© 2022 Journal of Pharmacy & Pharmacognosy Research, 10 (2), 279-302, 2022
ISSN 0719-4250
https://jppres.com

DOI: https://doi.org/10.56499/jppres21.1196_10.2.279

Original Article

Ethnobotanical and ethnopharmacological study of medicinal plants used in the treatment of anemia in the region of Haouz-Rehamna (Morocco)

[Estudio etnobotánico y etnofarmacológico de plantas medicinales utilizadas en el tratamiento de la anemia en la región de Haouz-Rehamna (Marruecos)]

Ouafae Benkhnigue[1,2]*, Noureddine Chaachouay[3], Hamid Khamar[1,2], Fatiha El Azzouzi[2], Allal Douira[2], Lahcen Zidane[2]

[1]Department of Botany and Plant Ecology, Scientific Institute, University Mohammed V, B. P. 703, Rabat 10106, Morocco.
[2]Plant, Animal Productions and Agro-industry Laboratory, Department of Biology, Faculty of Sciences, Ibn Tofail University, B.P. 133 14000, Kenitra, Morocco.
[3]Higher School of Education and Training, Berrechid, University Hassan, 1st, 50 Rue Ibnou Lhaytham B.P. 577, 26002 Settat, Morocco.
*E-mail: ouafae. benkhnigue@is.um5.ac.ma, benkhnigue@gmail.com

Abstract

Context: The ethnobotanical study of the plants used is of great interest in the medical field. In this perspective, we have carried out this ethnobotanical and ethnopharmacological study, which is part of the development of plant resources traditionally used against anemia in a large region of Middle Atlantic Morocco (Mam-4): Al Haouz-Rehamna.

Aims: To establish a catalog of medicinal plants used in traditional medicine against anemia disease.

Methods: For this purpose, we carried out an ethnobotanical survey using 1700 questionnaire cards during five campaigns (from 2012 to 2017) in the studied field. In addition, the information sought was about the plant including its local name, its part used, its toxicity and, medical practices related. Ethnobotanical indices, such as Use Value (UV), Family Use Value (FUV) and, Plant Part Value (PPV), were determined.

Results: The results allowed us to identify 48 medicinal plants of which 12 were toxic. The inventoried species were distributed in 45 genera and belong to 27 botanical families, of which four predominated in the number of species: *Apiaceae*, *Amaranthaceae*, *Fabaceae*, and *Asteraceae*. Also, 11 species were traditionally more used as effective plants against anemia: *Rubia peregrina*, *Lens culinaris, Malva sylvestris*, *Beta vulgaris*, *Spinacia oleracea*, *Mercurialis annua*, *Hibiscus sabdariffa, Corrigiola telephiifolia*, *Nasturtium officinale*, *Cistus laurifolius* and *Armeria mauritanica.* The leafy stems were the most used part (PPV = 0.28%) followed by the seed (PPV = 0.26%). These parts were usually used steamed, decocted, and rarely triturated in honey or infused in water. The recipes were administered orally until cured.

Conclusions: The present study established the importance of documenting traditional knowledge about the species of medicinal plants that are used to correct many chronic diseases such as anemia. Analysis of this knowledge has shown that several of the listed plants promoted anti-anemia activity and could become the basis for in-depth scientific investigations.

Keywords: anemia; ethnobotanic; Morocco; pharmacology; phytotherapy; toxicity.

Resumen

Contexto: El estudio etnobotánico de las plantas utilizadas es de gran interés en el ámbito médico. Es en esta perspectiva que hemos llevado a cabo este estudio etnobotánico y etnofarmacológico que forma parte del desarrollo de los recursos vegetales utilizados tradicionalmente contra la anemia en una gran región del Atlántico Medio de Marruecos (Mam-4): Al Haouz-Rehamna.

Objetivos: Establecer un catálogo de plantas medicinales utilizadas en la medicina tradicional contra esta enfermedad.

Métodos: Para ello, se realizó un relevamiento etnobotánico utilizando 1700 fichas de cuestionario durante cinco campañas (de 2012 a 2017). Además, la información buscada era sobre la planta, incluido su nombre local, la parte utilizada, su toxicidad y prácticas médicas relacionadas. Se determinaron los índices etnobotánicos, como el valor de uso (UV), el valor de uso familiar (FUV) y el valor de la parte de la planta (PPV).

Resultados: Se identificaron 48 plantas medicinales de las cuales 12 fueron tóxicas. Las especies inventariadas se distribuían en 45 géneros y pertenecían a 27 familias botánicas, de las cuales cuatro predominaron en el número de especies: *Apiaceae*, *Amaranthaceae*, *Fabaceae* y *Asteraceae*. Asimismo, tradicionalmente se utilizaban más 11 especies como plantas eficaces contra la anemia: *Rubia peregrina*, *Lens culinaris*, *Malva sylvestris*, *Beta vulgaris*, *Spinacia oleracea*, *Mercurialis annua*, *Hibiscus sabdariffa*, *Corrigiola telephiifolia*, *Nasturtium officinale*, *Cistus laurifolius* y *Armeria mauritanica*. Los tallos frondosos fueron la parte más utilizada (PPV = 0.28%) seguido de la semilla (PPV = 0.26%). Estas partes generalmente se usaban al vapor, cocidas y, rara vez, trituradas en miel o infundidas en agua. Las recetas se administraban por vía oral hasta que se curaban.

Conclusiones: El presente estudio estableció la importancia de documentar los conocimientos tradicionales sobre las especies de plantas medicinales que se utilizan para corregir muchas enfermedades crónicas como la anemia. El análisis de este conocimiento ha demostrado que varias de las plantas enumeradas promueven la actividad anti-anemia y podrían convertirse en la base para investigaciones científicas en profundidad.

Palabras Clave: anemia; etnobotánica; farmacología; fitoterapia; Marruecos; toxicidad.

ARTICLE INFO
Received: September 13, 2021.
Received in revised form: November 19, 2021.
Accepted: November 20, 2021.
Available Online: December 8, 2021.

INTRODUCTION

Anemia, or the silent emergency, is considered by the World Health Organization (WHO) to be one of the oldest, most common, and most prevalent blood disorders in the world (OMS, 2005). Certainly, this chronic disease affects people of all ages, but the main targets are infants, young children, pregnant women, and the elderly (Diouf et al., 2015; Chen et al., 2018). It is defined as a decrease in hemoglobin concentration below cut-off values concerning the age, sex, and physiological status of individuals (El Hioui et al., 2009). In children aged 6 months to 5 years, a hemoglobin level below 11g/dL signified anemia, which is mild up to 10g/dL, moderate between 7 and 10g/dL and, severe below 7g/dL (WHO, 2011; Ferlazzo et al., 2016). The health impact of anemia is significant in adults and children. It can lead to resistance to infections, general weakness and impairs motor and mental development in younger children (Stoltzfus, 2001; Moalem et al., 2004). Without effective management, anemia can promote cognitive decline, immune system impairment, and increased mortality (GBD 2015 Disease and Injury Incidence and Prevalence Collaborators, 2016). Although this endemic can be caused by bleeding, infections, genetic problems, or chronic diseases, its primary cause is inadequate intake of one or more essential nutrients (Iron, vitamin B9 (folic acid), and vitamins B12) in the diet (OMS, 2005; Adebo et al., 2018). WHO has classified anemia as one of the burdensome public health problems in both developing and developed countries (McLean et al., 2009; Peter et al., 2014).

WHO data reveal that the global prevalence of this disease in the general population is estimated to be 24.8% or about 2 billion people affected by this disease (McLean et al., 2009). In Africa, the proportion of anemic patients is abnormally high, with a prevalence of 67.6% in 2005 (McLean et al., 2009). In Morocco, the latest available statistics on the prevalence of anemia are somewhat old and cover the period 1994-2000. The prevalence of this survey shows that in 2000, anemia in children under five years of age and pregnant women decreased compared to 1994 (31.5% *versus* 35.4% and 37.2% *versus* 45.5%, respectively). In contrast, in the same period, anemia among men doubled from 9.9% to 18% (Ministère de la Santé, 2018).

The methods used to treat anemia are blood transfusion and oral administration of iron supplements. These methods are inexpensive and more effective but have many drawbacks and side effects, especially for oral therapy (insufficient absorption, lack of compliance, nausea, vomiting, constipation, and stomach pain) (Camashella, 2015; Maladkar et al., 2020). In addition, consumption of inappropriate doses of iron supplements can lead to serious health-related complications such as certain neurological disorders, cardiovascular conditions, oxidation formation, oxidative stress and, cancer (Beard et al., 1996; Knutson et al., 2000; Saha et al., 2018; Qi Zhang et al., 2020). Therefore, there would be a great need to find a safe and effective alternative for the management of anemia.

In front of the progress that has known the pharmaceutical industry of medicine today and the chemical arsenal of modern medicine was developed for the treatment of chronic diseases, including anemia (WHO, 2005), the use of plants in the traditional way, in the treatment of these diseases, is remained a common practice in some countries of the world and especially in developing countries (Sawadogo et al., 2017). In fact, in these countries, the large and popular use of traditional medicines could be related to a combination of two main factors viz., the socio-economic and the cultural. According to Eto (2013), in addition to the huge wealth of knowledge about the use of medicinal plants in the local flora, traditional treatment is economically affordable and easily accessible for the majority of people and especially which have low incomes.

As a result, the WHO recognizes that complementary and traditional medicines (including herbal medicine) are very important and even indispensable in basic medical care in some countries. Thus, since the 1990, the organization has encouraged all member states to take steps to incorporate these medicines into their basic health care systems and has recommended that they increase their knowledge of these different methods as well as the training of health care providers (WHO, 1996).

Currently, there is an increase in the number of clinical trials for herbal therapeutics used in various diseases including anemia, to confirm their therapeutic value and receive approvals for marketing (Varoni et al., 2015). Recent studies have shown that some herbal phytochemicals act directly to induce resolution of anemia, and others act pleiotropically through their antioxidant activity, increasing resistance to oxidative stress or triggering cellular mechanisms, such as autophagy (Trivedi and Pandey, 2021).

The vascular flora of Morocco is one of the most diverse in the Mediterranean region and the richest in North Africa, with about 5211 taxa (species and subspecies) (Fennane and Ibn Tattou, 2012; Dobignard and Chatelain, 2013), of which about 22% are endemic (Rankou et al., 2013). The use of medicinal and aro-

matic plants for self-care is a matter of culture and tradition common in most regions in Morocco (Bellakhdar et al., 1991; Ziyyat et al., 1997; Hmamouchi, 1999). One of the many chronic diseases that rural communities use traditional medicines to correct is anemia. Nevertheless, the works related to the inventory of plants used in the treatment of this pathology are scarce, hence the need to conduct ethnobotanical surveys in the field of traditional medicine to contribute to the search for other improved traditional medicines that could be endowed with interesting therapeutic properties (anti-anemic and antioxidant) in the treatment or prevention of anemia based on herbal medicine In this perspective, the present study was initiated to identify the plants used in the region of Al Haouz-Rehamna in the treatment of anemia.

MATERIAL AND METHODS

Study area

Morocco has been floristically subdivided into different phytogeographic regions by Fenanne and Ibn Tattou (1998, 2005) and Ibn Tattou and Fennane (2008) in their catalogs. The Al Haouz-Rehamna region is one of them (noted Mam-4) and belongs to Middle Atlantic Morocco. It is bounded to the north by the Chaouia-Doukkala region (Mam-1), to the northeast by the Middle Oum-Errabiâ region (Mam-5), to the east by the Mgoun region (HA-4), to the south by Ida-Ou-Tanane (HA-1), Seksaoua (HA-2), and the Central High Atlas (HA-3), and to the west by the Abda-Haha region (Mam-2) (Fig. 1).

The relief of the region is perhaps schematically divided into four major natural clusters (Piqué et al., 1993):

- Zone of plateaus with a moderate altitude below 1000 m, it includes the plateaus of Rehamna and Bahira;
- The plains zone includes the plains of Haouz, Rehamna and, Tassaout Upstream and Downstream. Most of the agricultural land is located in this area;
- Basin area: this is the Essaouira-Chichaoua basin characterized by depressions and elevations in the form of cereal growing or grazing land;
- The Djebilets: it is a mountain area of moderate altitude very limited.

The region has a Mediterranean-type climate regime with an average rainfall of 800 mm per year in the mountainous region and 190 mm in the plain (Knippertz et al., 2003; Ait El Mekki, 2017). The average annual temperature is about 18.5°C. The average maximum is 37.7°C, the average minimum is 4.9°C (Samia et al., 2018). More generally, the region falls between bioclimates ranging from arid with temperate winters to semi-arid with warm winters (Negre, 1959).

