Ethnobotanical and ethnopharmacological study of medicinal plants used in treating some liver diseases in the Al-Haouz Rehamna region (Morocco)

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Research

Abstract

Background: Medicinal plants have always been important in therapeutic and preventive folk medical remedies for humans and cattle. Plants are also quite important in today's global economy.

Objectives: This study is part of the development of plant resources in the Al-Haouz Rehamna region. Its general objective was to inventory the medicinal plants used in traditional pharmacopeia against certain liver diseases.

Methods: Ethnobotanical field surveys were conducted using 1700 questionnaire forms. Ethnobotanical indices such as the informant agreement ratio (IAR), the family use value (FUV), the use-value (UV), and the Plant Part Value (PPV) were employed in the data analysis rate.

Results: The findings enabled us to classify 86 medicinal plants into 79 genera and 37 families, among which four predominate: Asteraceae (17), Lamiaceae (9), and Fabaceae (8 species), and Apiaceae (7). Among the reported species, 21 are toxic, and the population of the said region widely uses ten: *Ridolfia segetum* (Guss.) Moris, *Curcuma longa* L., *Ononis natrix* L., *Rhamnus alaternus* L., *Cladanthus arabicus* (L.) Cass, *Rhaponcticum acaule* (L.) DC, *Corrigiola telephiifolia* Pourr, *Cynara cardunculus* L., *Cicer arietinum* L. and *Aframomum melegueta* K. Schum. The main parts used are leaves (PPV=0.183) and seeds (PPV= 0.165). A decoction is the most used method (34.88%).

The recipes are mainly administered orally and rarely by the cutaneous route as a poultice on the abdomen. The diversity of therapies identified in the study area is a cultural richness.

Conclusion: Thus, the data reported by this study could be a precious reference of data for this region and could be a basis for further study in the field of phytochemistry to produce and identify new natural drugs that could be endowed with interesting hepatoprotective properties in the treatment or prevention of certain liver diseases.

Keywords: Ethnobotany, ethnopharmacology, traditional medicine, liver disease, hepatoprotective, toxicity, Al-Haouz Rehamna, Morocco.

Background

Liver disorders are a serious global health issue; they are the leading cause of human mortality globally, accounting for roughly two million fatalities each year, one million from cirrhosis complications, and one million from hepatitis viruses and hepatocellular carcinoma (Mokdad *et al.* 2014). Furthermore, these disorders are distinguished by development from steatosis to chronic hepatitis, fibrosis, cirrhosis, and hepatocellular cancer (Notas *et al.* 2009). Several specific causes can be the origin of these conditions: parasitic, obstructive, viral hepatitis, alcohol abuse, drug abuse, metabolic diseases due to iron or copper overload, autoimmune attack of hepatocytes, bile duct epithelium, or congenital anomalies (Michel *et al.* 2009). Patients with the chronic liver disease suffer from fatigue, anxiety, depression, decreased work productivity, and other emotional problems that significantly impair their quality of life (Afendy *et al.* 2009). In addition to a heavy clinical burden, the management of patients represents an economic burden for health care systems. Despite significant advancements in current medicine, no effective medications are available that protect the liver from harm or boost its activity (Akther *et al.* 2013). In recent decades, herbal medicine has played a crucial role in primary health care worldwide; it can serve as a curative or preventive drug regarding safety and efficacy. Thus, the WHO encourages using herbal medicine to treat several diseases, including liver diseases.

In Morocco, thanks to the richness of its vascular flora, about 5211 species and subspecies (Dobignard and Chatelain 2013; Fennane and Ibn Tattou 2012), the over-the-counter access, and the possibility of self-medication, the Moroccans have a long and illustrious history in herbal remedies (Bellakhdar 1997). They often use medicinal herbs to treat various disorders, especially liver problems. In the Al-Haouz Rehamna region, phytotherapy remains integral to the local Moroccan culture. Thus, using medicinal plants is a matter of common tradition for most of this population. Moreover, the Moroccan medicinal reference study reveals that investigations on medicinal plants are of relative relevance in Morocco's health system. Indeed, various works have been published in the last decades on Moroccan ethnobotanical knowledge. But works related to medicinal plants' inventory against liver diseases are rare in Morocco. Thus, the requirement to conduct an ethnobotanical investigation in phytotherapy contributes to the search for other traditional medicines of natural origin that could be endowed with impressive therapeutic effects (anti-hepatoprotective, anti-inflammatory, and antioxidant) in the therapy or precluding of these diseases. Given these factors, the current preliminary study was undertaken to catalog the traditionally used plants in treating some hepatic affections (jaundice, hepatitis, and liver cancer), which seem to be more frequent in the local population of the said region.

Material and Methods

Description of the study area.

Due to its geographical position and climate, Morocco can be subdivided into different phytogeographical areas (Fennane & Ibn Tattou 1998, 2005; Ibn Tattou & Fennane 2008). The Al-Haouz Rehamna region belongs to the Middle Atlantic Morocco group. It is bounded to the north by the Chaouia-Doukkala region, to the northeast by the Middle Oum-Errabiâ region, to the east by the Mgoun region, to the south by Ida-Ou-Tanane, Seksaoua and the Central High Atlas and to the west by the Abda-Haha region (Fig. 1).

The study area is characterized by four major natural geographic areas (Piqué *et al.* 1993): Plateau areas with a moderate altitude below 1000m, including the plateaus of Rehamna and Bahira; Plain areas, including the plains of Al-Haouz Rehamna, and Tassaout Upstream and Downstream. This region contains large agricultural areas: the Basin area, i.e. the Essaouira-Chichaoua basin, characterized by depressions and elevations in the shape of cereal-producing land or rangeland and the Djebilets, a mountainous region of medium height with minimal vegetation.

Administratively, the study area is located within the Marrakech-Safi region. This region has a total area of 39 167 km2 or 5.51 % of the national land (MGRMS 2015). According to the most recent general census of population and

housing, the estimated population of the Marrakech-Safi area is 4,520,569 (4,511,933 Moroccans and 8,636 foreigners; 13.36% of the national population and 115 persons per km2). With a proportion of 57.12%, the bulk of its population (2 582 553) is rural. The high rural population rate demonstrates the country's agricultural commitment (HCP 2014).

