellakhdar 1997)
Chamaemelum nobile (L.) All.	babonj	Flower	Decoction	DT, AHT	12	0.02	(Bellakhdar 1997, Bouayyadi et *al.* 2015, Salhi et *al.* 2010,Tahraoui et *al*. 2007)
Cynar acardunculus L.	Khorchèf	Whole plant	Decoction, Infusion	DT	2	0.003	(Bellakhdar 1997, Bouayyadi et *al.* 2015)
Ormenis mixta (L.) Dumort.	Hellâla,	Flower	Infusion	AHT, DT	13	0.022	(Benkhnigue et *al.* 2014, Eddouks et *al.* 2002, Tahraoui et *al.* 2007)
Saussurea costus (Falc.) Lipsch.	AL Quest Al hindi	Whole plant	Powder, Decoction	ASH, CN	8	0.013	(Bellakhdar 1997, Fennane& Ibn Tattou 2005, Ghourri et *al.* 2013)
Silybum marianum (L.) Gaertn.	Tawra, Chouklahmir	Seeds, Leaves	Decoction	DT	9	0.015	(Bellakhdar 1997, Bouayyadi et *al.* 2015, Orch et *al.* 2015)
Berberidaceae						**0.036**	
Berberis hispanica Boiss. & Reut.	Aghris	Roots	Decoction	DT, CN	21	0.036	(Bellakhdar 1997, Fennane& Ibn Tattou 2005, Ghourri et *al.* 2013)
Brassicaceae						**0.012**	
Brassica rapa L.	Left	Seeds	Powder, Decoction	RHD	3	0.005	(Bellakhdar 1997, Fennane& Ibn Tattou 2005)
Lepidium sativum L.	HabErracha d	Seeds	Powder, Decoction	ASH, DT, AHT,	12	0.02	(Bellakhdar 1997, Eddouks et *al.* 2020,Fennane& Ibn Tattou2005, Mechchate et *al.* 2020, Tahraoui et *al.* 2007)
Cactaceae						**0.017**	
Opuntia ficus-indica (L.) Mill.	Nawarhandi a	Flower	Decoction, Infusion	CKD	10	0.017	(Bouayyadi et *al.* 2015, Eddouks et *al.* 2017, Tahraoui et *al.* 2007)
Capparaceae						**0.02**	
Capparis spinosa L.	Kebbar	Whole plant	Powder	AHT, RHD, CN	12	0.02	(Bouayyadi et *al*. 2015, Chebat et *al.* 2014 Eddouks et *al.* 2002, Ziyyat et *al*. 1997)

Caryophyllaceae							**0.029**	
Corrigiola telephiifolia Pourr.	Sarghina	Whole plant, Leaves	Decoction	RHD, CN	4	0.006		(Eddouks et *al*. 2017, Eddouks et *al.* 2002)
Herniaria glabra L.	Harrasslhjar	Whole plant	Decoction	CKD	27	0.046		(Bouayyadi et *al.* 2015, Khouchlaa et *al.* 2017, Lahsissene et *al.* 2009)
Chenopodiaceae							**0.005**	
Chenopodium ambrosioides L.	M'khinza	Leaves	Decoction	ASH	3	0.005		(Eddouks et *al.* 2002, Mechchate et *al.* 2020, Ziyyat et *al.* 1997)
Cucurbitaceae							**0.003**	
Citrullus colocynthis (L.) Schrad.	Lahdedj	Whole plant	Decoction	DT	2	0.003		(Bouayyadi et *al.* 2015, Ghourri et *al.* 2013, Lahsissene et *al.* 2009)
Cupressaceae							**0.008**	
Juniperus phoenicea L.	Aaraar	Whole plant	Decoction	DT	5	0.008		(Bouyahya et *al.* 2017, Eddouks et *al.* 2017, Eddouks et *al.* 2002)
Ephedraceae							**0.018**	
Ephedra alata Decne	Andla	Leaves	Infusion, Powder	CN, DT	11	0.018		(Bouayyadi et *al.* 2015, Chebat et *al.* 2014, Eddouks et *al*. 2002, Ghourri et *al*. 2013)
Euphorbiaceae							**0.016**	
Euphorbia resinifera O. Berg	Daghmous	Leaves	Powder, Decoction	CN, DT	17	0.029		(Bellakhdar 1997, Bouayyadi et *al.* 2015, Ghourri et *al.* 2013)
Ricinus communis L.	AL kharwaa	Seeds	Decoction	RHD	2	0.003		(Bouayyadi et *al.* 2015, Lahsissene et *al.* 2009, Salhi et *al.* 2010)
Fabaceae							**0.028**	
Cassia senna L.	Sannâ haram	Leaves	Decoction	DT	5	0.008		(Eddouks et *al.* 2002,Ghourri et al. 2013, Lahsissene et *al.* 2009)
Ceratonia siliqua L.	Lkharoubb	Fruits	Powder, Infusion	CN, ASH	9	0.015		(Barkaoui et *al*. 2017, Bouyahya et *al.* 2017, Mechchate et *al.* 2020)
Glycyrrhiza glabra L.	Araq-Sus	Stalk, Roots	Powder, Decoction	CN, ASH	37	0.063		(Bouayyadi et *al.* 2015, El Hilah et al. 2015, El Yahyaoui et *al.* 2015, Ghourri et *al.* 2013)
Retama monosperma (L.) Boiss.	R'tum	Leaves	Decoction	CN, DT	2	0.003		(Fennane& Ibn Tattou 2005, Lahsissene et *al.* 2009)
Trigonella foenum-graecum L.	El helba	Seeds	Decoction, Infusion, Powder, Maceration	DT	45	0.077		(Barkaoui et *al*. 2017, Eddouks et al. 2002, Lahsissene et *al*. 2009, Mechchate et *al.* 2020, Tahraoui et *al.* 2007, Ziyyat et *al.* 1997)