The hydrographic system of the region includes a large watershed, that of Tensift, and part of the Oum Errabia watershed, formed by several sub-catchments and draining the northern slopes of the High Atlas, with inputs of pluvial origin (Abourida, 2007).

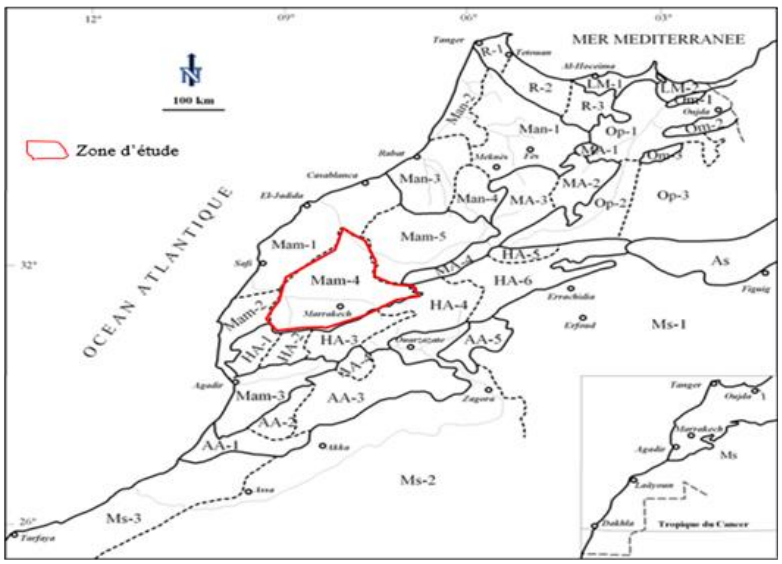

Figure 1. Map of phytogeographic divisions of northern Morocco.

Source: Fenanne and Ibn Tattou (1998; 2005). In red the study area Abbreviations: Saharan Morocco (Ms); Saharan Atlas (As); Anti Atlas (AA), High Atlas (HA); Middle Atlas (MA); Middle Atlantic Morocco (Mam); North Atlantic Morocco (Man); Eastern Moroccan Plateaux (Op); Eastern Moroccan Mountains (Om); Mediterranean Coast (LM) and the Rif (R).

Table 1. List of floristic and ethnobotanical survey points.

01- Marrakech	08- Youssoufia	15- Chichaoua	22- Lamzoudia	29- Jaidate
02- Ait-Ourir	09- Echemmaia	16- Sid L'Mokhtar	23- Skhour rehamna	30- Mguedgua
03- Ksiba	10- Sidi Bou Othmane	17- Benguerir	24- Tlat Ouelad-Dlim	31- Ras Ain Rehamna
04- Tamensourte	11- Ouelad Hassoune	18- Sebt Brikyne	25- Majjate	32- Sidi Ghanem
05- El-Kelaâ of Sraghna	12- Si Thami	19- Jemaat-Ghmate	26- Assahrij	33- Sid Zwine
06- Laataouia	13- Sidi Rahal	20- Tahennaoute	27- Tnin Bouchane	34- Mechraa-Ben Aabou
07- Imintanoute	14-Tamellalte	21- Tameslouhete	28- Mtal	

Pedological studies carried out throughout the study area (Cavallar, 1950; Billaux and Bayssine, 1967) have shown the presence of eight types of soils: isohumic, red on shale, calco-magnesimorphic, vertisol (tirs), halomorphic, hydromorphic, regosol, and poorly developed erosion soils; their texture is generally silty-clay, silty, and silty-sandy.

In Haouz-Tadla and Rehamna, it is represented by a bush with *Ziziphus lotus* (L.) Lam., *Withania frutescens* (L.) Pauquy and *Acacia gummifera* Willd; *Pistacia atlantica* Desf. here is very rare. However, in the Djebilets chain that forms the stop of this whole arid zone of Western Morocco, the vegetation cover is generally precarious and appears extremely reduced on the slopes (Negre, 1959). A few stunted bushes of *Acacia gummifera* and *Ziziphus lotus*, very scattered, and here and there, a *Withania frutescens* or an *Ephedra,* are the only representatives of shrubby vegetation that we have encountered (Emberger, 1938). Administratively, the territory of the study area is part of the Marrakech-Safi region. The latter covers a total area of 39 167 km² or 5.51% of the national territory (MGRMS, 2015). According to the latest general census of population and housing (HCP, 2014) the population of the Marrakech-Safi region is estimated at 4 520 569 inhabitants (4 511 933 Moroccans and 8636 foreigners) (i.e., 13.36% of the national population and a density of 115 inhabitants per km²). The majority of this population is rural (2 582 553), with a percentage of 57.12%. The high rate of the rural population highlights its agricultural vocation (HCP, 2014).

Methodology

For the realization of this study, two types of sources, oral and written, were drawn.

To draw up a list of plants used to treat anemia by the local population in the study area, ethnobotanical surveys were conducted in the field from March 1, 2012, to September 30, 2017, with traditional medicine practitioners and the local population. Depending on the availability of the interviewees, the interviews were conducted individually or in groups. They were conducted in the form of a free discussion so that people could answer without constraint. The questionnaires were prepared beforehand on a survey form. The location of the various ethnobotanical survey and floristic survey sites in the study area was determined using "stratified probabilistic" sampling techniques (Godron, 1971; Godron and Daget, 1982) to have the most complete floristic inventory possible and to carry out ethnobotanical surveys that varied from one area to another in the study region. The study area was divided into 34 homogeneous strata (Table 1; Fig. 2). Using simple random sampling, small samples (50 persons) are then formed for each of the 34 strata. In order to authenticate the questionnaires (Annex 1), all questions were tested following preliminary field surveys. Also, the data obtained from this first survey were analyzed and compared with other ethnobotanical studies carried out in other regions of Morocco (Bellakhdar, 1986; 1997; Benkhnigue et al., 2010).

Harvesting and identification

Plant sampling missions were organized in natural environments, during five campaigns from 2013 to 2017, to make control herbaria for each plant used. The identification of plants collected as well as observed was based on the main works concerning this area (Negre, 1961-1962; Bellakhdar, 1997; Fennane and Ibn Tattou, 1998; Fennane et al., 1999; 2007; 2014; Hmamouchi, 1999). Arduous determinations were checked in the herbarium (RAB) as well as via the websites of the Jstore, GBF databases, and The Plant List (http://www.theplantlist.org/). The nomenclature adopted conforms to that of (Dobignard and Chatelain, 2013) as well as (Fennane and Ibn Tattou, 2005; Ibn Tattou and Fennane, 2008). Plant families are taken in the sense of Angiosperm Phylogeny (APG, 2016). Biologic type of plants (life forms) assessment followed Raunkiaer (1934).

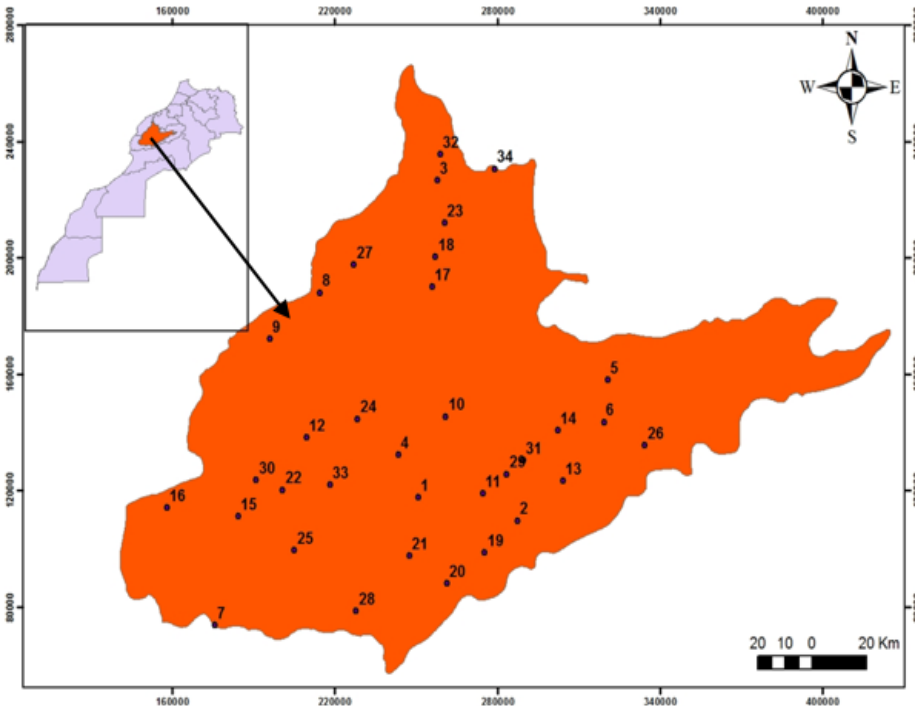

Figure 2. Map of the study area showing the study stations.

Data processing and statistical analysis

The data from these ethnobotanical and ethnopharmacological surveys were collected and noted on the questionnaire forms, then transcribed into a database and processed by SPSS version 21 (Statistical Package for the Social Sciences, IBM, New York, United states), to identify the groups of plants used against anemia, the mode of use, the form of use and the number of plants noted as toxic. To better analyze the data and interpret our results, we adopted the following specific quantitative and descriptive analyses:

Use value (UV)

The calculation of the species use-value (UV) allowed us to determine the relative importance of locally known species and the most frequently reported species in the treatment of the disease. It was calculated according to the equation [1].

$$UV = \Sigma Ui/N \quad [1]$$

Where Ui: number of uses cited by each informant for a given species, and N: total number of informants (Hudaib et al., 2008; Vitalini et al., 2013).

Family Use Value (FUV)

The calculation of FUV is an index of cultural importance that can be applied in ethnobotany to calculate a biological plant taxon value (Gakuubi and Wanzala, 2012). The use of FUV allowed us to identify the importance of medicinal plant families. It was calculated according to the equation [2].

$$FUV = UVs/ns \quad [2]$$

Where UVs: use value s of the species, and ns: total number of species within each family (Cadena-González et al., 2013).

Plant part value (PPV)

The plant part value (PPV) was calculated according to the equation [3].

$$VPP = RUplant_{part}/RU \quad [3]$$

Where: $RUplant_{part}$ is the sum of reported uses per plant part and RU is the number of reported uses of all plant parts. The part with the highest VPP is the most used by respondents (Chaachouay et al., 2019).

RESULTS AND DISCUSSION

Socio-demographic profile of respondents

During the surveys, 1700 people were interviewed. The time spent on each interview was approximately 15-120 minutes. More than 80% of the respondents (1530) preferred to use traditional medicine (TM) either alone (75%) or in combination with modern medicine (MM) with a percentage of 10%. A total of 578 (37.78%) used plants to treat anemia, and they gave information on the vernacular name of each species, the period of its availability in the field, its effectiveness, and the method and mode of use. From the different variables, notably gender, age, family

situation, and academic level, we were able to characterize the users of traditional medicine against anemia in this region (n = 578). Table 2 shows the socio-demographic profile of these people with the frequency in percentage.

The analysis of the results obtained shows that the majority of these people were women (63%) against 37% of men, with a sex ratio that is not balanced (F/M = 1.68). The predominance of women can be explained by the fact that they take care of the health of their families, with tools available, effective, and less expensive. These results confirm the findings of other ethnobotanical work conducted in different regions (Benkhnigue et al., 2010; Chaachouay et al., 2019; Orch et al., 2020). The use of medicinal species was widespread in all age groups, with a clear predominance of people between 41 and 50 years old (35%). This can be explained by the fact that people in this age group are more aware of the risks associated with modern medicine, and they are oriented towards other natural plant-based products. Regarding family status, 80% (n = 465) were married compared to only 20% (n = 113) who were single. Most than half of the plants' users (58%) have no monthly income; people with low monthly income occupy second place with a percentage of 34%. These two categories are followed by people with medium and high monthly income, and which are represented by rates 7% and 1%, respectively. The majority of these people (83%) lived in rural areas.

Floristic analysis

Table 3 lists the plants identified and collected during the ethnobotanical surveys conducted in the said region. They are presented according to family, scientific name, local vernacular name, biological type, nature of the plant (spontaneous, cultivated, and imported), part used, mode of preparation adopted by the local population, possible association with other plants, and use value (UV) and family use value (FUV) data. To further develop our results, we conducted a literature review of ethnobotanical and pharmacological studies, to prove the therapeutic activity of the identified plants.

Table 2. Socio-demographic profile of respondents (n = 578).