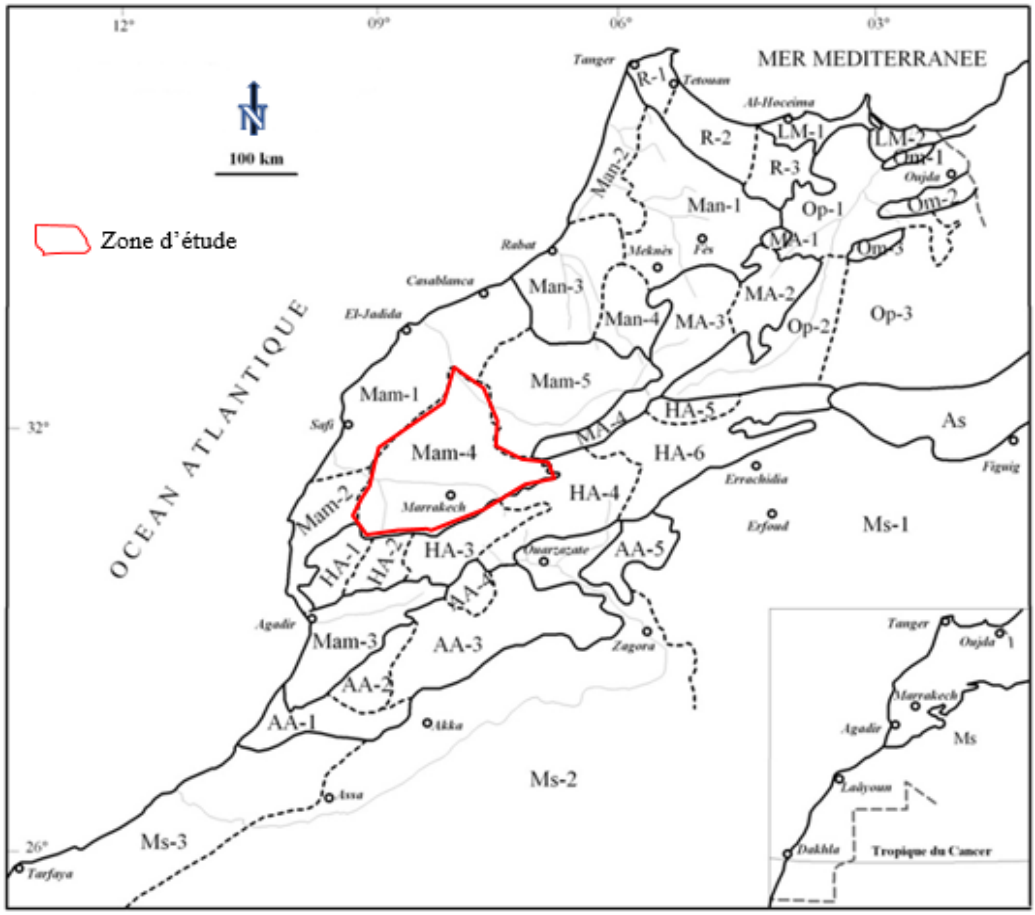

Figure 1. Carte Map of phytogeographic divisions of northern Morocco. (from Fenanne & Ibn Tattou 1998, 2005).

Soil studies conducted throughout the study area (Billaux and Bayssine 1967; Cavallar 1950) have shown the presence of eight types of soils: isohumic, red on shale, calco-magnesimorphic, vertisols (Tirs), halomorphic, hydromorphic, regosols, and soils not significantly evolved erosions, their texture is generally silty-clayey, silty and silty-sandy.

The area gets average annual precipitation of 800 millimeters in the hilly region and 190 millimeters on the plain (Ait El Mekki 2017; Knippertz *et al.* 2003). The yearly average temperature is around 18.5°C. The average maximum temperature is 37.7 degrees Celsius, while the average lowest temperature is 4.9 degrees Celsius (Samia *et al.* 2018). The area generally sits between arid and temperate winter bioclimates and semi-arid and mild winter bioclimates (Negre 1959).

The region's hydrographic system contains a vast watershed, the Tensift, and a portion of the Oum Errabia watershed, which is formed by multiple sub-watersheds and drains the northern slope of the High Atlas, with pluvial inputs (Abourida 2007).

From the point of view of the altitudinal zonation of ecosystems, two vegetation stages are defined in the study area: the thermo-Mediterranean stage (individualized in the north and south of the region) and the sub-Mediterranean stage, which is individualized in the center of the study area (Benabid 2000). Thus, the vegetation is classified in the arid Mediterranean vegetation stage; 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, it is scarce. However, in the Djebilets chain that forms the top of this whole arid zone of Western Morocco, the vegetation cover is generally precarious and appears highly reduced on the slopes. A few stunted bushes of

Acacia gummifera and *Ziziphus lotus*, very scattered here and there, a *Withania frutescens* or an *Ephedra*, are the only representatives of the shrubby vegetation that we have encountered (Emberger 1938; Negre 1959).

Thus, the region of Al-Haouz Rehamna is characterized by a diversity of hydro-geographical, climatic, and Phyto-genetic resources. This geographical, structural, and climatic diversity is reflected by a specific richness of spontaneous plants, incredibly aromatic and medicinal.

Ethnobotanical Methodology

Survey

To establish the list of plants used in traditional herbal medicine against liver diseases in the Al-Haouz Rehamna region, we conducted ethnobotanical field surveys during five campaigns from 2012 to 2017 to document plants employed in herbal medicine against liver diseases in the Al-Haouz Rehamna region, using 1700 questionnaires with herbalists and traditional practitioners and the local population. The interviews were conducted in an open discussion format so that people could respond without constraint and were conducted individually or in groups. All interviews were conducted after obtaining oral prior informed consent. The time devoted to each interview was approximately 15-120 minutes, depending on the availability of the participants. The questionnaires were previously prepared on a survey form (Appendix I). The data collected was recorded in this form, inspired by previous work (Bellakhdar 1997; Benkhnigue *et al.* 2010) and the questionnaires were adopted according to our study. Using stratified probabilistic sampling (Godron and Daget, 1982; Godron 1971; Benkhnigue *et al.* 2022), the locations of the different environments of ethnobotanical surveys and floristic surveys were determined in order to have the most comprehensive floristic inventory possible and to conduct ethnobotanical surveys in the studied region. The research region was subdivided into 34 identical strata (Fig. 2, Table 1). Using simple random selection, 50-person samples were drawn from each of the 34 strata.

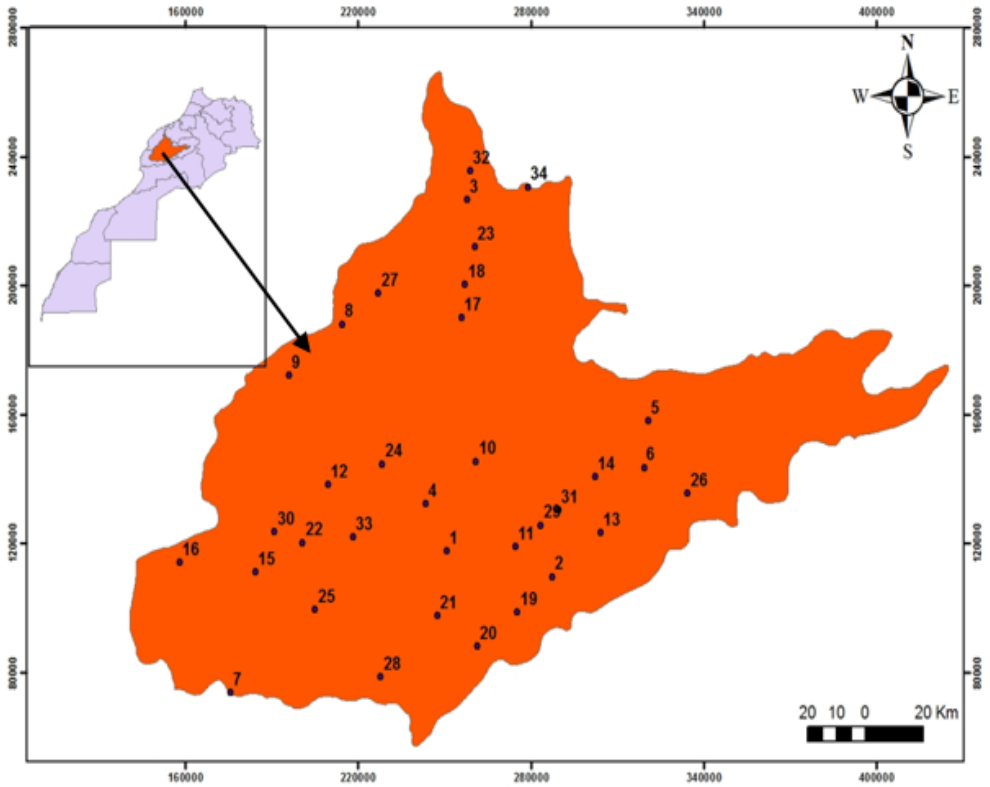

Figure 2. Map of the study area showing surveyed stations (Benkhnigue et al., 2022).

Collection and identification

To identifyr each plant used, we organized plant sampling missions in natural environments from March 1, 2012, to September 30, 2017. Identification of the collected plants and those observed was based on the main floras (Bellakhdar 1997; Fennane *et al.* 1999; 2007; 2014; Fennane and Ibn Tattou 1998; Hmamouchi, 1999; Negre, 1961; 1962), and samples checked herbarium (RAB), as well as via the Jstore (http://www.plants.jstore.org), Global Biodiversity Information Facility (http://www.gbif.org/occurence), and The Plant List databases (http://www.theplantlist.org/). The nomenclature follows (Dobignard and Chatelain 2013) as well as (Fennane and

Ibn Tattou 2005; Ibn Tattou and Fennane 2008). Plant families follow Angiosperm Phylogeny Group IV (APG 2016). The assessment of plant biological types (life forms) followed Raunkiaer (1934).