Vicia faba L.	El fûl	Fruits	Powder, Decoction	ASH	3	0.005		(El Hilah et *al*. 2015,Mechchate et *al.* 2020)
Gentianaceae							**0.018**	
Centaurium erythraea Rafn	Kosset el haya	Leaves	Decoction	DT	11	0.018		(Bouayyadi et *al.* 2015, Eddouks et *al*. 2002, Tahraoui et *al*. 2007)
Illiciaceae							**0.055**	
Illicium verum Hook.f.	Badiane	Seeds	Powder, Decoction	DT, ASH, AHT	32	0.055		(Bellakhdar 1997, Khabbach et *al.* 2012)
Juglandaceae							**0.006**	
Juglans regia L.	Gargaa	Fruits	Maceration	DT	4	0.006		(Ghourri et al. 2013, Lahsissene et *al.* 2009, Tahraoui et *al.* 2007, Ziyyat et *al.* 1997)
Lamiaceae							**0.038**	
Ajuga iva (L.) Schreb.	Chendgoura	Leaves	Decoction, Infusion	DT	14	0.024		(Bouayyadi et *al.* 2015, Ghourri et al. 2013, Khabbach et *al.* 2012, Ziyyat et *al.* 1997)
Lavandula dentata L.	Khzâma	Leaves	Decoction, Infusion	CKD, AHT, DT, RHD	34	0.058		(Eddouks et *al.* 2002, Khouchlaa et *al*. 2017, Mehdioui&Kahouadji 2007, Tahri et *al.* 2012)
Marrubium vulgare L.	Marwita	Leaves	Decoction, Infusion	CN, DT	11	0.018		(Eddouks et *al.* 2002, Khabbach et *al.* 2012, Mechchate et *al*. 2020, Tahri et *al.* 2012)
Mentha pulegium L.	Feliou	Leaves	Infusion	DT,ASH	16	0.027		(Eddouks et *al.* 2002, Khabbach et *al.* 2012, Mechchate et *al*. 2020, Tahraoui et *al*. 2007, Ziyyat et *al*. 1997)
Ocimum basilicum L.	Lhbak	Leaves	Decoction, Infusion	DT	7	0.012		(Bouyahya et *al*. 2017, Eddouks et *al*. 2002, Tahraoui et *al*. 2007, Ziyyat et *al.* 1997)
Origanum compactum Benth.	Zaatar	Aerial part	Decoction, Infusion	DT,ASH	53	0.091		(Bouyahya et *al*. 2017, Eddouks et *al.* 2017, Tahri et *al*. 2012,Tahraoui et *al*. 2007, Ziyyat et *al.* 1997)
Origanum majorana L.	Merdedouche	Leaves	Decoction, Infusion	DT,AHT	13	0.022		(Fadil et *al.* 2015, Khabbach et *al,* 2012, Salhi et *al.* 2010, Tahraoui et *al.* 2007, Ziyyat et *al*. 1997)
Rosmarinus officinalis L.	Azir	Leaves	Decoction, Infusion	ASH, DT	19	0.032		(Eddouks et *al*. 2017,Mehdioui&Kahouadji 2007, Mechchate et al. 2020, Salhi et *al*. 2010 Ziyyat et *al*. 1997)