Variable	Category	Informants (n)	Frequency (%)
Type	Female	362	63
	Male	216	37
Age	Between 18 and 30 years old	104	18
	Between 31 and 40 years old	114	20
	Between 41 and 50 years old	200	35
	Between 51 and 60 years old	97	17
	>60 years old	63	11
Family situation	Brides	465	80
	Singles	113	20
Academic level	Illiterate	398	69
	Primary	80	14
	Secondary	66	11
	University	34	6
Income/month*	Low	198	34
	Medium	43	7
	High	4	1
	No income	333	58
Geographical origin	Rural	477	83
	Urban	101	17

*Income low: Salary/month ≤ 3000 dh (ca. USD 328.5); Income medium: 3000 dh (ca. USD 328.5) ≤ Salary/month ≤ 8000 dh (ca. USD 875.5); Income high: Salary/month ≥ 8000 dh (ca. USD 875.5).

Table 3. List of medicinal plants used to treat anemia in the Al Haouz-Rehamna region, anti-anemic and antioxidant properties proven through pharmacological studies.

Family and species scientific names	Vernacular name	Biological type*	Nature of the plant	Part used	Preparation method	UV	FUV	Possible association and name of plants used (number of associations)	References for pharmacological effects (antioxidant and anti-anemic)
Amaranthaceae							**0.775**		
Beta maritima L.	Hmessou, Selque	Therophyte	Spontaneous	Leafy stem	Cooked in water vapor	0.052			
Beta vulgaris L.	Al Barba	Therophyte	Cultivated	Root	Cooked in water vapor	0.553		*Juglans regia, Vitis vinifera* (2)	(Jaiswal et al., 2014; El-Beltagi et al., 2018)
Chenopodium album L.	El Blîch	Therophyte	Spontaneous	Leaf	Cooked in water vapor	0.060			(Al-Snafi, 2015; Nowak et al., 2016)
Chenopodium quinoa Will.	Quinoa	Therophyte	Cultivated	Seed	Cooked in water vapor	0.077			(Han et al., 2019)
Spinacia oleracea L.		Therophyte	Cultivated	Leaf	Cooked in water vapor	0.155		*Rubia peregrina, Cuminum cyminum, Nigella sativa, Allium sativum* (4)	(Deven and Steesh, 2014; Roberts and Moreau, 2016)
Amaryllidaceae							**0.202**		
Allium cepa L.	Bessla	Geophyte	Cultivated	Bulb	Cooked	0.141		*Coriandrum sativum, Petroselinum sativum* (2)	(Fredotovíc et al., 2017)
Allium sativum L.	Touma	Geophyte	Cultivated	Bulb	Cooked	0.121		*Allium porrum* (1)	(Batiha et al., 2020)
Apiaceae							**0.516**		
Coriandrum sativum L.	Kasbour	Therophyte	Cultivated	Dried fruit	Decoction	0.131		*Petroselinum sativum* (1)	(Wei et al., 2019)
Cuminum cyminum L.	Kammoun	Therophyte	Cultivated	Dried fruit	Decoction	0.103		*Spinacia oleracea* (1)	(Moghaddam et al., 2015)
Magydaris panacifolia (Vahl.) Lange.	Frifra	Geophyte	Spontaneous	Leafy stem	Cooked in water vapor	0.060		*Mercurialis annua, Beta maritima, Malva sylvestris, Papaver rhoeas, Cladanthus arabicus, Chenopodium album (6)*	
Petroselinum sativum Hoffman.	Maadnousse	Therophyte	Cultivated	Leafy stem, seed	Cooked in water vapor	0.112		*Allium cepa* (1)	(Es-Safi et al., 2021)

Table 3. List of medicinal plants used to treat anemia in the Al Haouz-Rehamna region, anti-anemic and antioxidant properties proven through pharmacological studies (continued..).

Family and species scientific names	Vernacular name	Biological type*	Nature of the plant	Part used	Preparation method	UV	FUV	Possible association and name of plants used (number of associations)	References for pharmacological effects (antioxidant and anti-anemic)
Pimpinella anisum L.	Habete hlawa	Therophyte	Cultivated	Seed	trituration in honey	0.087		*Lens culinaris, Sesamum indicum* (2)	(Shojaii and Abdollahi Fard, 2012)
Ridolfia segetum (L.) Moris	Tebche	Therophyte	Spontaneous	Leafy stem, fruit	Cooked, decoction	0.128		*Rubia peregrina* (1)	(Cabral et al., 2015; Beeby et al., 2021)
Arecaceae							**0.162**		
Phoenix dactylifera L.	Tmare	Phanerophyte	Cultivated and spontaneous	Fruit (date)	In kind	0.162			(Saleh et al., 2011)
Asteraceae							**0.488**		
Anacyclus radiatus Loisel.	El-kantousse	Therophyte	Spontaneous	Leafy stem	Cooked in water vapor	0.152		*Malva sylvestris* (1)	
Centaurea calcitrapa L.	Nougire	Therophyte	Spontaneous	Leafy stem	Cooked in water vapor	0.159		*Malva sylvestris* (1)	(Trabsa et al., 2020)
Chrysanthemum coronarium L.	Maloule OAli	Therophyte	Spontaneous	Leafy stem	Cooked in water vapor	0.148		*Malva sylvestris* (1)	(Donia et al., 2014)
Cladanthus arabicus (L.) Cass.	Tafsse	Therophyte	Spontaneous	Flower	Decoction	0.112		*Rubia peregrina, Corrigiola telephiifolia, Ridolfia segetum* (3)	(Aghraz et al., 2018)
Brassicaceae							**0.278**		
Eruca sativa Miller.	El-jerjir, Kerkaze	Therophyte	Spontaneous	Leafy stem	Cooked in water vapor	0.155		*Malva sylvestris* (1)	(Sarwar Alam et al., 2007)
Nasturtium officinale R.Br.	Gernuneche	Fixed-hydrophyte	Spontaneous and cultivated	Leafy stem	Cooked in water vapor	0.245		*Malva sylvestris* (1)	(Bahramikia and Yazdanparast, 2010)
Caryophyllaceae							**0.299**		
Corrigiola telephiifolia Pourret.	Ssarghina	Hemicryptop-hyte	Spontaneous	Root	Infusion, decoction	0.299		*Rubia peregrina* (1)	

Table 3. List of medicinal plants used to treat anemia in the Al Haouz-Rehamna region, anti-anemic and antioxidant properties proven through pharmacological studies (continued...)

Family and species scientific names	Vernacular name	Biological type*	Nature of the plant	Part used	Preparation method	UV	FUV	Possible association and name of plants used (number of associations)	References for pharmacological effects (antioxidant and anti-anemic)
Cistaceae							**0.226**		
Cistus laurifolius L.	Agullide	Chamephyte	Spontaneous	Leaf	Cooked in water vapor	0.226			(Küpeli et al., 2006)
Euphorbiaceae							**0.425**		
Mercurialis annua L.	Hurriga el malssa	Therophyte	Spontaneous	Leafy stem	Cooked in water vapor	0.425		*Magydaris panacifolia* (1)	(Ben Nasr et al., 2021)
Fabaceae							**0.998**		
Arachis hypogaea L.	Kawkaw	Therophyte	Cultivated	Seed	Decoction	0.131		*Carum carvi, Ficus carica, Ridolfia segetum* (3)	(Sobolev et al., 2011)
Cicer arietinum L.	El hommesse	Therophyte	Cultivated	Seed	Maceration dans l'eau	0.086			(Ferreira et al., 2019)
Lens culinaris Medik.	Laadesse	Therophyte	Cultivated	Seed	trituration with a hard-boiled egg	0.660			(Jameel et al., 2015)
Medicago sativa L.	Fessa	Hemicryptop-hyte	Cultivated	Seed	Decoction	0.098		*Triticum durum* (1)	(Mirzaei et al., 2015; Zagórska-Dziok et al., 2020)
Trigonella foenum-graecum L.	El helba	Therophyte	Cultivated	Seed	Decoction	0.103			(Kaviarasan et al., 2007; Yadav and Baquer, 2014); antianemia (Chourasiya et al., 2019)
Juglandaceae							**0.178**		
Juglans regia L.	El-guergae	Phanerophyte	Cultivated and subspontaneous	Fruit, leaf	In kind	0.167		*Beta vulgaris* (1)	(Vieira et al., 2019)

Table 3. List of medicinal plants used to treat anemia in the Al Haouz-Rehamna region, anti-anemic and antioxidant properties proven through pharmacological studies (continued...)

Family and species scientific names	Vernacular name	Biological type*	Nature of the plant	Part used	Preparation method	UV	FUV	Possible association and name of plants used (number of associations)	References for pharmacological effects (antioxidant and anti-anemic)
Malvaceae							**0.684**		
Hibiscus sabdariffa L.	El -karkadi	Phanerophyte	Imported from Egypt	Dried flower, Seed	Infusion	0.385		*Quercus rotundifolia, Rubia peregrina, Juglans rejia, Punica granatum* (4)	(Ahmed et al., 2013; Aba et al., 2016; Jabeur et al., 2017)
Malva sylvestris L.	El bakoula	Hemicryptop-hyte	Spontaneous	Leafy stem	Cooked in water vapor	0.596		*Emex spinosa, Anacyclus radiatusn Centaurea calcitrapa, Beta marítima* (4)	(DellaGreca et al., 2009)
Moraceae							**0.142**		
Morus alba L.	Etûte	Phanerophyte	Cultivated	Fruit	In kind	0.141		*Citrus sinensis* (1)	(Xu et al., 2020)
Nitrariaceae							**0.040**		
Peganum harmala L.	Harmel	Chamephyte	Spontaneous	Seed	Trituration in honey	0.039		*Myristica fragrans, Curcuma longa* (2)	(Khlifi et al., 2013; Abolhasani et al., 2015)
Papaveraceae							**0.080**		
Papaver rhoeas L.	Bellamane	Therophyte	Spontaneous	Leafy stem	Cooked in water vapor	0.079		*Mercurialis annua, Beta maritima, Malva sylvestris, Cladanthus arabicus, Chenopodium album* (5)	(Marsoul et al., 2020)
Pedaliaceae							**0.140**		
Sesamum indicum L.	Jenjelane	Therophyte	Cultivated	Seed	Infusion in milk	0.140		*Lens culinaris* (1)	(Dravie et al., 2020)
Plumbaginaceae							**0.194**		
Armeria mauritanica Wallr.	Awedmi	Hemicryptop-hyte	Spontaneous	Root	Decoction	0.193			
Poaceae							**0.161**		
Triticum durum Desf.	El gumeh	Therophyte	Cultivated	Grain	Cooked	0.160			(Laus et al., 2012)

Table 3. List of medicinal plants used to treat anemia in the Al Haouz-Rehamna region, anti-anemic and antioxidant properties proven through pharmacological studies (continued...)

Family and species scientific names	Vernacular name	Biological type*	Nature of the plant	Part used	Preparation method	UV	FUV	Possible association and name of plants used (number of associations)	References for pharmacological effects (antioxidant and anti-anemic)
Polygonaceae							**0.155**		
Emex spinosa (L.) Campd.	Homayda romiya	Therophyte	Spontaneous	Leafy stem	Cooked in water vapor	0.155		*Anacyclus radiatusn Centaurea calcitrapa, Beta marítima* (3)	(Mona et al., 2013).
Portulacaceae							**0.154**		
Portulaca oleracea L.	Rejla	Therophyte	Spontaneous and cultivated	Leafy stem	Cooked in water vapor	0.153		*Malva sylvestris, Beta maritima* (1)	(Erkan, 2012)
Ranunculaceae							**0.164**		
Nigella sativa L.	Ssanouje	Therophyte	Cultivated and subspontaneous	Seed	Cooked in water vapor	0.164		*Rubia peregrina, Cuminum cyminum, Allium sativum* (3)	(El-Shanshory et al., 2019; Silva et al., 2020)
Rosaceae							**0.303**		
Prunus amygdalus Stokes *var dulcis* DC.	Luze lahlou	Phanerophyte	Spontaneous and cultivated	Seed	Trituration	0.148		*Ficus carica* (1)	
Prunus armeniaca L.	Mechmache	Phanerophyte	Cultivated	Seed	Trituration in honey, In kind	0.131			(Wani et al., 2017)
Rosa canina L.	Tighferte	Nanophanero -phyte	Spontaneous	Fruit	Decoction	0.069			(Fetni et al., 2020)
Rubiaceae							**0.719**		
Rubia peregrina L.	Fuwwa, Tarubia	Chamephyte	Spontaneous	Root	Decoction, trituration	0.719		*Corrigiola telephiifolia, Ridolfia segetum.* (2)	(Özgen et al., 2003)
Rutaceae							**0.157**		
Citrus sinensis (L.) Osbeck.	Limoune	Phanerophyte	Cultivated	Fruit	In kind	0.157		*Morus alba* (1)	(Benelli et al., 2010)
Vitaceae							**0.084**		
Vitis vinifera L.	Zbibe	Phanerophyte	Cultivated and subspontaneous	Fruit	In kind	0.084		*Lavandula officinalis* (1)	(Aouey et al., 2016; Gouvinhas et al., 2020)

Table 3. List of medicinal plants used to treat anemia in the Al Haouz-Rehamna region, anti-anemic and antioxidant properties proven through pharmacological studies (continued...)