Table 1. List of floristic and ethnobotanical survey points.

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

Statistical analysis and data processing

Statistical analysis

To extract the different information concerning the four axes of the research: the informant, the plant material, the mode of use and administration, and the treated disease, we processed the survey data using SPSS version 21 (Statistical Package for the Social Sciences, IBM, New York, United States).

Quantitative indices

To further examine and understand the data, we used quantitative and descriptive analyses using ethnobotanical indices such as:

Informant Agreement Ratio (IAR)

The IAR analysis has recently been used as an essential tool for ethnobotanical data analysis (Uniyal *et al.* 2011; Uprety *et al.* 2010). It depends on the availability of plants in the study area, and it informed us about the degree of shared knowledge about the medical use of plants among informants to treat specific disease categories. This rate is calculated as follows:

$$\mathbf{IAR = Nur\text{-}Nt / Nur\text{-}1}$$

where **Nur**: number of user records in each use category and **Nt**: number of use taxa in each use category. The IAR value ranges from 0 to 1; the higher value indicates taxon selection agreement among informants, while the lower value indicates disagreement. The value of 1 indicates that the taxa are used by many informants (Inta *et al.* 2013).

Plant Part Value (PPV).

The plant part value (PPV) was calculated using the following formula:

$$\mathbf{PPV = RU_{Plant\ part} / RU}$$

Where: $\mathbf{RU_{plant\ part}}$ 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 PPV is the most used by respondents (Benkhnigue *et al.* 2022; Chaachouay *et al.* 2020).

Use Value (UV).

It was calculated as follows:

$$\mathbf{UV = \Sigma Ui / N}$$

where **Ui**: is the number of uses cited by each informant for a given species, and **N**: is the total number of informants (Hudaib *et al.* 2008; Vitalini *et al.* 2013). Their calculation allowed us to determine the relative importance of locally known species and the most frequently reported species in treating disease.

Family Use Value (FUV).

The FUV allowed us to identify the importance of medicinal plant families. It was calculated using the following formula:

$$FUV=UVs/Ns$$

where **UVs**: use-value of the species, and **Ns**: total number of species within each family (Cadena-González *et al.* 2013). The calculation of FUVs is an index of cultural importance that can be applied in ethnobotany to calculate a natural plant taxon value (Benkhnigue *et al.* 2022; Chaachouay *et al.* 2020; Gakuubi and Wanzala 2012).

Results and Discussion

Socio-demographic profile of respondents

Out of a total of 1700 persons interviewed, 85% (1530) opted to utilize traditional medicine (TM), either alone (75%) or in conjunction with modern medicine (MM), with a 10% share. A total of 648 (42.35%) utilized plants to cure specific liver ailments (hepatitis, jaundice, and liver cancer), and they provided:

- Information on the vernacular name of each species,
- The season of availability in the field,
- Its efficacy,
- The technique of preparation and mode of use.

We could define the consumers of traditional medicine for liver disorders in this area using the various characteristics (Table 2).

Table 2. Socio-demographic profile of respondents (n=648).

Variables	Categories	Number of informants	Frequency (%)
Age category (years)	Between 18 and 30	88	13.58
	Between 31 and 40	112	17.28
	Between 41 and 50	204	31.48
	>50 years	244	37.66
Gender	Female	364	56.17
	Male	284	43.83
Family situation	Married	434	66.98
	Single	214	33.02
Educational level	Illiterate	430	66.36
	Primary	102	15.74
	Secondary	88	13.58
	Superior	28	4.32
Monthly income	Low	251	38.74
	Medium	53	8.18
	High	2	0.30
	No income	342	52.78
Place of residence	Dour	398	61.42
	Village	108	16.67
	City	142	21.91

The data suggest that medicinal species usage was prevalent across all age categories, with a definite preference for persons over 50 (37.66%), indicating that many elderly persons still hold traditional knowledge of herbal treatment. Women outnumbered men (43.83% to 56.17%), with an unbalanced sex ratio (F/M = 1.28). Women's predominance may be explained by being responsible for their families' health and using readily accessible,

effective, and less costly means. These findings corroborate previous ethnobotanical research undertaken in several locales (Belhaj *et al.* 2021; Benkhnigue *et al.* 2010; 2022; Tahraoui *et al.* 2007). Regarding the family situation, 66.98% of the participants were married, while only 33.02% were single. Regarding the academic level, we found a clear predominance of illiterate people (66.36%), followed by the categories of people who have a primary and secondary level, with percentages of 15.74% and 13.58%. At the same time, people at a university level use the most miniature medicinal plants with a percentage of 4.32%. The results also show that 52.78% of these users have no monthly income, 38.74% had a low income, and 8.18% had a medium income. On the other hand, people with higher income represent only 0.30%. In our study, we found that (61.42%) of these people lived in rural areas (Douars). These findings corroborate previous ethnobotanical research in the Rif area (Chaachouay *et al.* 2020).

Floristic analysis

The plants identified and collected during this study are presented in Table 3, categorized according to the alphabetical order of botanical families, the local vernacular name, the biological type, the nature of the plant (wild, cultivated, and imported), the portion utilized, the method of preparation employed by the local community, and the ethnobotanical indices (UV and FUV). To enhance our findings further, we did a literature analysis of ethnobotanical and pharmacological investigations to demonstrate the medicinal efficacy of the plant (hepatoprotective, antioxidant, anti-cancer, and anti-inflammatory).

Specific analysis of botanical families

In this ethnobotanical and ethnopharmacological study we found 86 medicinal species divided into 79 genera and belonging to 37 botanical families, of which four families accounted for 47.67% of the total of species recorded: Asteraceae (17 species), Lamiaceae (9 species), Fabaceae (8 species) and Apiaceae (7 species). The importance of these families can be explained on the one hand by their richness within the Moroccan flora, by their ability to adapt to often diversified environments, and on the other hand by their biogeographic range (Mediterranean). In addition, the other families (33) contribute to 52.33% (45 species) of the total number, of which only one species represent twenty-eight. In addition, the high use of the family Asteraceae can be explained by the fact that they are the wealthiest family of angiosperms, with 128 genera and about 550 species spread throughout Morocco (Fennane and Ibn Tattou 2012). Compared to less wealthy families such as Poaceae, Fabaceae, or Solanaceae, the Asteraceae family has fewer species of economic interest. However, it provides food plants such as *Artemisia arborescens* (Vaill.) L., *Helianthus annuus* L., *Lactuca sativa* L., and *Cynara scolymus* L. are cultivated to extract its vegetable oil. Other species are used in pharmacy as *Artemisia cina* Berg, *Arnica montana* L., *Matricaria chamomilla* L., and *Tussilago farfara* L. Finally; some Asteraceae are used as ornamental plants, including species belonging to the genera *Tagetes*, *Chrysanthemum*, *Dahlia*, *Tanacetum*, *Rudbeckia*, *Zinnia*, *Cosmos*, *Callistephus*, and *Calendula* (El Bouzidi 2013). Phytochemical studies on this family mainly show terpenes, alkaloids, and flavonoids (Benn and Gul 2007; Emerenciano *et al.* 2001; Ferrari *et al.* 2005).

Quantitative analysis according to the FUV and UV index

Based on the FUV index, we found six families being most used in traditional phytotherapy against liver diseases: Caryophyllaceae and Zingiberaceae occupy the first place (FUV= 0.331 for each), followed by Rhamnaceae (FUV= 0.259), Rubiaceae (FUV= 0.228), Apiaceae (FUV=0.187) and Fabaceae (FUV=0.174) (Fig. 3).