Salvia officinalis L.	Salmia	Leaves	Decoction, Infusion	DT	45	0.077	(Bouyahya et *al*. 2017, Eddouks et *al.* 2017, Ghourri et *al.* 2013, Mechchate et *al.* 2020, Orch et *al*. 2015)
Thymus vulgaris L.	Ziitra	Aerial part	Decoction, Infusion	DT	14	0.024	(Eddouks et *al.* 2017, Fadil et *al.* 2015, Ghourri et *al*. 2013, Mechchate et *al*. 2020)
Lauraceae						**0.023**	
Cinnamomum camphora (L.) J. Presl	Kafour	Whole plant	Powder	RHD	12	0.02	(Eddouks et *al.* 2017,Khabbach et *al.* 2012, Tahraoui et *al.* 2007, Orch et *al.* 2015)
Cinnamomum verum J. Presl	Qarfa	Fruits	Powder, Infusion	RHD, DT,ASH	26	0.044	(El Yahyaoui et *al.* 2015, Ghourri et *al.* 2013, Mechchate et *al.* 2020, Orch et *al.* 2015)
Persea americana Mill.	Avocat	Fruits	Powder	DT	3	0.005	(Bellakhdar 1997, Bouayyadi et *al.* 2015)
Linaceae						**0.067**	
Linum usitatissimum L.	Zeri'tLktan	Seeds	Decoction, Cataplasm	ASH	39	0.067	(Eddouks et *al.* 2002,El Yahyaoui et *al*. 2015, Fennane& Ibn Tattou 2005, Mechchate*et al*. 2020,)
Lythraceae						**0.046**	
Punica granatum L.	Eroumane	Fruits	Decoction, Cataplasm	DT	27	0.046	(Bouyahya et *al*. 2017,Fennane& Ibn Tattou 2005, Mechchate et *al*. 2020)
Malvaceae						**0.008**	
Hibiscus sabdariffa L.	Lkarkadi	Flower, Leaves	Decoction, Infusion	AHT	5	0.008	(Bellakhdar 1997, Fennane& Ibn Tattou 2005)
Moraceae						**0.03**	
Ficus carica L.	Karmouss	Fruits	Decoction, Infusion	CN, ASH	18	0.03	(Bouyahya et *al.* 2017, Eddouks et *al*. 2002, Fennane& Ibn Tattou 2005,Mechchate et *al*. 2020,)
Myrtaceae						**0.021**	
Eucalyptus globulus Labill.	Kalitus	Leaves	Cataplasm, fumigation	ASH	8	0.013	(Bouyhaya et al. 2017, Bellakhdar 1997, El Hilah et *al*. 2015)
Myrtus communis L.	Rihan	Leaves	Decoction, Infusion	DT, CN	10	0.017	(Bouyahya et *al*. 2017, ElYahyaoui et *al.* 2015, Fennane& Ibn Tattou 2005)
Syzygium aromaticum (L.) Merr.	Qrounfel	Floral buttons	Maceration, Infusion	ASH, RHD	20	0.034	(Bouayyadi et *al*. 2015, Bellakhdar 1997, El Hilah et *al.* 2015)

Oleaceae							**0.072**	
Olea europaea L.	Zitoune	Leaves	Decoction	DT	42	0.072		(Bouyahya et *al.* 2017, Fadil et al. 2015, Fakchich&Elachouri 2014, Orch et *al*. 2015)
Poaceae							**0.006**	
Phalaris canariensis L.	Zwan	Seeds	Decoction	DT	4	0.006		(Bellakhdar 1997, El Yahyaoui et *al.* 2015, Ghourri et *al.* 2013)
Ranunculaceae							**0.063**	
Nigella sativa L.	Sanouj	Seeds	Decoction, Powder	ASH, DT, AHT, CN	72	0.12		(Bellakhdar 1997, Chebat et *al.* 2015, El Hilah et *al*. 2015,El Yahyaoui et *al*. 2015, Fadil et *al.* 2015, Ghourri et *al.* 2013, Orch et *al*. 2015)
Ranunculus bullatus L.	Oudenlhalouf	Aerial part	Decoction, Cataplasm	ASH	4	0.006		(Bellakhdar 1997)
Rhamnaceae							**0.022**	
Ziziphus lotus (L.) Lam.	Nbeg	Fruits, Leaves	Decoction	CKD	13	0.022		(Fennane& Ibn Tattou 2005, Khouchlaa et *al.* 2017)
Rosaceae							**0.012**	
Eriobotrya japonica (Thunb.) Lindl.	Lmzah	Leaves	Decoction	DT	16	0.027		(Fennane& Ibn Tattou 2005Ghourri et *al.* 2013, Orch et *al.* 2015, Ziyyat et *al.* 1997)
Prunus cerasus L.	Hablmalouk	Fruits	Decoction	RHD	3	0.005		(Eddouks 2017, Mechchate et *al.* 2020)
Prunus dulcis (Mill.) D.A. Webb	LouzLhar	Fruits	Infusion	DT	7	0.012		No data
Rosa × *damascene* Herrm.	Lwardlbeldi	Flower	Decoction	CN	4	0.006		(Bellakhdar 1997, Bouayyadi et *al.* 2015,)
Rutaceae							**0.012**	
Ruta chalepensis L.	Elfijel	Leaves	Decoction	DT	7	0,012		(Bellakhdar 1997, Fennane& Ibn Tattou 2005, Ghourri et *al*. 2013
Sapotaceae							**0.015**	
Argania spinosa (L.) Skeels	Louzargan	Fruits	Decoction	DT	9	0.015		(Bouayyadi et *al*. 2015, El Hafian et *al.* 2014, El Yahyaoui et *al*. 2015, Mehdioui&Kahouadji 2007)
Theaceae							**0.003**	
Camellia sinensis (L.) Kuntze	Atay	Leaves	Decoction	DT	2	0.003		(Doukkali et *al.* 2015, El Amrani et *al*. 2010, EL Yahyaoui et *al.* 2015)

Urticaceae						**0.02**	
Urtica dioica L.	Harriga	Leaves	Decoction, Cataplasm, Powder	CKD	12	0.02	(Bouayyadi et *al*. 2015, Eddouks et *al.* 2002, Ghourri et *al.* 2013, Tahri et *al.* 2012)
Verbenaceae						**0.024**	
Aloysia aloysioides Loes. & Moldenke	Lwiza	Leaves	Infusion	DT, AHT	14	0.024	(Bellakhdar 1997, Bouayyadi et *al*. 2015)
Zingiberaceae						**0.041**	
Alpinia officinarum Hance	Khoudenjal	Roots	Decoction	RHD	19	0.032	(Bouayyadi et *a*l. 2015, Fennane& Ibn Tattou 2005)
Zingiber officinale Roscoe	Skinjbir	Roots	Decoction, Infusion	DT, RHD	30	0.051	(Bouayyadi et *al*. 2015,El Yahyaoui et *al*. 2015, Fakchich&Elachouri 2014, Ghourri*et al.*2013)
Zygophyllaceae						**0.048**	
Peganum harmala L.	Harmel	Seeds	Fumigation, Cataplasm	RHD	28	0.048	(Benkhnigue et *al*. 2010, Doukkali et *al*. 2015, Hseini&Kahouadji 2007, Lahsissene&Kahouadji 2010)

DT: diabetes, RHD: Rheumatic Diseases, ASH: asthma, AHT: arterial hypertension, CN: cancer, CKD: chronic kidney diseases.