Family and species scientific names	Vernacular name	Biological type*	Nature of the plant	Part used	Preparation method	UV	FUV	Possible association and name of plants used (number of associations)	References for pharmacological effects (antioxidant and anti-anemic)
Xanthorrhoeaceae							**0.026**		
Asphodelus ramosus L.	El berwague	Geophyte	Spontaneous	Rhizome	Infusion	0.025			
Zingiberaceae							**0.131**		
Curcuma longa L.	Kharkoum aorouk	Geophyte	Imported	Rhizome	Infusion	0.131		*Ridolfia segetum, Rubia peregrina, Petroselinum sativum* (3)	(Jiao et al., 2009; Mishra et al., 2018; Resty Basuki and Farmasi IIK Bhakti Wiyata Kediri, 2020)

Phanerophytes (Ph.): These are essentially trees, shrubs and bushes, whose buds are located more than 50 cm above the ground; Nanophanerophytes (Nph.): Small woody plants between 0.5 and 2 m in height; Chamephytes (Ch.): These are low plants, whose regenerative buds are located less than 50 cm above the ground; Hemicryptophytes (Hem.): Herbaceous perennials whose buds in the resting period are located at ground level and whose aerial part dies during the unfavorable season; Geophytes (G.): Herbaceous perennial plants whose buds, in the resting period, are buried in the ground and whose aerial part dies during the unfavorable season; Therophytes (Th.): These are annual or biennial plants surviving the unfavorable seasons in the form of seeds; Fixed-hydrophyte (FHyd): plants which live completely or partially submerged in freshwater, roots are fixed in mud, but leaves have long petioles, which keep them floating on the water surface (Raunkiaer, 1934). UV: Use value; FUV: Family use-value.

Table 4. Botanical families of medicinal plants used as anti-anemic agents, their number of species and their Family Use Value (FUV).

Botanical family	Number of species	FUV	Botanical family	Number of species	FUV
Amaranthaceae	5	0.775	*Papaveraceae*	1	0.08
Amaryllidaceae	2	0.202	*Pedaliaceae*	1	0.14
Apiaceae	6	0.516	*Plumbaginaceae*	1	0.194
Arecaceae	1	0.162	*Poaceae*	1	0.161
Asteraceae	4	0.488	*Polygonaceae*	1	0.155
Brassicaceae	2	0.278	*Portulacaceae*	1	0.154
Caryophyllaceae	1	0.299	*Ranunculaceae*	1	0.164
Cistaceae	1	0.226	*Rosaceae*	3	0.303
Euphorbiaceae	1	0.425	*Rubiaceae*	1	0.719
Fabaceae	5	0.998	*Rutaceae*	1	0.157
Juglandaceae	1	0.178	*Vitaceae*	1	0.084
Malvaceae	2	0.684	*Xanthorrhoeacea*	1	0.026
Moraceae	1	0.142	*Zingiberaceae*	1	0.131
Nitrariaceae	1	0.04			

According to ethnopharmacological studies (Rivera et al., 2019; Redouan et al., 2020; Fakchich and Elachouri, 2021), the majority of the identified species have presented various pharmacological activities (e.g., antioxidant, anti-inflammatory, anticonvulsant, neuroprotective, antiviral, immunostimulant, hepatoprotective, laxative) (Sendl et al., 1992; Shojaii and Abdollahi Fard, 2012; Roberts and Moreau, 2016; Fredotovic et al., 2017; Farkhondeha and Samarghandian, 2018; Li et al., 2020). The present study focuses mainly on antioxidant and anti-anemic activity.

Specific analysis of botanical families and quantitative analysis according to the FUV and UV index

Forty-eight medicinal species have been listed to treat anemia in the region of Al-Haouz Rehamna. They belong to 45 genera and are grouped in 27 botanical families of which the most represented (41.66% of the total number) are *Apiaceae* (6 species), *Amaranthaceae*, and *Fabaceae* (5 species each), and *Asteraceae* (4 species). While other families were represented by three, two, or only one species (Table 4).

Based on the FUV index, we found 4 families that were the most cited: *Fabaceae* (FUV = 0.998), *Amaranthaceae* (FUV = 0.775), *Rubiaceae* (FUV = 0.719), and *Malvaceae* (FUV = 0.684). The high use of the Fabaceae family in traditional medicine in this region can be explained on the one hand by the fact that it is well known, according to the traditional beliefs of local people, for its nutrient-rich seeds. On the other hand, this family includes many economically important species as food, medicinal and culinary plants, for example, *Lens culinaris* Medik. *Pisum sativum* L. *Arachis hypogaea* L., *Trigonella foenum graecum* L. *Vicia faba* L. and *Phaseolus vulgaris* L. Phytochemical studies have shown that most genera in this family are rich sources of tannins, flavonoids, alkaloids, phenolic compounds, and glutenins (Zarnowski et al., 2001; Demir et al., 2019).

The calculation of the UV index allowed us to extract 5 species that have the highest UV because they are more cited by the informants: *Rubia peregrina* L. (UV = 0.719), *Lens culinaris* Medik. (UV = 0.660), *Malva sylvestris* L. (UV = 0.596), *Beta vulgaris* L. (UV = 0.553) and *Mercurialis annua* L. (UV = 0.425). These spontaneous (*Malva sylvestris* L., *Mercurialis annua* L., and *Rubia peregrina* L.) or cultivated (*Beta vulgaris* L. and *Lens culinaris* Medik.) plant species need to be studied phytochemically and pharmaceutically to identify their chemical constituents and active ingredients responsible for their anti-anemic properties. Spontaneous species should be prioritized for conservation because their misuse may threaten their populations due to overharvesting. The species with the lowest UV is *Asphodelus ramosus* L. (UV = 0.025).

Based on the number of citations, the analysis of the collected data (Fig. 3) shows that 11 medicinal plants are more used against anemia in the said region, whose number of citations is more than 100 times, they are used alone or in association with other plants. The effectiveness of these species has been

confirmed by local users. Among these species, five species have the highest number of citations (over 300 citations) and they are highly recommended according to the statement of the people involved in this work:

- *Rubia peregrina* (*Rubiaceae*) known under the vernacular name Fuwa; is a spontaneous plant and cited 416 times. The plant is consumed for its dry roots.
- *Lens culinaris* (*Fabaceae*) commonly known as Laadess. It is a plant widely cultivated in the region as elsewhere, it is reported 382 times. It is consumed for its seeds.
- *Malva sylvestris* (*Malvaceae*) locally called Bakula; is a spontaneous plant, lives in climatic conditions ranging from humid to Saharan and is cited 345 times. Their leafy stems are highly recommended, especially during the flowering period, they are used alone or in association with other plants in the so-called "Bakula". In the study area there is a popular proverb that circulates to confirm the use of this plant in the flowering period: "إذا البقولة نورت على السكين دورت" (= Bakula ela nawret aala ssikin dawerte; which means): If the Great mallow blooms, it looks for the knife. This may justify their use, alone or in combination with other plants, in 35 anti-anemic recipes. None of the reported pharmacological studies are a cause for safety concern (HMPC, 2018).
- *Beta vulgaris* (*Amaranthaceae*) is commonly known as El Barba. It is a cultivated species, and it has been cited 320 times. For its fresh roots, the plant is consumed either in nature, in decoction in water, or cooked in steam.
- *Spinacia oleracea* (*Amaranthaceae*), known by the vernacular name Ssabanekh, is a cultivated plant, sometimes subsumed on rubble, lives in subhumid to humid climatic conditions, and is cited 302 times. Its fresh leaves are recommended, sautéed with olive oil and eggs.

The bibliographic analysis of published works (Google, Google Scholar, Pubmed, and Science Direct) concerning ethnobotanical and ethnopharmacological evidence shows that these plants are already cited in other studies of the same type, and no work has been traced their toxicity (Tables 3 and 5).

Moreover, among the 48 species identified, the anti-anemic activity of 19 species has been previously reported by ethnobotanical studies conducted in different regions of Morocco and different countries of the world: *Beta vulgaris* L. (Hseini and Kahouadji, 2007; Suzanne et al., 2017; Chaachouay et al., 2019; Gumisiriza et al., 2019); *Spinacia oleracea* L. (Hseini, 2008; Lahsissène, 2010; Ben Akka et al., 2015; Cheraghi and Asadi-Samani, 2016; Hachi, 2017); *Allium sativum* L. (Cheraghi and Asadi-Samani, 2016); *Petroselinum sativum* Hoffman. (Lahsissène, 2010; Ben Akka et al., 2015); *Phoenix dactylifera* L. (Sadeghi and Kuhestani, 2014); *Lens culinaris* Medik. (Hseini, 2008; Lahsissène, 2010); *Trigonella foenum-graecum* L. (Hseini, 2008; Sijelmassi, 2011; Hachi, 2017; Rahmani et al., 2018); *Juglans regia* L. (Lahsissène, 2010; Sijelmassi, 2011); *Hibiscus sabdariffa* L. (El Hafian et al., 2014; Peter et al., 2014; Yenilougo et al., 2019); *Malva sylvestris* L. (Hseini, 2008); *Morus alba* L. (Chaachouay et al., 2019); *Papaver rhoeas* L. (Hachi, 2017), *Triticum durum* Desf. (Hachi, 2017) *Portulaca oleracea* L. (Hseini, 2008; Lahsissène, 2010; Hachi, 2017); *Prunus amygdalus* Stokes *var. dulcis* DC. (Hachi, 2017); *Prunus armeniaca* L. (Cheraghi and Asadi-Samani, 2016; Hachi, 2017); *Rosa canina* L. (El-Hilaly et al., 2003; Sijelmassi, 2011); *Rubia peregrina* L. (Bammi and Douira, 2002; El-Ghazouani et al., 2021) and *Vitis vinifera* L. (Hachi, 2017). However, the anti-anemic activity has only been experimentally proven for six species: *Hibiscus sabdariffa* L. (Ahmed et al., 2013; Aba et al., 2016), *Beta vulgaris* L. (Jaiswal et al., 2014), *Curcuma longa* L. (Jiao et al., 2009), *Medicago sativa* L. (Mirzaei et al., 2015), *Trigonella foenum graecum* L. (Chourasiya et al., 2019) and *Nigella sativa* L. (El-Shanshory et al., 2019). Therefore, it would be interesting to conduct confirmatory experimental studies for the curative power reported by users to make available to the population natural products that can be used as main, alternative or adjuvant therapies in many diseases, such as anemia.

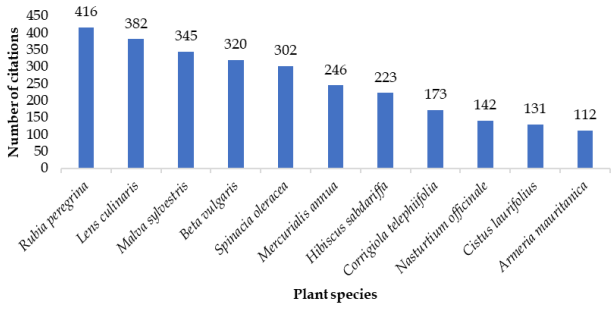

Figure 3. Distribution of the most commonly used species against anemia with their number of citations.

Biological spectrum

The biological spectrum for all 48 species shows that therophytes dominate and occupy the first place (54%) in the treatment of anemia. The strong presentation of therophytes can be explained on the one hand by the fact that they are annual species, with short life cycles, often better adapted in environments that are often disturbed (Bouhache et al., 2002). On the other hand, these species are easily accessible,

very abundant, and easily harvested. However, despite the importance of annuals, phanerophytes maintain a fairly important place (17%); geophytes come third and contribute 11%, hemicryptophytes occupy the 4th place with 8%, followed by champhytes (6%). At the same time, hydrophytes and nanophanerophytes occupy the last place with the same percentage of 2% (Fig. 4).

Type of plants used

Concerning the distribution of specimens according to their degree of spontaneity, this study reveals that the cultivated species are well represented. They contribute to 52.08% of the total number of species collected, followed by the spontaneous species (43.75%), while the imported species are represented by only two species (4.17%).

Table 5. Toxic species used in the traditional pharmacopeia of the Al Haouz Rehamna region against anemia.