Table 3. List of medicinal plants used against liver diseases in the Al-Haouz Rehamna region; their local use, ethnobotanical and ethnopharmacological literature that justifies their therapeutic properties.

Familiy and species	Vernacular name	Plant type	Biological type	Part used	Preparation	Local use	UV	FUV	Ethnobotanical evidence	Literature to support the therapeutic claims
Amaryllidaceae ***Allium sativum* L.**	Touma	Cultivated	Geophyte	Bulb	Nature	H, I	0.157	0.157	Jaundice (Miara et al., 2019).	Anti-inflammatory and antioxidant (Shang *et al.* 2019).
Anacardiaceae ***Pistacia lentiscus* L.**	Dro	Spontaneous	Phanerophyte	Leaf	Decoction	H	0.123	0.123	Jaundice (Ljubuncic et al., 2005).	Hepatoprotective and antioxidant (Janakat and Al-Merie; Maameri *et al.* 2015; Mehenni *et al.* 2016).
Apiaceae ***Ammodaucus leucotrichus* Coss et Durieu.**	Kammûn essôfi	Cultivated	Therophyte	Seed	Infusion	Cf	0.185	0.187		Anti-inflammatory (Es-Safi et al., 2020).
Apiaceae ***Carum carvi* L.**	El-Karwiya	Cultivated	Therophyte	Seed	Infusion	H, I	0.201			Hepatoprotective (Samojlik *et al.* 2010)
Apiaceae ***Coriandrum sativum* L.**		Cultivated	Therophyte	Seed	Infusion	H	0.083		Blood depurative (Bouayyadi et al., 2015).	Hepatoprotective (Pandey *et al.* 2011).
Apiaceae ***Petroselinum sativum* Hoffman.**	Maadenouss	Cultivated	Therophyte	Seed	Decoction	H	0.123		Hepatic (Ben Akka, et al., 2015; Tahri et al., 2012); liver detoxification (Bouayyadi et al., 2015).	Anticancer (Farshori *et al.* 2013).
Apiaceae ***Pimpinella anisum* L.**	Habate hlawa	Cultivated	Therophyte	Seed	Infusion	H	0.227		Cholagogue (Tahri et al., 2012); liver disorders (Al-Asmari et al., 2014); anti-inflammatory and antioxidant (Ghlissi et al., 2020).	Anti-inflammatory and antioxidant (Martins *et al.* 2016).
Apiaceae ***Ridolfia segetum* Moris.**	Tebche, Slilou	Spontaneous	Therophyte	Leafy stem Flower	Infusion	H	0.525		Liver disease (Ben Akka, et al., 2015) and jaundice (Hseini, 2008).	Antitumour (Beeby *et al.* 2021).
Apiaceae ***Thapsia transtagana* Brot.**	Deryâs, daryoussa	Spontaneous	Geophyte	Leaf	Poultice	H	0.046			Antioxidant (Alilou and Akssira 2021).

Asparagaceae ***Drimia marítima*** **(L.) Stearn.**	El-aansla, Bassal dib, El bassila	Spontaneous	Geophyte	Leaf, Bulb	Poultice	H	0.031	0.031	Anti-inflammatory, antioxidant (Nejatbakhsh et al., 2017); Jaundice (Bellakhdar, 1997; Hseini, 2008); Hepatitis (Ouarghidi et al., 2013).	Antioxidant (Tahri *et al.* 2020).
Asteraceae ***Artemisia atlantica*** **Coss et Dur. var.** ***maroccana*** **(Coss) Maire.**	Chih Ourika	Spontaneous	Chamephyte	Leafy stem, Flower	Decoction	H	0.117	0.168		
Asteraceae ***Artemisia herba-alba*** **Asso.**	Chih Dwidi	Spontaneous	Chamephyte	Leafy stem, Flower	Decoction	H, I	0.170		Cholagogue (Tahri et al., 2012) and liver diseases (Eddouks et al., 2017).	Antioxidant (Boukhennoufa et al., 2021).
Asteraceae ***Artemisia huguetii*** **Caball.**	Chih beldi	Spontaneous	Chamephyte	Leafy stem, Flower	Decoction	H	0.046			
Asteraceae ***Calendula stellata*** **Cav.**	Jemra	Spontaneous	Therophyte	Flower , Root	Infusion	H, I	0.167		Hepatic (Miara et al., 2021).	
Asteraceae ***Carlina gummifera*** **(L.) Less.**	Addad	Spontaneous	Hemicrypto-phyte	Root	Fumigation	H	0.056			Antioxidant (Bouabid et al., 2020).
Asteraceae ***Carthamus tinctorius*** **L.**	El-aossfore, Kaff essabea, Zaafour	Cultivated	Therophyte	Flower , Leafy stem	Powder	H	0.239			Hepatoprotective and antioxidant (Wang et al., 2015; Wu et al., 2013).
Asteraceae ***Centaurea maroccana*** **Ball.**	Bejjâe n-nhal, Negguîr	Spontaneous	Therophyte	Root	Decoction	H, Cf	0.250			Against cancer (Aissous et al., 2021).
Asteraceae ***Chrysanthemum coronarium*** **L.**	El-gahwâne, Hmessou, Maloule o Aali	Spontaneous	Therophyte	Flower	Decoction	H	0.043			Antioxidant and hepatoprotective (Bardaweel et al., 2015; M. Donia, 2014).
Asteraceae ***Cichorium intybus*** **L.**	Bou-Aggad	Spontaneous	Hemicrypto-phyte	Leaf	Decoction	H, Cf, I	0.120		Choleretic (Ben Akka et al., 2015); cholagogue and Choleretic (Bellakhdar, 2006).	Hepatoprotective (Neha et al., 2014).
Asteraceae	Tâfsse	Spontaneous	Therophyte	Flower	Decoction	H, I, Cf	0.440		Icterus (Benchaabane and Abbad, 1994).	Antioxidant (Aghraz et al., 2017).

***Cladanthus arabicus* (L.) Cass.**										
Asteraceae ***Cynara cardunculus* L.**	Kharchouf	Cultivated	Geophyte	Stem, Root,	Nature, Decoction	Cf, H	0.324		Liver disease (Bouayadi et al., 2015; Hachi et al., 2015; Hseini, 2008); cholagogue and choleretic (Hmamouchi, 1999).	
Asteraceae ***Cynara humilis* L.**	Timta	Spontaneous	Geophyte	Root	Decoction	H, Cf	0.193		Liver diseases (Bellakhdar, 1997; Lahsissène, 2010).	
Asteraceae ***Cynara scolymus* L.**	El-qôq	Cultivated	Geophyte	Root, Flower , Leaf	Nature, Decoction	H, Cf, I	0.148		Hepatic (Ben-Akka et al., 2015; Lahsissène, 2010).	Liver improvement (Mejri et al., 2020); Antioxidant, anti-inflammatory, and Anti-hepatitis C (Elsebai et al., 2016).
Asteraceae ***Matricaria chamomilla* L.**	Babounj romi	Naturalized	Therophyte	Leafy stem, Flower	Infusion	H	0.025		Jaundice (Bouayyadi et al., 2015).	Hepatoprotective (Shebbo et al., 2020).
Asteraceae ***Rhaponticum acaule* (L.) DC.**	Tavgha	Spontaneous	Hemicrypto-phyte	Root	Decoction	H, Cf, I	0.380		Liver disease (Lahsissène, 2010).	Antioxidant (Mosbah et al., 2020)
Asteraceae ***Scolymus hispanicus* L.**	El-Guernina	Spontaneous	Hemicrypto-phyte	Stem	Cooked	H, Cf, I	0.105		Liver diseases (Lahsissène, 2010), Icterus, and hepatic (Bellakhdar, 1997; Sbai-Juilili et al., 2017).	Anti-inflammatory, hepatoprotective, and antioxidant (Berdja et al., 2021).
Asteraceae ***Warionia saharae* Benth et Coss.**	Afessas	Spontaneous	Nanophanero - phyte	Leaf, Root	Decoction	H, Cf, I	0.040			Antioxidant (Ajebli & Eddouks, 2019).
Berberidaceae ***Berberis hispanica* Boiss & Reut.**	Arguîs, Atîzar	Spontaneous	Nanophanero - phyte	Ecr	Decoction	H, Cf, I	0.133	0.133	Liver disorders and choleretic (Bellakhdar, 1997).	Antioxidant and anticancer (El Fakir et al., 2021).
Brassicaceae ***Brassica rapa* L.**	Lefte el-mahfour	Cultivated	Therophyte	Seed	Cooked	H	0.102	0.082		
Brassicaceae ***Lepidium sativum* L.**	Habb Er-rchâd, Habb errajee	Cultivated	Therophyte	Seed	Powder	H	0.069		Inflammatory disorders (Al-Asmari et al., 2014).	Hepatoprotective (Abdulmalek et al., 2021).
Brassicaceae	Lefjel	Cultivated	Therophyte	Root	Decoction	H, D	0.077			Antioxidant (Beevi et al., 2012).