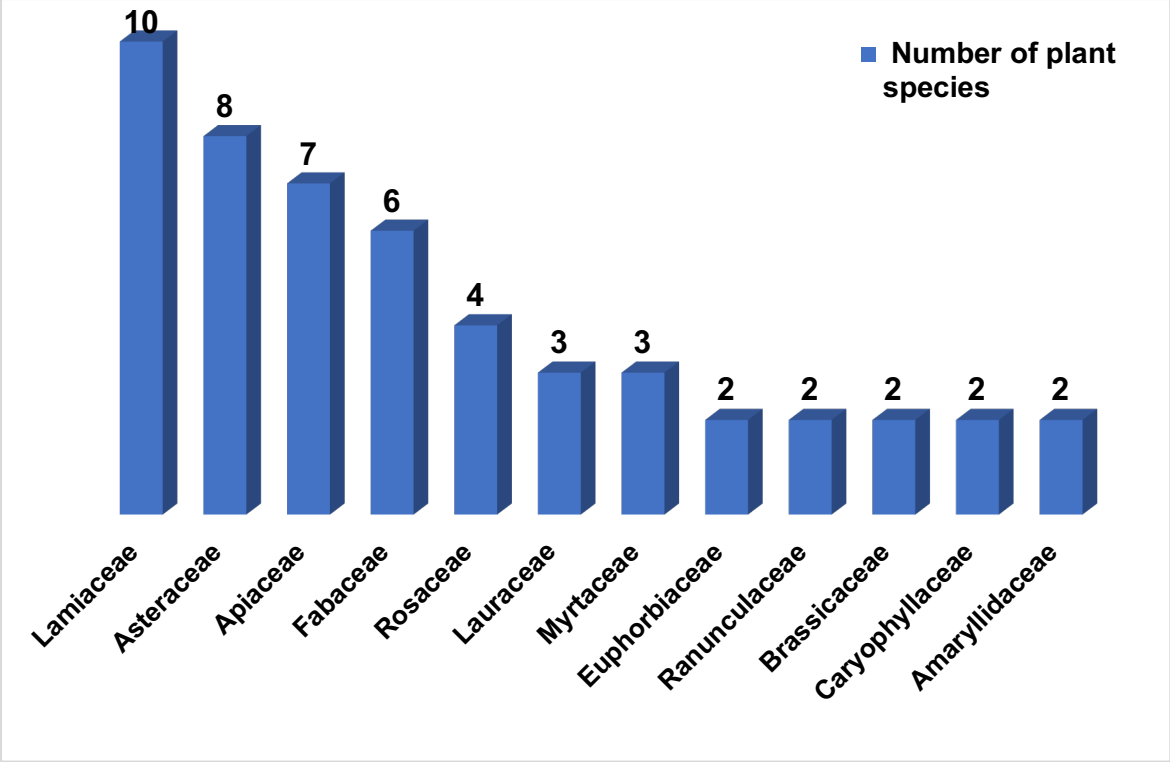

Figure 2. Frequency of the most represented botanical families.

RFC indicates the use frequency of each plant species, its value varies between 0.0017 and 0.12, with an important representation of the species *Nigella sativa* L. (RFC= 0.12), *Origanum compactum* Benth. (RFC= 0.091), *Trigonella foenum-graecum* L.(RFC= 0.077), *Salvia officinalis* L. (RFC= 0.077), *Olea europaea* L. (RFC= 0.072) and *Linum usitatissimum* L. (RFC= 0.067). This shows the relative importance of these plant species in the treatment of chronic diseases such as diabetes, cancer, hypertension, asthma and rheumatism in the study area (Table 4).

Ethnopharmacological aspect

All medicinal plants used in the study area have been pharmacologically validated by previous in vitro and in vivo studies. Indeed, this study results revealed that these medicinal plants have various pharmacological properties such as antimicrobial, anti-inflammatory, antihypertensive, anticancer, antidiabetic and antioxidant activities (Table 5), which explains their use by the local population in herbal medicine.

Plant parts used for remedy preparation

The results obtained from our ethnopharmacological surveys show that the population of Rabat-Sale-Kenitra region uses different parts of medicinal plants as traditional remedies. Based on PPV values, leaves are the most used part by the population with PPV=0.246, followed by seeds (PPV=0.174), whole plant (PPV= 0.124), aerial part (PPV= 0.117), fruits (PPV= 0.108), roots (PPV= 0.079) then flowers (PPV= 0.063) (Fig. 3). The frequent use of leaves can be explained by their harvesting ease and use simplicity (Salhi *et al*. 2010), as well as that they are sites both of photochemical reactions and storage of secondary metabolites responsible for many biological activities (Bigendako & Lejoly 1990).