Species	Toxicity
Allium sativum L.	At high doses, the plant extract is reported to induce liver, spleen, and lung damage, with anorexia and mild anemia (Gatsing et al., 2005).
Cuminum cyminum L.	Repeated oral administration in female Wistar rats of 1000 mg/kg/d of *C. cyminum* essential oil after the 23-day interval causes an increase in serum alanine transaminase levels (Taghizadeh et al., 2017).
Petroselinum sativum Hoffman.	A preliminary diagnosis of parsley (*Petroselinum sativum*) induced photosensitization was confirmed by experimental reproduction of typical lesions in ducks (Kuttin, 1988).
Corrigiola telephiifolia Pourr.	Much higher doses pose toxicological risks. At 2000 mg/kg/day, the extract significantly increased serum creatinine, alkaline phosphatase, gamma-glutamyltransferase, and phosphorus concentrations ($p<0.05$), all suggesting functional nephrotoxicity and hepatotoxicity (Lakmichi et al., 2011).
Arachis hypogaea L.	Peanut allergy is common in children. It brutally manifests itself in gastrointestinal disorders (nausea, vomiting, diarrhea), respiratory disorders (rhinitis, nasal and oral pruritus, laryngeal edema), and skin disorders (urticaria and eczema) (Bruneton, 1999).
Medicago sativa L.	The Alfalfa can be responsible for several types of accidents: photosensitization accident, nitrate poisoning, and estrogenic isoflavone poisoning (Bellakhdar, 1997).
Trigonella foenum-graecum L.	Fenugreek consumption has induced serious toxicological side effects: teratogenic effects ranging from congenital malformations to death have been reported in humans, rodents, rabbits, and chicks. In addition, results from studies in rats, mice, and rabbits show anti-fertility, anti-implantation, and abortive activity in females related to the saponin compound, as well as testicular toxicity and anti-fertility effects in males associated with oxidative stress and DNA damage (Ouzir et al., 2016).
Peganum harmala L.	It is contraindicated during pregnancy due to its abortifacient and mutagenic activities. Adverse events such as neurosensory symptoms, visual hallucination, bradycardia, hypotension, agitation, tremors, ataxia, abortion, and vomiting prompt people to use this plant with caution (Niroumand et al., 2015).
Papaver rhoeas L.	At high doses, poppies can become toxic causing drowsiness and hallucinations (Sijelmassi, 2011).
Portulaca oleracea L.	An acute oral toxicity study of the 50% ethanolic extract of the whole plant showed that a single administration of any of the following doses: 500, 1000, 1500, and 2000 mg/kg body weight (b. w) to albino mice caused behavioral changes in these animals: grooming, hyperactivity, sedation, respiratory arrest, convulsions, increased and decreased activity of the plant, and a decrease in the amount of the plant.) to albino mice resulted in behavioral changes in these animals: grooming, hyperactivity, sedation, respiratory arrest, convulsions, increased and decreased motor activity and mortality were observed (animals died at 500 mg/kg bw and 100% of the animals died at 1000, 1500 and 2000 mg/kg b. w.) (Shafi and Tabassum, 2013).
Prunus armeniaca L.	The nucleus (rich in amygdaloside) can cause serious accidents (headaches, tachycardia, asthenia, vomiting, hypotension, and even respiratory failure). Poisoning mainly affects children (Bruneton, 2009).
Nigella sativa L.	Black cumin intoxications are manifested by: dry mouth, oral-pharyngeal irritation, inflammations of the tongue, palate, tonsils, and nasopharynx (Bellakhdar, 1997).

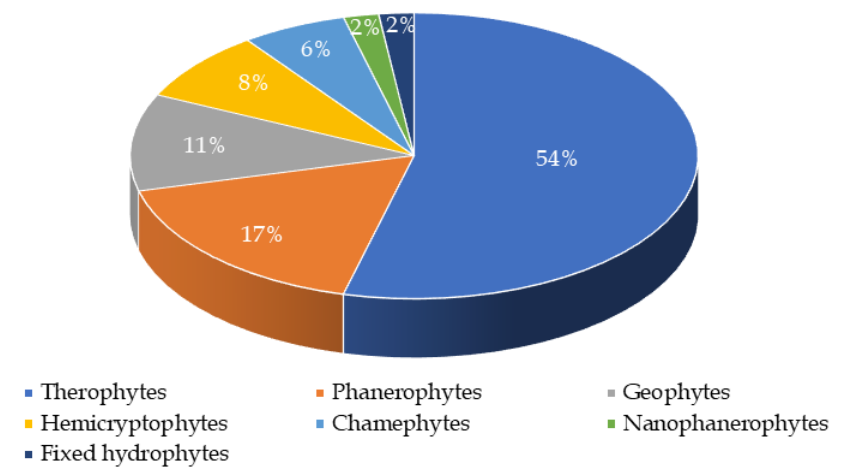

Figure 4. Distribution of the medicinal flora of the Al Haouz Rehamna region according to their biological types.

Parts of medicinal plants used to treat anemia

To treat anemia based on herbal medicine, the people, concerned by this study, use different parts of plants (leaf, seed, root, bulb, leafy stem, fruit, and rhizome) to prepare different anti-anemic recipes. Based on the PPV index (value of the plant part), the analysis of the obtained results shows that the leafy stem is more used (PPV = 0.28%), followed by seed (PPV = 0.26), fruit (PPV = 0.18), root (PPV = 0.08), leaf (PPV = 0.06), The three parts: bulb, rhizome and flower have the same index (PPV = 0.04) and they come before the last position. Finally, the grain occupies the last position with PPV = 0.02 (Fig. 5). The preference for leafy stems, in this region, is explained by the fact that the majority of the people concerned prefer to use them to take advantage of both the active principles of the stems and the leaves, responsible for their therapeutic effects, especially for annual and herbaceous plants.

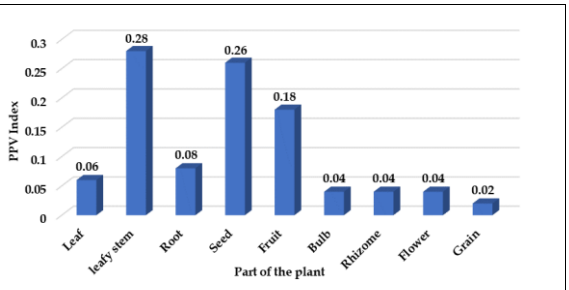

Figure 5. Plant parts used to treat anemia in study area.

Instructions for use, dosage, and dose

The contents of the therapeutic recipes are administered to the patients orally via water, orange juice, or in the form of salad in the so-called "Bakula" dishes until recovery. The choice of the oral route can be explained by the fact that anemia is related to deep and internal organs. To reach them, any compound must pass through the digestive system to facilitate its assimilation (Tra Bi et al., 2008). In addition, some users prefer to accompany the remedy with a diet enriched with animal proteins: fish, seafood, spleen, meat, beef liver, and eggs (preferably from domesticated chickens).

During our field survey, we noticed that the prescribed doses varied from one person to another, even if it was the same plant, the same therapeutic indication (anemia), or the same method of preparation. Thus, most people (76.44%) use plants with non-precise doses (pinch, spoonful, handful), whereas the precise dose is used by only a few people (23, 56%). These results confirm the results of other ethnobotanical work conducted in other regions of Morocco (Benkhnigue et al., 2010; 2016; Najem et al., 2018).

It is very interesting to note that, according to our ethnobotanical survey, the majority of users including herbalists have limited knowledge about this disease and the majority of them confuse liver diseases (hepatitis, jaundice, and icterus) with anemia. Thus, to reconcile inherited empiricism with in-depth research, it is necessary to provide training to herbalists, traditional healers, and healers, to improve the quality of their interventions in the fight against diseases.

Risk of toxicity related to herbal medicine in the Al-Haouz Rehamna region

While ethnomedicinal practices have been able to treat some diseases with plants, it should not be forgotten that some of the plants have been the cause of poisoning and death of many people (Subramanian et al., 2018). The toxicity caused by medicinal plants is a very important factor to know to use medicinal and aromatic plants safely.

The pharmacological analysis of the plants identified 12 toxic species used in traditional pharmacopeia

to treat anemia in the study area (Table 5). However, according to the statements of the traditional practitioners interviewed, the toxicity of only one species (*Peganum harmala* L.*)* was known by the local population. The toxicity of 11 species remained unknown to the respondents. Thus, self-medication with these plants can harm public health, given that the majority of these people are illiterate and live in rural areas. Moreover, during our fieldwork, we observed that the majority of users did not respect the dosage, they did not take into account the precautions of use of the prescribed recipes, and they did not know the side effects and the toxicity of the majority of the plants used. Similarly, the lack of scientific evidence in favor of the efficacy of certain plants and the scarcity of clinical studies on the side effects and toxicity of herbal medicines increase the risks associated with herbal medicine (Adjanohoun, 1989).

CONCLUSION

The results of this prospective and descriptive study carried out in the region of Al Haouz Rehamna, show that despite the revolution in medical technology exploiting the accumulation of real know-how on the virtues of medicinal plants, the population of the studied geographical area often resorts to traditional medicine in the treatment of anemia. For example, our study identified 48 species divided into 45 genera and belonging to 27 botanical families. Among the species mentioned, 11 species are reported by the local population as being more effective in treating anemia: *Rubia peregrina, Lens culinaris, Malva sylvestris, Beta vulgaris, Spinacia oleracea, Mercurialis annua, Hibiscus sabdariffa, Corrigiola telephiifolia, Nasturtium officinale, Cistus laurifolius* and *Armeria mauritanica.* In addition, to the total of 48 species reported, 19 species are previously cited as antianemic in other ethnobotanical studies carried out in different regions of Morocco namely: *Beta vulgaris, Spinacia oleracea, Petroselinum sativum, Phoenix dactylifera, Lens culinaris, Medicago sativa, Trigonella foenum-graecum, Juglans regia, Hibiscus sabdariffa, Malva sylvestris, Morus alba, Papaver rhoeas, Triticum durum, Portulaca oleracea, Prunus amygdalus Stokes var dulcis* DC., *Prunus armeniaca*, *Rosa canina, Rubia peregrina* and *Vitis vinifera).* While the antianemic curative power of these plants has only been experimentally proven for 6 species: *Hibiscus sabdariffa, Beta vulgaris*, *Curcuma longa*, *Medicago sativa*, *Trigonella foenum graecum*, and *Nigella sativa*.

It would therefore be more interesting to validate the effectiveness of these plants mentioned in this study by appropriate experimental studies so that their use is more scientifically based and also to seek and isolate new active principles that could have curative and preventive properties against anemia.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

ACKNOWLEDGMENTS

The authors thank all the guides and inhabitants of the Haouz-Rehamna region for their help. To all sellers of medicinal plants. The authors also extend acknowledgments to all those who participated in the achievement of this product. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

REFERENCES

Aba PE, Joshua PE, Oli C (2016) *In vivo* studies on the possible haematological changes in rats administered *Hibiscus sabdariffa* L. aqueous extract. Int Blood Res Rev 5(1): IBRR.23170.

Abolhasani L, Salehi EA, Kenari RE (2015) Study of antioxidant capacity and stability of phenolic compounds from the seeds of *Peganum harmala* L. J Appl Environ Biol Sci 4(11s): 218–222.

Abourida A (2007) Approche hydrogéologique de la nappe du Haouz (Maroc) par Teledetection, isotopie, sig et modelisation. Thèse de Doctorat, Fac des sci, Semlaliya. Univ Cadi Ayyad Marrakech, p. 146.

Adebo AA, Yessoufou AG, Behanzin JG, Kabanoude AA, Yessoufou AK (2018) Anémie chez les enfants de moins de 5 ans reçus en consultation au service de pédiatrie de l'Hôpital de Zone d'Abomey-Calavi/So-Ava (Sud du Bénin). J Appl Biosc 123: 12373c12378.

Adjanohoun E (1989) Contribution aux études ethnobotaniques et floristiques en République populaire du Bénin (Médecine traditionnelle et pharmacopée). Vol. 1. A de coopération culturelle et Technique. Paris, p. 895.

Aghraz A, Gonçalves S, Rodríguez-Solana R, Dra LA, Di Stefano V, Dugo G, Cicero N, Larhsini M, Markouk M, Romano A (2018) Antioxidant activity and enzymes inhibitory properties of several extracts from two Moroccan Asteraceae species. S Afr J Bot 118: 58–64.

Ahmed HR, Mohammed HWA, El Hadi MH, El Khalifa YM (2013) The effect of aqueous extract of *Hibiscus sabdariffa* L. seeds on hematological parameters of anemic rats. Int J Phytomed 5: 278–281.

Ait El Mekki O (2017) Spatialisation du potentiel de recharge diffuse d'un aquifère libre sous climat semi-aride par techniques géospatiales et hydrochimiques: cas de l'aquifère du Haouz (Marrakech, Maroc). Thèse de Doctorat, Fac des sci, Semlalia, Univ Cadi Ayyad, Marrakech, Maroc, p. 181.