***Raphanus sativus* L.**										
Caryophyllaceae ***Corrigiola telephiifolia* Pourret.**	Tasserghinte, Ssarghina	Spontaneous	Hemicrypto-phyte	Root	Powder	H, I	0.331	0.331	Liver diseases (Bellakhdar, 1997).	Cytotoxic and antioxidant Doudach et al., 2013).
Combretaceae ***Combretum micranthum* G. Don.**	Kinkiliba	Imported	Phanerophyte	Leaf	Infusion	I	0.020	0.02		
Cucurbitaceae ***Citrullus colocynthis* (L.) Schrad.**	El-hedja, Taferzîzt, El handal	Spontaneous	Geophyte	Leaf, Seed	Fumigation	I	0.031	0.031	Hepatitis (Miara et al., 2019).	
Cupressaceae ***Tetraclinis articulata* (Vahl.) Masters.**	El-ar'ar, Azouka, Al qitrane laghlide	Spontaneous	Phanerophyte	Leaf	Decoction	H, I	0.012	0.012		Antioxidant (Rabib et al., 2020).
Fabaceae ***Cassia fistula* L.**	Aud ssalib	Imported	Phanerophyte	Fruit	Distillation	Cf	0.006	0.174	Anti-inflammatory, hepato-protective, anticancer (Chaudhari & Professor, 2013); Liver trouble (Uniyal et al., 2011).	Hepatoprotective and antioxidant (Pradeep et al., 2010).
Fabaceae ***Ceratonia siliqua* L.**	L-kharrôb, Tikidda	Cultivated, Sup Spontaneous	Phanerophyte	Fruit	Powder	H, Cf, I, D	0.096			Anti-inflammatory and antioxidant (Rtibi et al., 2017).
Fabaceae ***Cicer arietinum* L.**	El hommess	Cultivated	Therophyte	Seed	Maceration	H	0.306		Jaundice (Bouayyadi et al., 2015; El-Azzouzi & Zidane, 2015; Hseini & Kahouadji, 2007; Tahri et al., 2012).	Antioxidant (Ahmad Nadzri et al., 2021).
Fabaceae ***Glycyrrhiza glabra* L.**	Aarq assûss	Imported	Hemicrypto-phyte	Root	Decoction	H	0.074			Hepatoprotective, anticancer, and anti-inflammatory (Çevik et al., 2018).
Fabaceae ***Lens culinaris* Medik.**	L'âdess	Cultivated	Therophyte	Seed	Powder	H	0.168			Antioxidant (Jameel et al., 2015).
Fabaceae ***Medicago sativa* L.**	Fessa	Cultivated	Hemicrypto-phyte	Seed	Powder	H, I	0.111		Hepatitis (Ben-Akka et al., 2015).	Anti-inflammatory (Seddighfar et al., 2020).
Fabaceae ***Ononis natrix* L.**	Afesdad	Spontaneous	Chamephyte	Leafy stem	Powder	H	0.486		Icterus (Ghourri et al., 2012; Sbai-Juilili et al., 2017).	Antioxidant (Sayari et al., 2016).
Fabaceae ***Trigonella foenum-graecum* L.**	El-halba, Tifidass	Cultivated	Therophyte	Seed	Powder, Poultice	H, I	0.142		Hepatitis and icterus (Hachi et al., 2015); depurative (Lahsissène, 2010).	Hepatoprotective (Kaviarasan et al., 2007); anti-inflammatory (Mandegary et al., 2012); anticancer (Verma et al., 2010).

Fagaceae ***Quercus ilex* L.**	Dbagh laghlide, Lakrrouche, Tassaft	Spontaneous	Phanerophyte	Bark	Decoction	H, I	0.015	0.015		Antioxidant and anticancer (Amessis-Ouchemoukh et al., 2017).
Gentianaceae ***Centaurium erythraea Rafn.***	Gosset alhaya	Spontaneous	Therophyte	Leafy stem	Infusion	Cf	0.171	0.171		Hepatoprotective (Hamza et al., 2015).
Geraniaceae ***Pelargonium roseum* Willd.**	Laatter cha	Cultivated	Geophyte	Leaf	Infusion	H, Cf, I, D	0.022	0.022		
Lamiaceae ***Ajuga iva* (L.) Schreb.**	Chendgûra, Tûf tolba	Spontaneous	Hemicrypto-phyte	Leafy stem, Flower	Decoction	H	0.046	0.073	Choleretic (Tahri et al., 2012).	Antioxidant (Saad et al., 2019); anticancer (Bouyahya et al., 2020).
Lamiaceae ***Lavandula officinalis* Chaix ex Villars.**	El-khzama fassiya	Cultivated	Chamephyte	Flower	Decoction	I, H	0.039		choleretic (Bellakhdar, 2006).	
Lamiaceae ***Lavandula multifida* L.**	EL-kohayla, Kohaylate el himir	Spontaneous	Chamephyte	Leafy stem, Infl	Pow	H, Cf, I	0.068		Hepatic (Eddouks et al., 2017).	
Lamiaceae ***Marrubium vulgare* L.**	Marro ut	Spontaneous	Chamephyte	Leafy stem	Poultice	H	0.025		Icterus (Bammi & Douira, 2002; El-Azzouzi & Zidane, 2015; Lahsissène, 2010); cholagogue and jaundice (Tahri et al., 2012).	Hepatoprotective (Verma et al., 2012), cytotoxic (Zarai et al., 2011); Antioxidant (Akther et al., 2013).
Lamiaceae ***Origanum compactum* Bentham.**	Zaater tadlawi	Spontaneous	Chamephyte	Leaf, Flower	Infusion	H, I	0.076			
Lamiaceae ***Salvia rosmarinus* Spenn.= *Rosmarinus officinalis* L.**	Al-Azir, Yazir	Spontaneous	Nanophanero -phyte	Leaf	Infusion	H, I	0.059		Cholagogue and choleretic (Bellakhdar, 2006; Tahri et al., 2012); anti-inflammatory, cholagogue (Ould El Hadj et al., 2003).	Hepatoprotective (Abdel-Wahhab et al., 2011); antioxidant (Bajalan et al., 2017).
Lamiaceae ***Thymus satureioides* Cosson. & Bal.**	Zîtra, Azoukoni	Spontaneous	Chamephyte	Leaf	Infusion	H, I	0.151		Choleretic (Ben-Akka et al., 2015).	Anti-inflammatory (Ismaili et al., 2004).
Lamiaceae ***Thymus zygis* L.**	Zaitra.	Spontaneous	Chamephyte	Leaf	Infusion	H, I	0.110			