This dominance of leaves use is confirmed by ethnobotanical studies carried out in Rabat-Sale region (Bouyyadi et *al*. 2015, Khouchlaa *et al*. 2017) and in southern Morocco (Ghourri *et al*. 2013) which have shown that majority of traditional remedies used for the treatment of renal lithiasis are essentially prepared from the plants leaves.

Preparation methods and administration mode of remedies

Several medicinal plants preparation methods are used in traditional medicine; such as decoction, infusion, inhalation, grinding, maceration, injection, powder and cataplasm. Data analysis showed that decoction is the most common preparation method used by the population studied (37.7%), followed by infusion (27.37%), powder (22.69%), and other rarely used methods (cataplasm, maceration and fumigation) (Fig. 4).

Table 5. Ethnomedicinal use and pharmacological properties of most cited medicinal species in the study area.

Plant species	Local name	RFC	Recorded literature ethnopharmacological uses for chronic diseases treatment inside in Morocco	Pharmacological properties
Allium cepa L.	Lbessla	0,061	Cancer (Chebat et *al*. 2014) Diabetes (Barkaoui et *al*. 2017, Benkhnigue et *al*. 2014, Ghourri et *al*. 2013) Hypertension (Bouayyadi et *al*. 2015) Rheumatic disorders (Youbi et *al*. 2016)	Antioxidant, antimicrobial and antidiabetic activities (Akash et *al*. 2014, Marrelli et *al*. 2019)
Allium sativum L.	Toma	0,048	Diabetes (Barkaoui et *al*. 2017, Benkhnigue et *al*. 2014, Eddouks et *al*. 2002) Cancer (Chebat et *al*. 2014 Chronic kidney diseases (Bouayyadi et *al*. 2015) Hypertension (Orch et *al*. 2015)	Antimicrobial, anti-inflammatory, anti-tubercular, antiprotozoal, antioxidative, anticancer and anthelminthic activities (Nair et *al*. 2017, Yetgin et *al*. 2018) Hypoglycemic and hypolipidemic effects (Gaamoussi et *al*. 2018)
Glycyrrhiza glabra L.	Araq-sus	0,063	Cancer (Chebat et *al*. 2014) Asthma and rheumaticdisorders (Bouayyadi et *al*. 2015, Bellakhdar 1997, Salhi et *al*. 2010) Diabetes (Bellakhdar 1997)	Antimicrobial, antiinflammatory, hepatoprotective, sedative, neuroprotective, antidepressive, antiviral and antioxidantactivities (Gupta et *al*. 2008, Pastorino et *al*. 2018)
Linum usitatissimum L.	Zeri-t Iktan	0,067	Cancer (Chebat et *al*. 2014) Diabetes (Eddouks 2017, Eddouks et *al*. 2002, Skalli et *al*. 2019) Asthma (Bellakhdar 1997, Salhi et *al*. 2010)	Antioxidant, immunomodulatory, anti-inflammatory, analgesic, antimicrobial, antiprotozoal, insecticidal, antihyperlipidemia, and antihyperglycemic activities (Ansari et *al*. 2019)
Nigella sativa L.	Sanouj	0,12	Cancer (Bellakhdar 1997, Chebat et *al*. 2014) Rheumaticdisorders (Bouayyadi et *al*. 2015) Hypertension and diabetes (Ghourri et *al*. 2013, Orch et *al*. 2015)	Antihypertensive, anti-diabetic, antihyperlipidemic, antioxidant, antiInflammatory, analgesic antimicrobial, anti-cancer, and antihypertensive activities (Al-Ghamdi 2001, Bordoni 2019)
Olea europaea L.	Zitoun	0,072	Diabetes (Benkhnigue et *al*. 2014, Bousta et *al*. 2014, Eddouks et *al*. 2002) Rheumaticdisorders (Bouayyadi et *al*. 2015) Hypertension (Orch et *al*. 2015)	Anti-acne activity (Vaghasiya 2015) Antioxidant, antiatherogenic, antihypertensive, anti-inflammatory and hypoglycemic properties (ELSedef 2009)
Origanum compactum Benth.	Zaitar	0,091	Diabetes (Bellakhdar 1997, Eddouks et *al*. 2002, Ghourri 2013, Tahraoui et *al*. 2007) Hypertension (Orch et *al*. 2015) Cancer (Chebat et *al*. 2014)	Antimicrobial, antioxidant, antileishmanial, antimutagenic, cytotoxic, antidermatophytes, anticorrosion and anticancer properties (Bouyahya et *al*. 2017b, Bouyahya et *al*. 2016)
Salvia officinalis L.	Salmiya	0,077	Hypertension, chronic kidney disease, and diabetes (Bouayyadi et *al*. 2015 Tahraoui et *al*. 2007, Ziyyat et *al*. 1997) Cardiac disease, hypertension (Orch et *al*. 2015)	Synergistic antifungal, antimicrobial, insecticide, allelopatic, antiaroliferative, antiinflammatory and antioxidant (Alexa 2018, Khedher 2017, Kolac 2017)
Trigonella foenum-graecum L.	Lhelba	0,077	Cancer (Chebat et *al*. 2014) Diabetes (Barkaoui et *al*. 2017, Salhi et *al*. 2010, Tahraoui et *al*. 2007, Ziyyat et *al*. 1997) Hypertension (Orch et *al*. 2015)	Antioxidant, anti-arthritic, haemato-protective and anticancer properties (Al Dabbagh 2018, Pradeep & Srinivasan 2018) Anti-hyperglycemic and hypoglycemic effect (Vats 2002)