Al-Snafi AE (2015) The chemical constituents and pharmacological effects of pharmacological screening methods the chemical constituents and pharmacological effects of *Chenopodium album* L.- an overview. Int J Pharmacol Screen Method 5(1): 10–17.

Aouey B, Samet AM, Fetoui H, Simmonds MSJ, Bouaziz M (2016) Anti-oxidant, anti-inflammatory, analgesic and

antipyretic activities of grapevine leaf extract (*Vitis vinifera* L.) in mice and identification of its active constituents by LC–MS/MS analyses. Biomed Pharmacother 84: 1088–1098.

APG - The Angiosperm Phylogeny Group, Chase MW, Christenhusz MJM, Fay MF, Byng JW, Judd WS, Soltis DE, Mabberley DJ, Sennikov AN, Soltis PS, Stevens PF (2016) An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. Bot J Linn Soc 181(1): 1–20.

Bahramikia S, Yazdanparast R (2010) Antioxidant efficacy of *Nasturtium officinale* R. Br. extracts using various *in vitro* assay systems. J. Acupunct. Meridian Stud 3(4): 283–290.

Bammi J, Douira A (2002) Les plantes médicinales dans la forêt de l'Achach (Plateau central, Maroc). Acta Bot Malac 27: 131–145.

Batiha EG, Beshbishy AM, Wasef LG, Elewa YHA, Al-Sagan AA, Abd El-Hack ME, Taha AE, Abd-Elhakim YM, Devkota HP (2020) Chemical constituents and pharmacological activities of garlic (*Allium sativum* L.): A review. Nutrients 12(3): 872.

Beard JL, Dawson H, Piñero DJ (1996) Iron metabolism: A comprehensive review. Nutr Rev 54(10): 295–317.

Beeby E, Magalhães M, Lemos MFL, Pires IM, Cabral C (2021) Cytotoxic effects of *Ridolfia segetum* (L.) Moris phytoproducts in cancer cells. J Ethnopharmacol 267: 113515.

Bellakhdar J (1986) Propositions de questionnaires-fiches pour enquêtes ethnomédicales au Maghreb. Al Biruniya Rev Maroc Pharmacogn 2: 45–65.

Bellakhdar J (1997) La pharmacopée marocaine traditionnelle: Médecine arabe ancienne et savoirs populaires. Paris: Le Fennec, p. 764.

Bellakhdar J, Claisse R, Fleurentin J, Younos, C (1991) Repertory of standard herbal drugs in the Moroccan pharmacopoea. J Ethnopharmacol 35(2): 123–143.

Ben Akka F, Elhilah F, Benkhnigue O, Salhi S, Zidane L (2015) Eutde ethnobotanique des plantes médicinales dans la province de Khouribga (région d'Oum Rbai). ScienceLib Ed Mersenne 7: 150504.

Ben Nasr R, Baudelaire ED, Dicko A, El Ferchichi Ouarda H (2021) Phytochemicals, antioxidant attributes and larvicidal activity of *Mercurialis annua* L. (Euphorbiaceae) leaf extracts against *Tribolium confusum* (du val) larvae (Coleoptera; Tenebrionidae). Biology 10(4): 344.

Benelli P, Riehl CAS, Smânia A, Smânia EFA, Ferreira, SRS (2010) Bioactive extracts of orange (*Citrus sinensis* L. Osbeck) pomace obtained by SFE and low pressure techniques: Mathematical modeling and extract composition. J Supercrit Fluid 55(1): 132–141.

Benkhnigue O, Hachi M, Fadli M, Douira A, Zidan L (2016) Catalogue of the medicinal plants used in the treatment of urinary infections in the area of al-haouz rhamna (Central Morocco). Eur J Bot Plant Sci Phytol 3(1): 1–49.

Benkhnigue O, Zidane L, Fadli M, Elyacoubi H, Rochdi A, Douira A (2010) Etude ethnobotanique des plantes médicinales dans la région de Mechraâ Bel Ksiri (Région du Gharb du Maroc). Acta Bot Barcinon 53: 191–216.

Billaux P, Bayssine G (1967) Les sols du Maroc. In Les Cahièrs De La Recherche Agronomique, pp. 59–101.

Bouhache, M, Ezzahiri B, Houmy K, Rzozi SB, Taleb A (2002) Protection phytosanitaire des céréales. IAV Hassan II. Rabat, p. 22.

Bruneton J (1999) Pharmacognosie - Phytochimie Plantes médicinales (3rd ed.). Paris: Lavoisier, p. 1120.

Bruneton J (2009) Pharmacognosie - Phytochimie Plantes médicinales (4th ed.). Paris: Lavoisier, p. 1270.

Cabral C, Poças J, Gonçalves MJ, Cavaleiro C, Cruz MT, Salgueiro L (2015) *Ridolfia segetum* (L.) Moris (Apiaceae) from Portugal: A source of safe antioxidant and anti-inflammatory essential oil. Ind Crops Prod 65: 56–61.

Cadena-González AL, Sørensen M, Theilade I (2013) Use and valuation of native and introduced medicinal plant species in Campo Hermoso and Zetaquira, Boyacá, Colombia. J Ethnobiol Ethnomed 9: 23.

Camaschella CMD (2015) Iron-deficiency anemia. New Engl J Med 372(19): 1832–1843.

Cavallar W (1950) Etude des sols des différentes régions du Maroc. Société des Sciences Naturelles du Maroc, Travaux de la Section de pddologie. T.1, pp. 19–45.

Chaachouay N, Benkhnigue O, Fadli M, El Ibaoui H, Zidane L (2019) Ethnobotanical and ethnopharmacological studies of medicinal and aromatic plants used in the treatment of metabolic diseases in the Moroccan Rif. Heliyon 5(10): e02191.

Chen W Di, Huang H Sen, Su YC, Chou SC, Ho WC, Kao MC, Lin HJ, Huang ST (2018) The characteristics and prescription patterns of Chinese herbal medicine in clinical practice for the treatment of anemia. Taiwan J Obstet Gynecol 57(4): 570–577.

Cheraghi M, Asadi-Samani M (2016) Hematopoietic medicinal plants based on ethnobotanical documents of Iran: A strategy to develop nature-based drugs effective on anemia. Der Pharm Lett 8(5): 393–399.

Chourasiya A, Sahu RK, Khan MA (2019) Anti-anemic and haemopoietic evaluation of *Trigonella foenum-graecum* (Fenugreek) in rodent model. J Drug Deliv Ther 9: 332–337.

DellaGreca M, Cutillo F, D'Abrosca B, Fiorentino A, Pacifico S, Zarrelli A (2009) Antioxidant and radical scavenging properties of *Malva sylvestris* L. Nat Prod Comm 4(7): 893–896.

Demir S, Turan İ, Mısır S, Aliyazıcıoğlu Y (2019) Dorycnium pentaphyllum Ekstraktının İnsan Meme, Karaciğer ve Akciğer Kanseri Hücrelerindeki Seçici Sitotoksik Etkisi. Kahramannaraş Sütçü İmam Univ Doğa Bilim Derg 2(3): 473–479.

Deven M, Steesh B (2014) Pharmacological activity of *Spinacia oleracea* L. A complete overview. Asian J Pharm Res Dev 2(1): 83–93.

Diouf S, Folquet M, Mbofung K, Ndiaye O, Brou K, Dupont C, N'dri D, Vuillerod M, Azaïs-Braesco V, Tetanye E (2015) Prévalence et déterminants de l'anémie chez le

jeune enfant en Afrique francophone - Implication de la carence en fer. Arch Pediatr 22(11): 1188–1197.

Dobignard A, Chatelain C (2013) Index synonymique de la Flore d'Afrique du Nord. Dicotyledoneae: Oleaceae – Zygophyllaceae, vol 5. In Conservatoire et Jardin botaniques de la Ville de Genève, Genève: ECWP, p. 451.

Donia AM (2014) Biological activity of *Chrysanthemum coronarium* L. extracts. Ann Res Rev Biol 4(16): 2617-2627.

Dravie EE, Kortei NK, Essuman EK, Tettey CO, Boakye AA, Hunkpe G (2020) Antioxidant, phytochemical and physicochemical properties of sesame seed (*Sesamum indicum* L). Sci Afr 8: e00349.

El Hafian M, Benlandini N, Elyacoubi H, Zidane L, Rochdi A (2014) Étude floristique et ethnobotanique des plantes médicinales utilisées au niveau de la préfecture d'Agadir-Ida-Outanane (Maroc). J Appl Biosci 81: 7198–7213.

El Hioui M, Aboussaleh Y, Ahami A, Farsi M (2009) Contribution à l'étude de la prévalence de l'anémie chez les enfants préscolaires de la région de Kenitra, Maroc. Antropo 19: 1–5.

El-Beltagi HS, Mohamed HI, Megahed BMH, Gamal M, Safwat G (2018) Evaluation of some chemical constituents, antioxidant, antibacterial and anticancer activities of *Beta vulgaris* L. root. Fresenius Environ Bull 27(9): 6369–6378.

El-Ghazouani F, El-Ouahmani N, Teixidor-Toneu I, Yacoubi B, Zekhnini A (2021) A survey of medicinal plants used in traditional medicine by women and herbalists from the city of Agadir, southwest of Morocco. Eur J Integr Med 42: 101284.

El-Hilaly J, Hmamouchi M, Lyoussi B (2003) Ethnobotanical studies and economic evaluation of medicinal plants in Taounate province (Northern Morocco). J Ethnopharmacol 86(2–3): 149–158.

El-Shanshory M, Hablas NM, Aboonq MS, Fakhreldin AR, Attia M, Arafa W, Mariah RA, Baghdadi H, Ayat M, Zolaly M, Nabo MMH, Almaramhy HH, El-Sawy SA, Zidan M, Elshazley M, Alharbi R, Moustafa S, Abu-el Naga M, El Sayed SM (2019) *Nigella sativa* L. improves anemia, enhances immunity and relieves iron overload-induced oxidative stress as a novel promising treatment in children having beta-thalassemia major. J Herb Med 16: 100245.

Emberger L (1938) Aperçu général sur la végétation du Maroc. Berne: Hans Huber, p. 157.

Erkan N (2012) Antioxidant activity and phenolic compounds of fractions from *Portulaca oleracea* L. Food Chem 133(3): 775–781.

Es-Safi I, Mechchate H, Amaghnouje A, Kamaly OMAl, Jawhari FZ, Imtara H, Grafov A, Bousta D (2021) The potential of parsley polyphenols and their antioxidant capacity to help in the treatment of depression and anxiety: An *in vivo* subacute study. Molecules 26(7): 2009.

Eto B (2013) Research in clinical phytopharmacology to develop health care in developing countries: state of the art and perspectives. Phytopharmacology 4(2): 149–205.

Fakchich J, Elachouri M (2021) An overview on ethnobotanico-pharmacological studies carried out in Morocco, from 1991 to 2015: Systematic review (part 1). J Ethnopharmacol 267: 113200.

Farkhondeha T, Samarghandian S (2018) The therapeutic effects of *Portulaca oleracea* L. in hepatogastric disorders. Gastroenterol Hepatol 42(2): 127–132.

Fennane M, Ibn Tattou M (1998) Catalogue des plantes vasculaires rares, menacées ou endémiques du Maroc. Bocconea 8: 5–243.

Fennane M, Ibn Tattou M (2005) Flore vasculaire du Maroc: Inventaire et chorologie. Vol. 1. Série botanique N 37. Rabat: Trav. Inst Sci. Université Mohamed 5, p. 483.

Fennane M, Ibn Tattou M (2012) Statistiques et commentaires sur l'inventaire actuel de la flore vasculaire du Maroc. Bull de l'inst Sci Section Sci de la Vie 34(1): 1–9.

Fennane M, Ibn Tattou M, El Oualidi J (2014) Flore pratique du Maroc. Vol. 3. Série botanique N 40. Rabat: Trav. Inst Sci. Université Mohamed 5, p. 793.

Fennane M, Ibn Tattou M, El Oualidi J, Ouyahya A (2007) Flore pratique du Maroc. Vol. 2. Série botanique N 38. Rabat: Trav. Inst Sci. Université Mohamed 5, p. 636.

Fennane M, Ibn Tattou M, Mathez J, Ouyahya A, El Oualidi J (1999) Flore pratique du Maroc. Vol. 1. Série botanique N 36. Rabat: Trav. Inst Sci. Université Mohamed 5, p. 558.

Ferlazzo N, Visalli G, Cirmi S, Lombardo GE, Laganà P, Di Pietro A, Navarra M (2016) Natural iron chelators: Protective role in A549 cells of flavonoids-rich extracts of Citrus juices in Fe^{3+}-induced oxidative stress. Environ Toxicol Pharmacol 43: 248–256.