Lamiaceae ***Vitex agnus-castus* L.**	El-kherwaa, Angarf	Spontaneous	Nanophanero - phyte	Fruit	Poultice	H, I	0.085			
Lauraceae ***Cinnamomum zeylanicum* Nees.**	Dar ssini	Imported	Phanerophyte	Bark	Decoction	I	0.120	0.096	Liver disease (El Azzouzi & Zidane, 2015).	Antioxidant and anti-microbial (Ranasinghe et al., 2013).
Lauraceae ***Cinnamomum cassia* Blum.**	L-Qarfa	Imported	Phanerophyte	Bark	Decoction	I	0.093			Anti-inflammatory, and anti-apoptotic (Golshahi et al., 2019); hepatoprotective (Mohammad et al., 2021).
Lauraceae ***Laurus nobilis* L.**	War akat-sîdna Moussa, E-rrand	Spontaneous	Phanerophyte	Leaf	Infusion	H, I	0.074			Antioxidant and anti-inflammatory (Ozcan et al., 2010; Taban et al., 2018).
Lythraceae ***Punica granatum* L.**	Rommâne	Cultivated	Phanerophyte	Bark	Powder	H, Cf, I	0.215	0.215		Hepatoprotective (Yogeeta et al., 2007).
Malvaceae ***Hibiscus sabdariffa* L.**	El Karkadi	Imported	Phanerophyte	Flower	Infusion	H	0.198	0.198	Jaundice and liver disease (El-Azzouzi & Zidane, 2015).	Hepatoprotective (Da-Costa-Rocha et al., 2014).
Moraceae ***Ficus carica* L.**	l-karmouss, El karma, Chreha	Cultivated	Phanerophyte	Leaf, Fruit	Powder	H	0.099	0.099	Icterus (El-Azzouzi & Zidane, 2015).	Antioxidant and anticancer (Jasmine et al., 2015).
Myrtaceae ***Eugenia caryophyllata* Thunb.**	Kronffel, Uod nuwwâr	Imported	Phanerophyte	Fruit	Decoction	H, Cf, I	0.184	0.184		Anti-inflammatory and anticancer (Han & Parker, 2017).
Papaveraceae ***Fumaria parviflora* Lam.**	Hachichat as-sebyâne, Sibana, Narelbarda, Chehmate el felouss	Spontaneous	Therophyte	Leafy stem	Infusion	I	0.019	0.019		Hepatoprotective (Tripathi et al., 2010).
Parmeliaceae ***Evernia prunastri* Ach.**	Lihyate E-chikh	Spontaneous	Fixed-hydrophyte	Thalle	Decoction	D	0.011	0.011		Antioxidant (Shcherbakova et al., 2021).
Pinaceae ***Pinus halepensis* Milerl.**	Tayda, Aode enarr, Chejrat ssanawbar	Spontaneous, Cultivated	Phanerophyte	Bark, Leaf, Cof	Powder Infusion	H	0.005	0.005		Antioxidant and anti-inflammatory (Abbou et al., 2019).
Plumbaginaceae ***Armeria mauritanica* Wallr.**	Erq Awadmî. El-Aarqlahmer	Spontaneous	Hemicrypto-phyte	Root	Decoction	D	0.003	0.003		
Poaceae ***Hordeum vulgare* L.**	Chaâir	Cultivated	Therophyte	Seed	Maceration	H, I	0,025	0.018		Antioxidant (Deng et al., 2020).
Poaceae ***Poa bulbosa* L.**	Annadkher	Spontaneous	Hemicrypto-phyte	Rhizo me	Decoction	H	0.012			

Poaceae ***Zea mays* L.**	Dra	Cultivated	Therophyte	Seed, Sty	Powder	H, I	0.019		Cirrhosis (Bouayyadi et al., 2015); cholagogue & choleretic (Tahri & *al.*, 2012; Saidi, 1999).	Cytotoxicity (Rajkumar et al., 2019).
Portulacaceae ***Portulaca oleracea* L.**	Rejla	Spontaneous	Therophyte	Leafy stem	Cooked	H	0.151	0.151	Liver disorders, and inflammatory disorders (Al-Asmari et al., 2014).	Hepatoprotective (Farkhondeh & Samarghandian, 2019).
Polygonaceae ***Emex spinosa* (L.) Campd.**	Homayda romiya, Aychamo thaycha	Spontaneous	Therophyte	Leaf, Root	Cooked	H	0.182	0.156	Jaundice (Bammi and Douira, 2002).	Cytotoxic and antimicrobial (Donia et al., 2014).
Polygonaceae ***Rumex crispus* L.**	Tarteka, nfifiha	Spontaneous	Hemicrypto-phyte	Seed, Root	Cooked	H	0.130			Antioxidant, cytotoxic, and anti-acetylcholinesterase (Saoudi et al., 2021).
Ranunculaceae ***Nigella sativa* L.**	Haba ssawda, Ssanouj	Cultivated, Sup	Therophyte	Seed	Powder	H, Cf, I	0.043	0.024	Liver disease (Bouayyadi et al., 2015); cholagogue (Hmamouchi, 1999), liver tonics, anti-inflammatory, immunostimulant, and remedy for jaundice (Al-Asmari et al., 2014).	Hepatoprotective (Hegazy et al., 2018).
Ranunculaceae ***Ranunculus muricatus* L.**	Wedene el halouf	Spontaneous	Therophyte	Root	Powder	H	0.006		Jaundice (Ullah et al., 2013).	Antioxidant (Deghima et al., 2020).
Rhamnaceae ***Rhamnus alaternus* L.**	Amlîlss, Aferzadade, Wariwri	Spontaneous	Nanophanerophyte	Leafy stem, Leaf, Bark, Fruit	Decoction	H, I, Cf	0.463	0.259	Icterus hepatic (Miara et al., 2019); jaundice (Lahsissène, 2010), and liver diseases (Ljubuncic et al., 2005).	Hepatoprotective (Berroukche et al., 2015).
Rhamnaceae ***Ziziphus lotus* (L.) Lam.**	Ssedra, Nbeg. Azogar	Spontaneous	Nanophanero -phyte	Fruit	Powder	H, I	0.056		Anti-inflammatory (Miara et al., 2019).	Antihyperlipidemic and antioxidant (Bencheikh et al., 2021).
Rubiaceae ***Rubia peregrina* L.**	Fuwwa, Tarûbia	Spontaneous	Chamephyte	Root	Powder	H, I	0.228	0.228	Hepatitis (Ouarghidi et al., 2013); jaundice and liver diseases (Bammi et Douira, 2002; El-Azzouzi & Zidane, 2015).	Antioxidant and anticancer (Longo et al., 2008).

Rutaceae ***Citrus aurantium* L. var. *amara* Link.**	Ranj, Trenje Zenboue	Cultivated	Phanerophyte	Fruit	Jus	I	0.023	0.023	Cholagogue (Sijelmassi, 2011).	Anti-inflammatory (Shen et al., 2017).
Schisandraceae ***Illicium verum* Hook. F.**	Badian a	Imported	Phanerophyte	Fruit	Decoction	H, I	0.017	0.017		Anti-inflammatory (Tuseef et al., 2021).
Thymelaeaceae ***Daphne gnidium* L.**	Alezaz, Lezaze	Spontaneous	Chamephyte	Leaf	Infusion	H	0.002	0.002	Antiinflammatory (Boudjelal et al., 2013).	Anticancer (Sanna et al., 2015); antioxidant (Chaves et al., 2020).
Vitaceae **Vitis vinifera L.**	**Dalya, zbibe, kerma, Al-ainab**	Cultivated	Phanerophyte	Fruit	Maceration	H	0.170	0.17		Hepatoprotective (Ahmad & Khan, 2012).
Xanthorrhoeaceae ***Asphodelus ramosus* L.**	El berwague, blallûze	Spontaneous	Geophyte	Rhizo me	Powder	H	0.002	0.002		
Zingiberaceae ***Aframomum melegueta* K. Schum.**	El goza rqîqa ou sahrawiya	Imported	Geophyte	Seed	Powder	H	0.255	0.331		Hepatoprotective and antioxidant (Adefegha et al., 2016).
Zingiberaceae ***Curcuma longa* L.**	Kharcûm aorouk, Al airk al assfar	Imported	Geophyte	Rhizo me	Powder	H, Cf	0.494		Hepatitis (Ben-Akka, et al., 2015); jaundice (Lahsissène, 2010); jaundice and liver problems (Al-Asmari et al., 2014).	Antitumor, antioxidant, hepatoprotective, and anti-inflammatory (Darvesh et al., 2012; Dhatchayani et al., 2020).
Zingiberaceae ***Zingiber officinale* Rosc.**	Skenjbîr	Imported	Geophyte	Rhizo me	Powder	H	0.244		Hepatic (Hachi et al., 2015).	Antioxidant (Otunola et al., 2017).
Zygophyllaceae ***Zygophyllum gaetulum* Emberger & Maire.**	El-aaggâya	Spontaneous	Chamephyte	Seed, Flower	Decoction	I	0.026	0.026	Antiinflammatory (Bellakhdar, 1997)	Antiinflammatory (Ait El Cadi et al., 2012).