These results are well justified because decoction allows better extraction of molecules responsible for the plants therapeutic activities and attenuates or eliminates the toxic effect of some herbal remedies. Moreover, this finding is in line with the studies carried out on medicinal plants in Taza region (Khabbach *et al*. 2012), in Marrakech (Ouakrouch *et al*. 2017), in Middle Central Atlas (Daoudi *et al*. 2014), in Kenitra (Salhi *et al*. 2010), and also in Mechraâ Bel Ksiri region (Benkhnigue *et al*. 2011). However, this method could destroy some active compounds of the used medicinal plants (Benlamdini *et al*. 2014).

Medicinal plants used, by the local population, in chronic diseases treatment were administered mainly orally (89%) followed by the dermal route (8.5%). This is consistent with a study conducted in Mascara in Algeria (Benlamdini *et al*. 2014), which showed that the oral route allows a better absorption of active compounds contained in an herbal remedy.

Fidelity level index (FL)

The fidelity level FL has been calculated considering only the plant species cited more than twice for the treatment of a particular disease. Data analysis showed that FL value varies between 8.33% and 100%. More than 41 plant species present a FL=100%. These plant species, used to treat diabetes, are distributed into 24 species among which there are *Trigonella foenum-graecum* L., *Salvia officinalis* L. and *Artemisia herba-alba*Asso. Five other species are used for asthma treatment (*Linum usitatissimum* L., *Chenopodium ambrosioides* L., *Vicia faba* L., *Eucalyptus globulus* Labill. and *Ranunculus bullatus* L.). Five species used for rheumatic diseases treatment were *Asparagus officinalis* L., *Brassica rapa* L., *Alpinia officinarum* Hance., *Peganum harmala* L. and *Cinnamomum camphora* (L.) J. Presl. Four species used for the treatment of chronic kidney diseases: *Opuntia ficus-indica* (L.) Mill., *Herniaria glabra* L., *Ziziphus lotus* (L.) Lam. and *Urtica dioica* L. Two species (*Aristolochia longa* L. and *Rosa* × *damascena* Herrm.) are used to treat cancer and only one species for the arterial hypertension treatment: *Hibiscus sabdariffa* L. (Table 6). These results can be explained by the local importance and therapeutic effectiveness of these plant species. The lowest FL value observed for *Nigella sativa* L. may be justified by this species wide use by the studied population, due to the multitude of its substantial pharmacological effects. Indeed, in addition to its anti-inflammatory and cytotoxic effect, *Nigella sativa* L. has a lot of antiasthmatic effects through its anti-leukotriene and antihistaminic action and has also a bronchodilator effect through its anticholinergic and calcium antagonist actions (Delmas & Fuhrman 2010, Salem 2005).

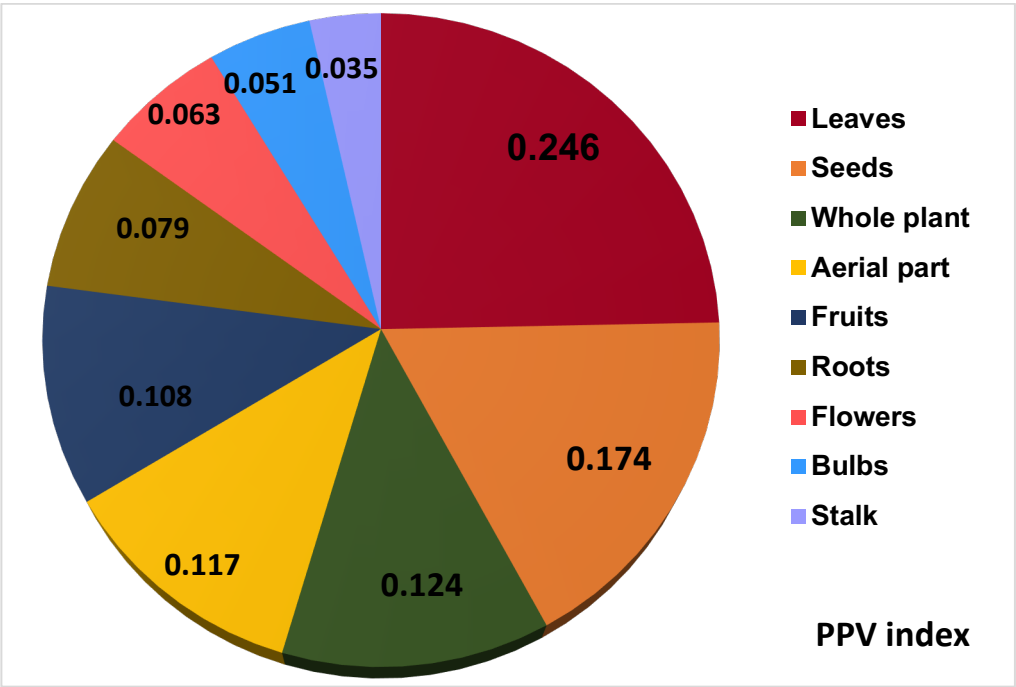

Fig. 3. Plant parts used in the chronic disease treatment in the study area.