Ferreira CD, Bubolz VK, da Silva J, Dittgen CL, Ziegler V, de Oliveira Raphaelli C, de Oliveira M (2019) Changes in the chemical composition and bioactive compounds of chickpea (*Cicer arietinum* L.) fortified by germination. LWT - Food Sci Technol 111: 363–369.

Fetni S, Bertella N, Ouahab A, Martinez Zapater JM, De Pascual-Teresa Fernandez S (2020) Composition and biological activity of the Algerian plant *Rosa canina* L. by HPLC-UV-MS. Arab J Chem 13(1): 1105–1119.

Fredotovíc Ž, Šprung M, Soldo B, Ljubenkov I, Budić-Leto I, Bilušić T, Cikeš-Čulić V, Puizina J (2017) Chemical composition and biological activity of *Allium cepa* L. and *Allium* × *cornutum* (Clementi ex Visiani 1842) methanolic extracts. Molecules 22(3): 448).

Gakuubi MM, Wanzala W (2012) A survey of plants and plant products traditionally used in livestock health management in Buuri district, Meru County, Kenya. J Ethnobiol Ethnomed 8: 39.

Gatsing D, Aliyu R, Kuiate JR, Garba IH, Jaryum KH, Tedongmo N, Tchouanguep FM, Adoga GI (2005) Toxicological evaluation of the aqueous extract of

Allium sativum L. bulbs on laboratory mice and rats. Cameroon J Exp Biol 1(1): 39–45.

GBD 2015 Disease and Injury Incidence and Prevalence Collaborators: Vos T, Allen C, Arora M, Barber RM, Brown A, Carter A, Casey DC, Charlson FJ, Chen AZ, Coggeshall M, et al. (2016) Global, regional, and national incidence, prevalence, and years lived with disability for 310 diseases and injuries, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet 388(10053): 1545–1602.

Godron M (1971) Essai sur une approche probabiliste de l'écologie des végétations. Thèse Doct. D'Etat,. U.S.T.L., Montpellier, p. 247.

Godron M, Daget P (1982) Analyse fréquentielle de l'écologie des espèces. Collection Ecologia mediterranea, 18 Masson, p. 163.

Gouvinhas I, Pinto R, Santos R, Saavedra MJ, Barros AI (2020) Enhanced phytochemical composition and biological activities of grape (*Vitis vinifera* L.) stems growing in low altitude regions. Sci Hortic 265: 109248.

Gumisiriza H, Birungi G, Olet EA, Sesaazi CD (2019) Medicinal plant species used by local communities around Queen Elizabeth National Park, Maramagambo Central Forest Reserve and Ihimbo Central Forest Reserve, Southwestern Uganda. J Ethnopharmacol 239: 111926.

Hachi M (2017) Etude floristique et ethnobotanique des plantes médicinales dans la région du moyen Atlas central (Maroc). Thèse de Doctorat, Fac. des Sci, Unv. Ibn Tofail, Kénitra, p. 190.

Han Y, Chi J, Zhang M, Zhang R, Fan S, Dong L, Huang F, Liu L (2019) Changes in saponins, phenolics and antioxidant activity of quinoa (*Chenopodium quinoa* willd) during milling process. LWT - Food Sci Technol 114: 108381.

HCP (2014) Recensement Général de la Populatiion et de l'Habitat. Monograpie de la région Marrakech-Safi. Direction régionale de Marrakech-Safi. Rabat, p. 171.

Hmamouchi M (1999) Les Plantes médicinales et aromatiques Marocaines: Utilisations, biologie, écologie, chimie, pharmacologie, toxicologie. Mohammedia, p. 389.

HMPC - Committee on Herbal Medicinal Products (2018) Assessment report on *Malva sylvestris* L. and/or *Malva neglecta* Wallr., folium and *Malva sylvestris* L., flos. European Medicines Agency, p. 44.

Hseini (2008) Etude ethnobotanique de la flore médicinale dans la région de Rabat. Thèse de Doctorat, Fac. des Sci, Uni, Mohamed V. Rabat, p. 173.

Hseini S, Kahouadji A (2007). Étude ethnobotanique de la flore médicinale dans la région de Rabat (Maroc occidental). Lazaroa 28: 79–93.

Hudaib M, Mohammad M, Bustanji Y, Tayyem R, Yousef M, Abuirjeie M, Aburjai T (2008) Ethnopharmacological survey of medicinal plants in Jordan, Mujib Nature Reserve and surrounding area. J Ethnopharmacol 120(1): 63–71.

Ibn Tattou M, Fennane M (2008) Flore vasculaire du Maroc: Inventaire et chorologie. Vol. 2. Série botanique N 39. Rabat: Trav. Inst Sci. Université Mohamed 5, p. 398.

Jabeur I, Pereira E, Barros L, Calhelha RC, Soković M, Oliveira MBPP, Ferreira ICFR (2017) *Hibiscus sabdariffa* L. as a source of nutrients, bioactive compounds and colouring agents. Food Res Int 100: 717–723.

Jaiswal A, Ganeshpurkar A, Awasthi A, Bansal D, Dubey N (2014) Protective effects of beetroot extract against phenyl hydrazine induced anemia in rats. Pharmacognosy J 6(5): 1–4.

Jameel M, Ali A, Ali M (2015) Isolation of antioxidant phytoconstituents from the seeds of *Lens culinaris* Medik. Food Chem 175: 358–365.

Jiao Y, Wilkinson IV J, Di X, Wang W, Hatcher H, Kock ND, D'Agostino R, Knovich MA, Torti FM, Torti SV (2009) Curcumin, a cancer chemopreventive and chemotherapeutic agent, is a biologically active iron chelator. Blood 113(2): 462–469.

Kaviarasan S, Naik GH, Gangabhagirathi R, Anuradha CV, Priyadarsini KI (2007) *In vitro* studies on antiradical and antioxidant activities of fenugreek (*Trigonella foenum graecum* L.) seeds. Food Chem 103(1): 31–37.

Khlifi D, Sghaier RM, Amouri S, Laouini D, Hamdi M, Bouajila J (2013) Composition and anti-oxidant, anti-cancer and anti-inflammatory activities of *Artemisia herba-alba* Asso., *Ruta chalpensis* L. and *Peganum harmala* L. Food Chem Toxicol 55: 202–208.

Knippertz P, Christoph M, Speth P (2003) Long-term precipitation variability in Morocco and the link to the large-scale circulation in recent and future climates. Meteorol Atmospheric Phys 83(1–2): 67–88.

Knutson MD, Walter PB, Ames BN, Viteri FE (2000) Both iron deficiency and daily iron supplements increase lipid peroxidation in rats. J Nutr 130(3): 621–628.

Küpeli E, Orhan DD, Yesilada E (2006) Effect of *Cistus laurifolius* L. leaf extracts and flavonoids on acetaminophen-induced hepatotoxicity in mice. J Ethnopharmacol 103(3): 455–460.

Kuttin ES (1988) Parsley-induced photosensitivity in ostriches and ducks. Avian Pathol 17(1): 183–192.

Lahsissène H (2010) Recherches ethnobotanique & floristique des plantes médicinales utilisées dans la région phytogéographique de Zaër. Thèse de doctorat, Fac. des sci, Univ Mohamed 5, Rabat, p. 258.

Lakmichi H, Bakhtaoui FZ, Gadhi CA, Ezoubeiri A, El Jahiri Y, El Mansouri A, Zrara I, Loutfi K (2011) Toxicity profile of the aqueous ethanol root extract of *Corrigiola telephiifolia* Pourr. (Caryophyllaceae) in rodents. Evid Based Complement Alternat Med 2011: 317090.

Laus MN, Tozzi D, Soccio M, Fratianni A, Panfili G, Pastore D (2012) Dissection of antioxidant activity of durum wheat (*Triticum durum* Desf.) grains as evaluated by the new LOX/RNO method. J Cereal Sci 56(2): 214–222.

Li D, Liu D, Lv M, Gao P, Liu X (2020) Isolation of triterpenoid saponins from *Medicago sativa* L. with neuroprotective activities. Bioorganic Med Chem Lett 30(4): 126956.

Maladkar M, Sankar S, Yadav A (2020) A novel approach for iron deficiency anaemia with liposomal iron: Concept to clinic. J Biosci Med 8(9): 27–41.

Marsoul A, Ijjaali M, Oumous I, Bennani B, Boukir A (2020) Determination of polyphenol contents in *Papaver rhoeas* L. flowers extracts (Soxhlet, maceration), antioxidant and antibacterial evaluation. Mater Today Proc 31: S183–S189.

McLean E, Cogswell M, Egli I, Wojdyla D, De Benoist B (2009) Worldwide prevalence of anaemia, WHO vitamin and mineral nutrition information system, 1993-2005. Public Health Nutr 12(4): 444–454.

MGRMS (2015) Monographie générale la région de marrakech-safi. Ministère de l'Intérieur, Direction Générale des Collectivités Locales. Rabat, p. 58.

Ministère de la Santé (2018) Enquête Nationale sur la Population et la Santé Familiale (ENPSF)- Rapport préliminaire. http://srvweb.sante.gov.ma/Lists/Actualites/DispForm.aspx?ID=44 [Consuted 20th August 2021]

Mirzaei A, Delaviz H, Mirzaei M, Tolooei M (2015) The Effects of *Medicago sativa* L. and *Allium porrum* L. on iron overload in rats. Glob J Health Sci 7(7): 137–142.

Mishra R, Gupta AK, Kumar A, Lal RK, Saikia D, Chanotiya CS (2018) Genetic diversity, essential oil composition, and *in vitro* antioxidant and antimicrobial activity of *Curcuma longa* L. germplasm collections. J Appl Res Med Aromat Plant 10: 75–84.

Moalem S, Weinberg ED, Percy ME (2004) Hemochromatosis and the enigma of misplaced iron: Implications for infectious disease and survival. BioMetals 17(2): 135–139.

Moghaddam M, Miran SNK, Pirbalouti AG, Mehdizadeh L, Ghaderi Y (2015) Variation in essential oil composition and antioxidant activity of cumin (*Cuminum cyminum* L.) fruits during stages of maturity. Ind Crops Prod 70: 163–169.

Mona AA, Emad MA, Anis BH (2013) Evaluation of antimicrobial and antioxidant properties of leaves of *Emex spinosa* and fruits of *Citrillus colocynthis* from Saudi Arabia. Afr J Biotechnol 12(34): 5308–5313.

Najem M, Belaidi R, Slimani I, Bouiamrine EH, Ibijbijen J, Nassiri L (2018) Traditional pharmacopoeia of the Zerhoun region - Morocco -: Ancestral knowledge and risks of toxicity. Int J Biol Chem Sci 12(6): 2797–2807.

Negre R (1959) Recherches phytogéographiques sur l'étage de végétation méditerranéen aride (sous étage chaud) au Maroc occidental. (Issue 13). Trav. Inst. Sci. Chérifien, Série Botanique N. 13.

Negre R (1961-1962) Petite flore des régions arides du Maroc occidental. Tome 1 et 2. (CNRS), p. 979.

Niroumand MC, Farzaei MH, Amin G (2015) Medicinal properties of *Peganum harmala* L. in traditional Iranian medicine and modern phytotherapy: A review. J Tradit Chin Med 35(1): 104–109.

Nowak R, Szewczyk K, Gawlik-Dziki U, Rzymowska J, Komsta Ł (2016) Antioxidative and cytotoxic potential of some *Chenopodium* L. species growing in Poland. Saudi J Biol Sci 23(1): 15–23.

OMS (2005) Déclaration conjointe de l'Organisation mondiale de la Santé et du Fonds des Nations Unies pour l'enfance Focaliser sur l'anémie. Vers une approche intégrée pour un contrôle efficace de l'anémie, p. 2.

Orch H, Benkhnigue O, Fadli M, Zidane L, Douira A (2020) Treatment of urolithiasis: Ethnobotanical study of plants used by the population bordering the forest of izarène. Ethnobot Res Appl 19: 1–15.

Ouzir M, El Bairi K, Amzazi S (2016) Toxicological properties of fenugreek (*Trigonella foenum graecum* L.). Food Chem Toxicol 96: 145–154.

Özgen U, Houghton PJ, Ogundipe Y, Coşkun M (2003) Antioxidant and antimicrobial activities of *Onosma argentatum* and *Rubia peregrina* L. Fitoterapia 74(7–8): 682–685.

Peter EL, Rumisha SF, Mashoto KO, Malebo HM (2014) Ethno-medicinal knowledge and plants traditionally used to treat anemia in Tanzania: A cross sectional survey. J Ethnopharmacol 154(3): 767–773.

Piqué A, El Hassani A, Hoepffner C (1993) Les déformations ordoviciennes dans la zone des Sehoul (Maroc septentrional): une orogenèse calédonienne en Afrique du Nord. Can J Earth Sci 30(7): 1332–1337.