(H: hepatitis, I: Icterus, J: jaundice, D: Depurative, Cf: Liver cancer).

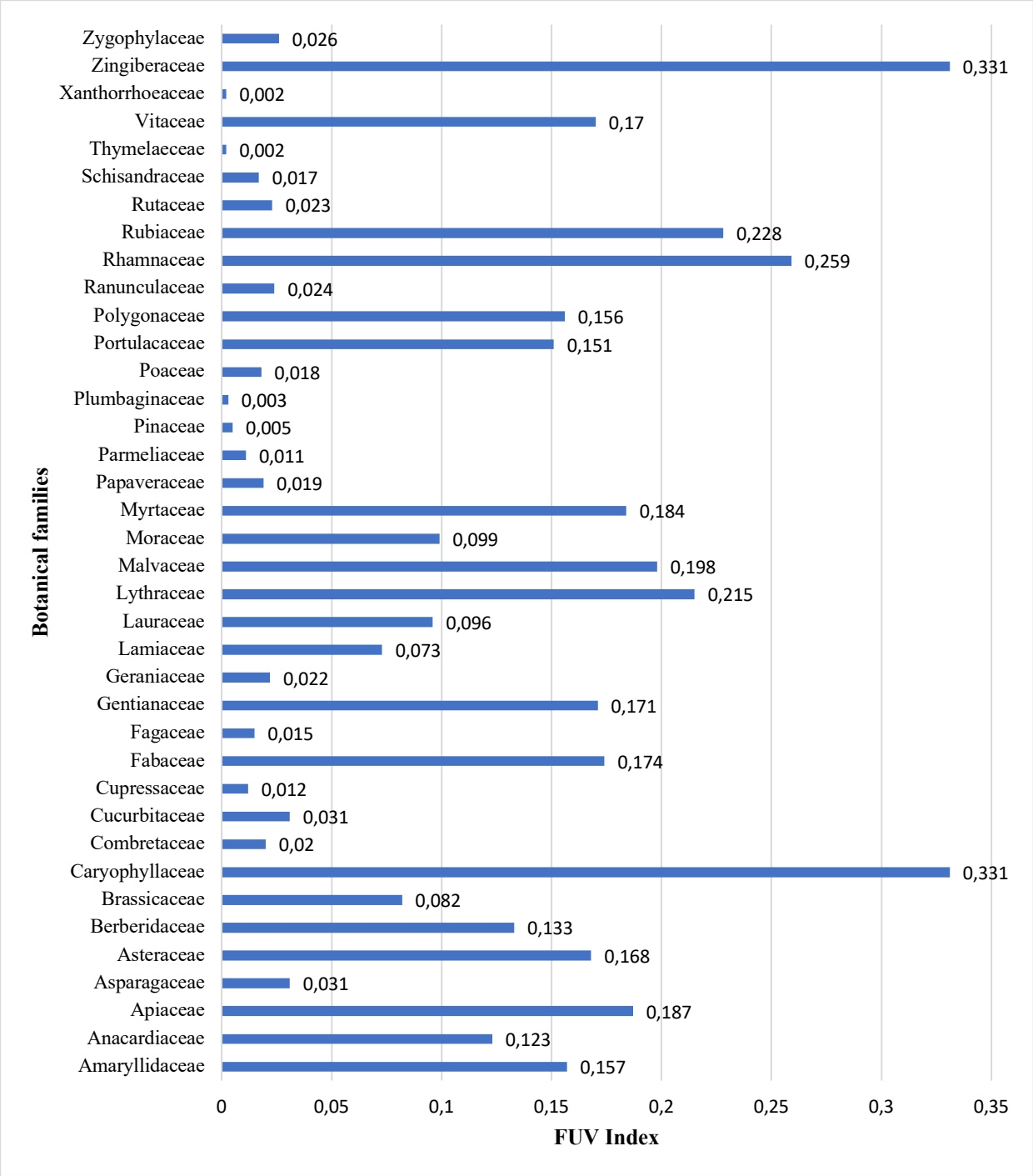

Figure 3. Family use-value (FUV) of medicinal plants.

The calculation of the UV index allowed us to extract seven species that had the highest UV because the informants cited them more: *Curcuma longa* L. (UV= 0.494), *Ononix natrix* L. (UV= 0.486), *Rhamnus alaternus* L. (UV= 0.463), *Cladanthus arabicus* (L.) Cam. (UV= 0.440), *Rhaponcticum acaule* (L.) DC. (UV= 0.380), *Cynara cardunculus* L. (UV=0.324) and *Cicer arietinum* L. (UV= 0.306). However, we found two species with the smallest UV: Asphodelus *ramosus* L. and *Daphne gnidium* L. (UV= 0.002 for each). The plant species with the highest UV shoulkd be studied phytochemically and pharmacologically to identify their chemical constituents and possible active ingredients responsible for their hepatoprotective property. The analysis of the data matrix composed of all the respondents and the species identified according to the diseases treated shows a significant number of notifications spread over the 86 species, of which the most requested by the respondents are presented in Figure 4.

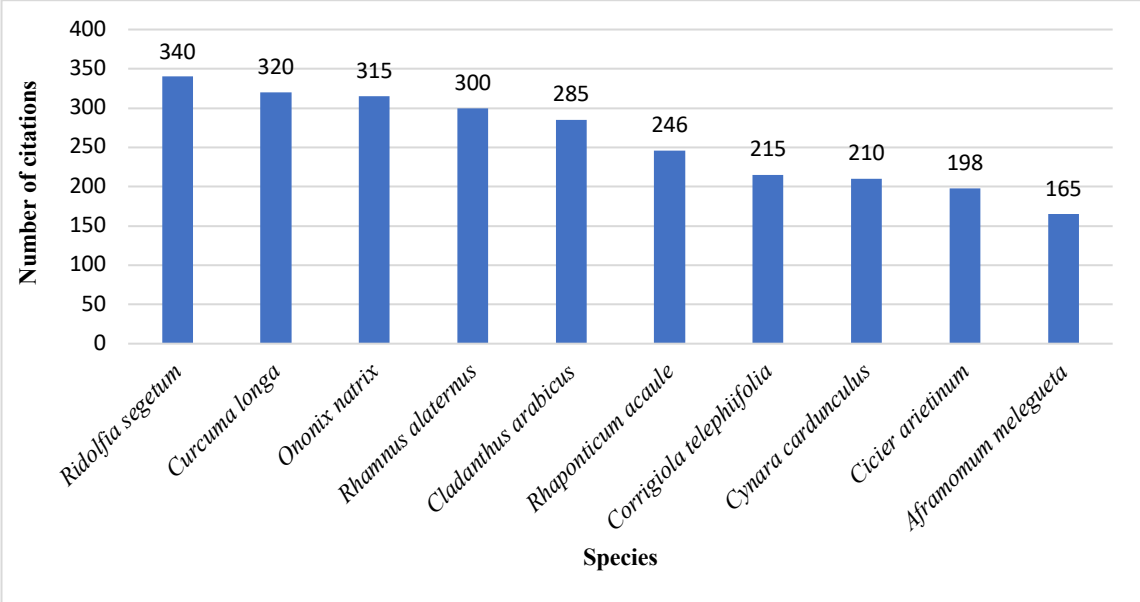

Figure 4: Distribution of the most commonly used species against liver diseases in the Al-Haouz Rehamna region with their number of citations**.**

Four plants were more cited in the said region (having several citations greater than or equal to 300), and they are considered effective against liver diseases:

Ridolfia segetum (Apiaceae), known by the vernacular name Tebche, is an annual, therophyte plant, spontaneous in plains and low mountains, growing mainly in crops and uncultivated fields, living in arid to humid climate conditions and widely distributed in the Mediterranean countries. It was reported 340 times and is used for its leafy stems or inflorescences, in powder form, to treat hepatitis.