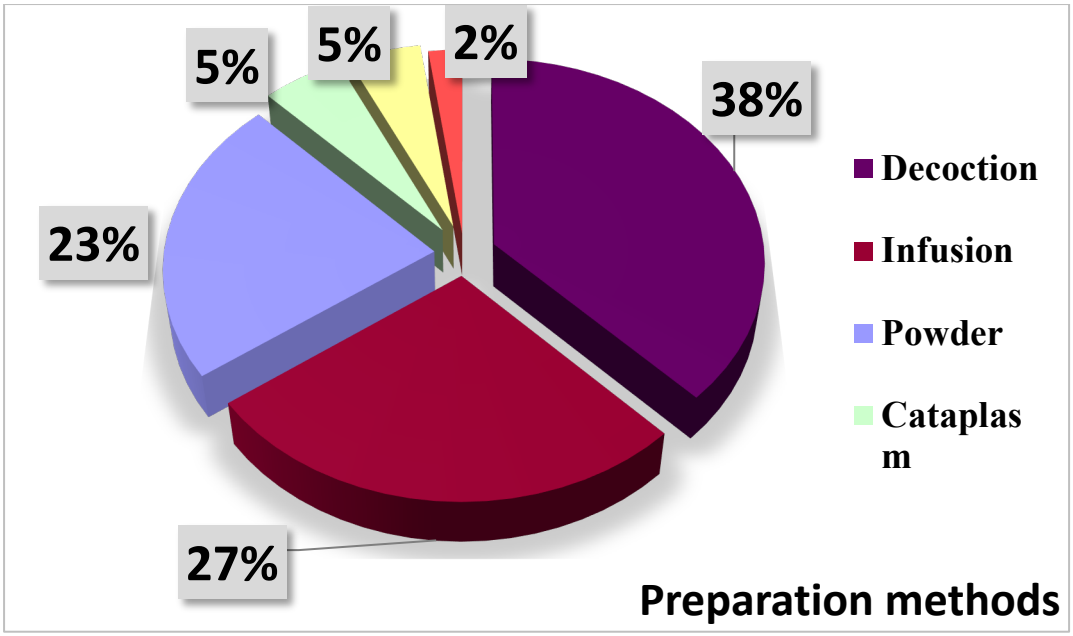

Figure 4. Frequency of different plants preparation methods used in the study area

Table 6. Most commonly used plant species in the study area, based on the highest FL (%) values and ICF values, by categories of chronic diseases.

Chronic diseases treated	Plants species	FL(%)	Nur	Nt	ICF
Arterial hypertension			76	11	0.86
	Hibiscus sabdariffa L.	100			
	Aloysia aloysioides Loes. & Moldenke	71.42			
	Origanum majorana L.	69.23			
	Chamaem elumnobile (L.) All.	66.66			
Asthma			233	20	0.918
	Linumus itatissimum L.	100			
	Eucalyptus globulus Labill.	100			
	Chenopodium ambrosioides L.	100			
	Ranunculus bullatus L.	100			
Cancer			154	18	0.88
	Aristolo chialonga L.	100			
	Rosa × *damascena* Herrm.	100			
	Berberishispanica Boiss. & Reut.	76			
	Saussurea costus (Falc.) Lipschitz	75			
Chronic kidney disease			88	7	0.93
	Ziziphus lotus (L.) Lam.	100			
	Urticadioica L.	100			
	Opuntia ficus-indica(L.) Mill.	100			
	Herniaria glabra L.	100			
Diabetes			521	51	0.9
	Trigonella foenum-graecum L.	100			
	Artemisia herba-alba Asso.	100			
	Olea europaea L.	100			
	Silybum marianum(L.) Gaertn	100			
Rheumatic diseases			93	13	0.86
	Alpinia officinarum Hance	100			
	Peganum harmala L.	100			
	Cinnamomum camphora (L.) J. Presl.	100			
	Brassi carpa L.	100			

Disease categories and their ICF values

The Informant Consensus Factor (ICF) indicates the degree of knowledge exchange on the traditional use of medicinal plants. In this study, six categories of diseases were reported, namely, Diabetes, asthma, cancer, arterial hypertension, chronic kidney disease and rheumatic diseases. ICF values range from 0.86 to 0.93. The categories with high ICF values are chronic kidney disease (0.93), followed by asthma (0.918), diabetes (0.9), cancer (0.88), arterial hypertension (0.86) and rheumatic diseases (0.86) (Table 6).These high ICF values indicate reasonable reliability of informants concerning the traditional use of medicinal and aromatic plants (Lin *et al*. 2002), as well as that traditional knowledge, about treating chronic diseases or alleviating chemotherapy side effects in the cancer case is well shared between people in the study area.

Posology and adverse effects

Posology is not specified and varies between people for the same indication. In case of diabetes treatment with funegrec "*Trigonella foenum-graecum*", the use varies from one to three times a day, for an indefinite period from one month to a year and the dose is used randomly. These results could be justified by variations in diseases incidence and by knowledge lack about safety of using plants and use duration having a beneficial effect in the disease treatment. In this sense, an ethnobotanical study carried out in the Meknes-Tafilalet region showed that treatment duration depends on the treated disease, the used plant and the recommended word-of-mouth prescription (Fadil *et al*. 2015).