Qi Zhang Y, Guo H, Hai Y, Luo Y, Yue T (2020) Mechanism and intervention measures of iron side effects on the intestine. Crit Rev Food Sci Nutr 60(12): 2113–2125.

Rahmani M, Toumi-Benali F, Hamel L, Dif MM (2018) Survey ethnobotanical and phytopharmacological on *Trigonella foenum-graecum* L. Phytotherapie 16(1): 35–37.

Rankou H, Culham A, Jury SL, Christenhusz MJM (2013) The endemic flora of Morocco. Phytotaxa 78(1): 1–69.

Raunkiaer C (1934) The Life Forms of Plants and Statistical Plant Geography. London: Clarendon Press, p. 632.

Redouan FZ, Benítezb G, Piconec RM, Crisafullic A, Yebouka C, Bouhbala M, Ben Drissa A, Kadiria M, Molero-Mesab J, Merzoukia A (2020) Traditional medicinal knowledge of Apiaceae at Talassemtane National Park (Northern Morocco). S Afr J Bot 131: 118–130.

Resty Basuki D, Farmasi IIK Bhakti Wiyata Kediri F (2020) Korespondensi: alamat email penulis uji aktivitas antianemia ekstrak etanol dan perasan rimpang kunyit (*Curcuma longa* L.) ditinjau dari peningkatan kadar haemoglobin dan eritrosit pada tikus galur wistar dengan pengindukasi nano2 secara *in vivo* antian. J Wiyata: Penelit Sains Kesehat 6(2): 117–127.

Rivera D, Verde A, Fajardo J, Obón C, Consuegra V, García-Botía J, Ríos S, Alcaraz F, Valdés A, Del Moral A, Laguna E (2019) Ethnopharmacology in the Upper Guadiana River area (Castile-La Mancha, Spain). J Ethnopharmacol 241: 111968.

Roberts JL, Moreau R (2016) Functional properties of spinach (*Spinacia oleracea* L.) phytochemicals and bioactives. Food Funct 7(8): 3337–3353.

Sadeghi Z, Kuhestani K (2014) Ethnobotany of date palm (*Phoenix dactylifera* L.) in Baluch Tribe of Saravan region, Baluchistan, Iran. Int J Agric Technol 10(6): 1563–1571.

Saha U, Dharwadkar PS, Sur S, V, Malleshappa M (2018) Plant extracts as an astounding remedy to anemia - A review. Ann Plant Sci 7(4): 2166–2171.

Saleh EA, Tawfik MS, Abu-Tarboush HM (2011) Phenolic contents and antioxidant activity of various date palm (*Phoenix dactylifera* L.) fruits from Saudi Arabia. Food Nutr Sci 2(10): 1134–1141.

Samia R, Abdennabi EM, Youssef D, Paul B, Ismail C, José T, Alberto G (2018) 3D geological model of the Eastern Haouz Region (Morocco): Hydrogeological implications. Euro Sci J 14(24): 53–68.

Sarwar Alam M, Kaur G, Jabbar Z, Javed K, Athar M (2007) *Eruca sativa* Mill. seeds possess antioxidant activity and exert a protective effect on mercuric chloride induced renal toxicity. Food Chem Toxicol 45(6): 910–920.

Sawadogo S, Sanou SD, Dabire P, Belemtougri GR, Sawadogo L, De Leiris J, Tanguy S, Boucher F (2017) Activité antifalcémiante d'extraits de trois plantes médicinales du Bukina Faso: *Jatropha curcas* L., *Khaya senegalensis* (Desr.) A.Juss et *Dichrostachys* cinerea (L.) Wight & Arn. Int J Biol Chem Sci 11(5): 2016–2027.

Sendl A, Elbl G, Steinke B, Redl K, Breu W, Wagner H (1992) Comparative pharma-cological investigations of *Allium ursinum* and *Allium sativum*. Planta Med 58 (1): 1–7.

Shafi S, Tabassum N (2013) Acute oral toxicity and hypoglycaemic study of ethanolic extract of *Portulaca oleracea* L. (whole plant) in Swiss albino mice. Int J Pharm Pharm Sci 5(4): 389–393.

Shojaii A, Abdollahi Fard M (2012) Review of pharmacological properties and chemical constituents of *Pimpinella anisum* L. ISRN Pharm 2012: 510795.

Sijelmassi A (2011) Les plantes médicinales du Maroc. 8éme éd. Casablanca: Le Fennec, p. 285.

Silva AFC, Haris PI, Serralheiro ML, Pacheco R (2020) Mechanism of action and the biological activities of *Nigella sativa* L. oil components. Food Biosc 38: 100783.

Sobolev VS, Khan SI, Tabanca N, Wedge DE, Manly SP, Cutler SJ, Coy MR, Becnel JJ, Neff S A, Gloer JB (2011) Biological activity of peanut (*Arachis hypogaea* L.) phytoalexins and selected natural and synthetic stilbenoids. J Agric Food Chem 59(5): 1673–1682.

Stoltzfus RJ (2001) Iron-deficiency anemia: reexamining the nature and magnitude of the public health problem. Summary: implications for research and programs. J Nutr 131(2S-2): 697S–700S.

Subramanian K, Sankaramourthy D, Gunasekaran M (2018) Toxicity Studies Related to Medicinal Plants. In Natural Products and Drug Discovery: An Integrated Approach. Elsevier, chapter 18, pp. 491–505.

Suzanne SBB, Mathieu N, Luther MKM, Rosalie ANN, Clergé T (2017) Ethnobotanical survey of medicinal plants used for treating preschool children anemia in an urban setting, Douala-Cameroon. Afr J Plant Sci 11(5): 160–167.

Taghizadeh M, Ostad SN, Asemi Z, Mahboubi M, Hejazi S, Sharafati-Chaleshtori R, Rashidi A, Akbari H, Sharifi N (2017) Sub-chronic oral toxicity of *Cuminum cyminum* L. essential oil in female Wistar rats. Regul Toxicol Pharmacol 88: 138–143.

Tra Bi F, Irie G, N'Gaman K, Mahou C (2008) Études de quelques plantes thérapeutiques utilisées dans le traitement de l'hypertension artérielle et du diabète: deux maladies émergentes en Côte d'Ivoire. Sci Nat 5(1): 39–48.

Trabsa H, Baghiani A, Boussoualim N, Krache I, Arrar L (2020) The *in vivo* and *in vitro* antioxidant and anti-hemolytic effect of Algerian *Centaurea calcitrapa* L. extracts. J Drug Deliv Ther 10(5): 202–207.

Trivedi S, Pandey R (2021) 5′-Hydroxy-6, 7, 8, 3′, 4′-pentamethoxyflavone extends longevity mediated by DR-induced autophagy and oxidative stress resistance in *C. elegans*. GeroScience 43(2): 759–772.

Varoni EM, Lodi G, Iriti M (2015) Efficacy behind activity-Phytotherapeutics are not different from pharmaceuticals. Pharm Biol 53(3): 404–406.

Vieira V, Pereira, C, Pires TCSP, Calhelha RC, Alves MJ, Ferreira O, Barros L, Ferreira ICFR (2019) Phenolic profile, antioxidant and antibacterial properties of *Juglans regia* L. (walnut) leaves from the Northeast of Portugal. Ind Crops Prod 134: 347–355.

Vitalini S, Iriti M, Puricelli C, Ciuchi D, Segale A, Fico G (2013) Traditional knowledge on medicinal and food plants used in Val San Giacomo (Sondrio, Italy)-An alpine ethnobotanical study. J Ethnopharmacol 145(2): 517–529.

Wani SM, Jan N, Wani TA, Ahmad M, Masoodi FA, Gani A (2017) Optimization of antioxidant activity and total polyphenols of dried apricot fruit extracts (*Prunus armeniaca* L.) using response surface methodology. J Saudi Soc Agric Sci 16(2): 119–126.

Wei JN, Liu ZH, Zhao YP, Zhao LL, Xue, TK, Lan QK (2019) Phytochemical and bioactive profile of *Coriandrum sativum* L. Food Chem 286: 260–267.

WHO - World Health Organization (2011) Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. Geneva, Switzerland: World Health Organization, pp. 6.

WHO (1996) Guidelines for the Evaluation of Herbal Medicines. From the WHO Expert Committee on Specifications for Pharmaceutical Preparations. Thirty-fourth report.

Xu X, Huang Y, Xu J, He X, Wang Y (2020) Anti-neuroinflammatory and antioxidant phenols from mulberry fruit (*Morus alba* L.). J Funct Food 68: 103914.

Yadav UCS, Baquer NZ (2014) Pharmacological effects of *Trigonella foenum-graecum* L. in health and disease. Pharm Biol 52(2): 243–254.

Yenilougo S, Doudjo ON, Koffi M, Adama B (2019) Analyse de la diversité floristique de quelques îles aménagées du Barrage de Buyo (Côte d'Ivoire). Eur Sci J 15(18): 165–182.

Zagórska-Dziok M, Ziemlewska A, Nizioł-ŁUkaszewska Z, Bujak T (2020) Antioxidant activity and cytotoxicity of *Medicago sativa* L. seeds and herb extract on skin cells. BioResearch Open Access 9(1): 229–242.

Zarnowski R, Zarnowska ED, Kozubek A (2001) Alkylresorcinols in the family Fabaceae. Acta Soc Bot Pol 70(1): 25–29.

Ziyyat A, Legssyer A, Mekhfi H, Dassouli A, Serhrouchni M, Benjelloun W (1997) Phytotherapy of hypertension and diabetes in oriental Morocco. J Ethnopharmacol 58(1): 45–54.

AUTHOR CONTRIBUTION:

Contribution	Benkhnigue O	Chaachouay N	Khamar H	El Azzouzi F	Douira A	Zidane L
Concepts or ideas	x					x
Design	x	x	x			x
Definition of intellectual content	x				x	
Literature search	x	x	x			
Experimental studies	x		x			x
Data acquisition	x					x
Data analysis	x					
Statistical analysis	x	x				
Manuscript preparation	x	x	x	x		
Manuscript editing	x	x	x			
Manuscript review	x	x	x	x	x	x

Citation Format: Benkhnigue O, Chaachouay N, Khamar H, El Azzouzi F, Douira A, Zidane L (2022) Ethnobotanical and ethnopharmacological study of medicinal plants used in the treatment of anemia in the region of Haouz-Rehamna (Morocco). J Pharm Pharmacogn Res 10(2): 279–302. https://doi.org/10.56499/jppres21.1196_10.2.279

Annex 1. Questionnaire on medicinal plants and phytotherapy.

Date: Commune:

Statement number: Station:

Informant and therapeutic choice:

- Age:……..
- Profession:……..
- Income / month (MAD): Unemployed □ {≤ 3000}□ {3000 - 8000} □ {≥ 8000} □
- Family situation: Single □ Married □
- Gender: Male □ Female □
- Academic level: None□ Primary □ Secondary □ University □
- Locality: Douar □ Town □ City □
- When you feel sick, you choose:
- Traditional medicine (MT) □: Efficient □ Less expensive □ Easy access □
- Modern medicine (MM) □: Efficient □ No TM experience □
- The two types of medicine □ The reason: According to the disease □
-

Use of plants in the treatment of anemia:

- You know the diseases of anemia? yes □ No □
- What are the symptoms of anemia?
- Diagnosis by: Himself □ The herbalist □ The pharmacist □ Experience of others □
- Results of treatment: Healing □ Improvement □ Inefficient □
-

Plant material:

- Vernacular name: ……
- Scientific name: ……
- Status of the plant: Spontaneous □ Cultivated □ Imported □
- Use of the plant: Therapeutics □ Cosmetics □ Other □
- Plant alone □ Possible association with other plants □:……..
- Condition of the plant used: Fresh □ Dried □ Both □ After pre-treatment □
  - If dried out, drying method: Exposed to the sun □ In the shade □
- Parts used: Stem □ Flower □ Fruit □ Seed □ Inflorescence □ Bark □ Rhizome □ Bulb □ Leaf □ Flowering tops □
- Side effects:……
- Toxicity (this plant causes toxicity?):……..
- Precautions for use:……

Form and method of use:

- Form of employment: Herbal tea □ Powder □ Essential oils □ In nature □
- Method of preparation: Infusion □ Decoction □ Cataplasm □ Maceration □ Cooked □
  - ✓ Fumigation □ Inhalation □ Raw □
- Dose used: Dose not precise □: Pinch □ Handle □ Spoon □
  Dose precise □: Quantity in g/glass:…….. Quantity in g/ liter :……
- Method of administration: Oral □ Massage □ Brushing □ Rectal □ Cutaneous □
- Dosage: number of times per day.
  1 time/day □ 2 time/day □ 3 time/day □ Other □:……..
- Duration of use: One day □ One week □ One month □ Until healed □