In the present study, we recorded 18 cases of side effects related to medicinal plants use, which are minor and mainly of digestive nature while other side effects were identified such as liver damage, hypotension, dizziness and generalized pain. These side effects may be caused by specific plant species toxicity, drug-plant interactions, interactions between secondary metabolites from different plants, or overdose in ingested quantities. Indeed, random use of doses generates adverse effects on human health because some plant species can, like any medication, be toxic when used in unspecified quantities. A study conducted in Mechrâa Bel Ksiri circle shows similar results (Benkhnigue *et al*. 2011).

The medicinal species involved in side effects are *Aristolochia longa* L. (liver damage and kidney disease), *Herniaria glabra* L. (gastric damage and severe polyuria), *Allium sativum* L. (hypotension), *Peganum harmala* L. (dizziness) and *Nigella sativa* L. (liver and gastric damage). Comparable results were obtained in a similar survey conducted at National Institute of Oncology in Rabat with cancer patients, revealing that *Aristolohchia longa* L. is one of the plant species most reported in side effects (Chebat *et al*. 2014). Another study showed thatt he high frequency of chronic interstitial nephritis in the Indian population could be linked to the traditional use of *Aristolochia longa* L. (Vanherweghem 1997).

Conclusions

Ethnobotanical surveys conducted in Rabat-Sale-Kenitra region have identified 79 species of medicinal plants used for the treatment of various chronic diseases. These plants belong to 74 genera and 39 botanical families, of which Lamiaceae and Asteraceae are the most represented. The most cited plant species are *Nigella sativa* L. (RFC=0.12), *Origanum compactum* Benth. (RFC= 0.091), *Trigonella foenum-graecum* L. (RFC= 0.077) and *Salvia officinalis* L. (RFC= 0.077). Foliage is the most widely used galenic form (PPV=0.246), while decoction is the most common preparation method used by this population (37.7%). The posology is not precise and varies from one person to another for the same indication. Furthermore, 18 cases of side effects were recorded, most of which were digestive. These side effects are related to the use of different medicinal plants such as *Aristolochia longa* L. and *Peganum harmala* L. Respondents profile showed that older people have a large knowledge and great expertise in medicinal plants use domain compared to other age groups, with a dominance of traditional phytotherapeutic knowledge among illiterate people.

Furthermore, it appears that phytotherapy remains a practice widely used by the Moroccan population for the treatment of many chronic diseases, despite socio-economic development and medical care. In Rabat-Sale-Kenitra region, the socio-economic context imposes traditional medicine on the most deprived social strata to obtain adequate therapeutic solutions at low cost, combining proven scientific effectiveness and cultural acceptability. The scientific development of traditional medicine must lead in particular to the development of herbal medicines, taking into consideration the safety, efficacy, quality of medicinal plants use and the preservation of this heritage.

This study enabled to appreciate and discover traditional knowledge of the population of Rabat-Sale-Kenitra region; and showed the interest of valorizing Moroccan natural resources. Therefore, it will be important to extend this type of work to other kingdom regions, which will allow to collect a maximum of information on medicinal species and to establish exhaustive catalogs of Moroccan medicinal flora. The results of this study could also provide a database for the valorization of plant species used in the treatment of chronic diseases through biological and phytochemical studies of listed plants, with the

aim of identifying and characterizing new natural active compounds usable in the pharmaceutical sector.

Declarations

List of abbreviations: RFC: Relative Citation Frequency, FIV: Family Importance Value, PPV: Plant Part Value, FL: Fidelity Level, ICF: Informant Consensus Factor, FC: citation frequency, N: total number of people surveyed, Nur: number of use citations for a disease category, Nt: number of species used by informants in a given use category, DT: diabetes, RHD: Rheumatic Diseases, ASH: asthma, AHT: arterial hypertension, CN: cancer, CKD: chronic kidney diseases, DPMYH: Department of Pulmonology Moulay Youssef hospital; ANFAS: Moroccan association for the help of patients with chronic respiratory pathology.

Ethics approval and consent to participate: The data were collected with respect to confidentiality, anonymity and consent. All respondents were informed about the aim of this study.

Consent for publication: Not applicable

Availability of data and materials: The data was not deposited in public repositories.

Competing interests: The authors declare no conflict of interest.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' contributions: Naoufal El Hachlafi: Study design, ethnobotany surveys conduction, active participation in structuring of the methodology, manuscript writing, data analysis and interpretation. Abderrahim Chebat: Study conception and supervision, Methodology description and botanical identification. Rachida Soulaymani Bencheikh: Contribution to the study design and authorizations of different institutions to conduct the surveys. Kawtar Fikri-Benbrahim: Work supervising, contribution to Methodology, manuscript improving and Review-Editing. All authors read, reviewed and approved the manuscript.

Acknowledgements

The authors wish to express their sincere thanks to all health institutions and all associations of patients with chronic diseases for their help durin carrying out this work. The authors are also grateful to all informants from the population of Rabat-Sale-Kenitra region and the traditional herbalists who have participated in this survey.

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