Curcuma longa (Zingiberaceae), commonly called Kharkoum-aorouk, is a perennial plant, a geophyte, imported from Southeast Asia. It was cited 320 times, widely used for its rhizomes, in powder form, in the treatment of jaundice and hepatitis.

Ononix natrix (Fabaceae), locally called Afesdade; is a spontaneous plant, champhyte, which lives in clear forests, matorals, ermes; in plains, low and medium mountains; in climate ranging from Saharan to subhumid zones and was reported 315 times. Its leafy stems were dried in the sun, and used in decoction in water or powder, against hepatitis.

Rhamnus alaternus (Rhamnaceae) has the vernacular name Amriris; it is a spontaneous plant, phanerophyte, living in plains and mountains in the climate ranging from semi-arid to humid. This species was quoted 300 times. The leafy stems or the bark of the trunk, dried in the sun, are wildly used in decoction in the water against the hepatic affections.

All these species were included in several preparations, alone or associated with other plants.

Out of a total of 86 taxa, 48 species were cited in other similar previous ethnobotanical studies conducted nationally and internationally (Tab. 3). In addition, the hepatoprotective, antioxidant, anticancer or anti-inflammatory activity of 70 plants has been proven by pharmacological studies: *Allium sativum*, *Pistacia lentiscus*, *Ammodaucus leucotrichus*, *Carum carvi*, *Coriandrum sativum*, *Petroselinum sativum*, *Pimpinella anisum*, *Ridolfia segetum*, *Thapsia transtagana*, *Drimia marítima*, *Artemisia herba-alba*, *Carlina gummifera*, *Carthamus tinctorius*, *Centaurea maroccana*, *Chrysanthemum coronarium*, *Cladanthus arabicus*, *Cichorium intybus*, *Cynara cardunculus*, *Cynara scolymus*, *Matricaria chamomilla*, *Rhaponticum acaule*, *Scolymus hispanicus*, *Warionia saharae*, *Berberis hispanica*, *Brassica rapa*, *Lepidium sativum*, *Raphanus sativus*, *Corrigiola telephiifolia*, *Tetraclinis articulata*, *Cassia fistula*, *Ceratonia siliqua*, *Cicer arietinum*, *Glycyrrhiza glabra*, *Lens culinaris*, *Medicago sativa*, *Trigonella foenum graecum*, *Quercus ilex*, *Centaurium erythraea*, *Ajuga iva*, *Marrubium vulgare*, *Rosmarinus officinalis*, *Thymus satureioides*, *Cinnamomum zeylanicum*, *Cinnamomum cassia*, *Laurus nobilis*, *Punica granatum*, *Hibiscus sabdariffa*, *Ficus carica*,

Eugenia caryophyllata, *Fumaria parviflora*, *Evernia prunastri*, *Pinus halepensis*, *Hordeum vulgare*, *Zea mays*, *Portulaca oleracea*, *Emex spinosa*, *Rumex crispus*, *Nigella sativa*, *Ranunculus muricatus, Rhamnus alaternus*, *Ziziphus lotus*, *Rubia peregrina*, *Citrus aurantium* var. *amara*, *Illicium verum, Vitis vinifera*, *Asphodelus ramosus*, *Aframomum melegueta*, *Curcuma longa*, *Zingiber officinale* and *Zygophyllum gaetulum* (Table 3). Therefore, it would be exciting to carry out phytochemical and pharmacological studies for the other species to identify other chemical molecules or natural drugs with hepato-protective properties.

Disease categories and their IAR values

In the present study, the IAR values ranged from 0.970 to 0.992 by categories of diseases treated (Tab. 4). Liver cancer with IAR = 0.992 represents the disease with the highest degree of agreement among the informants, followed by hepatitis (IAR =0.989) and jaundice (IAR =0.987). In contrast, plants used as detoxifiers were only represented by (IAR=0.970). Therefore, it can be inferred that there is a reasonable likelihood between the people involved in this study and the use of these medicinal species (Lin et al., 2002) and that the people in the study area share the knowledge of medicinal plants used to treat these liver conditions. Therefore, liver cancer was the most common disease in the said area. This may be the result of several reasons: the lack of hygiene, the high consumption of alcohol or medicinal products, and the abusive use of some toxic or hepatotoxic plants because the majority of the people concerned by this study live in rural areas, they are illiterate, and they use the spontaneous plants that are in their surroundings. Therefore, the species with high IAR should be the subject of phytochemical, pharmacological, and toxicological research to evaluate their therapeutic properties.

Table 5. IAR values by categories for treating metabolic diseases.

Categories	List of plant species used and number of uses	Nt	Nur	IAR
Jaundice	*Allium sativum* (102), *Carum carvi* (130), *Artemisia herba-alba* (110), *Calendula stellata* (108), *Cichorium intybus* (78), *Cladanthus arabicus* (285), *Cynara scolymus* (96), *Rhaponticum acaule* (246), *Scolymus hispanicus* (68), *Warionia saharae* (26), *Berberis hispanica* (86), *Corrigiola telephiifolia* (215), *Combretum micranthum* (13), *Citrullus colocynthis* (20), *Tetraclinis articulata* (8), *Ceratonia siliqua* (62), *Trigonella foenum graecum* (92), *Quercus ilex* (10), *Pelargonium roseum* (14), *Lavandula officinalis* (25), *Lavandula multifida* (44), *Origanum compactum* (49), *Salvia rosmarinus* (38), *Thymus satureioides* (98), *Thymus zygis* (71), *Vitex agnus-castus* (55), *Cinnamomum zeylanicum* (78), *Cinnamomum cassia* (60), *Laurus nobilis* (48), *Punica granatum* (139), *Eugenia caryophyllata* (119), *Fumaria parviflora* (12), *Hordeum vulgare* (16), *Zea mays* (12), *Nigella sativa* (28), *Rhamnus alaternus* (300), *Ziziphus lotus* (36), *Rubia peregrina* (148), *Citrus aurantium* var. *amara* (15); *Illicium verum* (11), *Zygophyllum gaetulum* (17).	41	3188	0.987
Hepatitis	*Allium sativum* (102), *Pistacia lentiscus* (80), *Carum carvi* (130), *Coriandrum sativum* (54), *Petroselinum sativum* (80), *Pimpinella anisum* (147), *Thapsia transtagana* (30), *Drimia marítima* (20), *Ridolfia segetum* (340), *Artemisia atlantica* var. *Maroccana* (76), *Artemisia herba-alba* (110), *Artemisia huguetii* (30), *Calendula stellata* (108), *Carlina gummifera* (36), *Carthamus tinctorius* (155), *Centaurea maroccana* (162), *Chrysanthemum coronarium* (28), *Cichorium intybus* (78), *Cladanthus arabicus* (285), *Cynara cardunculus* (210), *Cynara humilis* (125), *Cynara scolymus* (96), *Matricaria chamomilla* (16), *Rhaponticum acaule* (246), *Scolymus hispanicus* (68), *Warionia saharae* (26), *Berberis hispanica* (86), *Brassica rapa* (66), *Lepidium sativum* (45), *Corrigiola telephiifolia* (215), *Tetraclinis articulata* (8), *Ceratonia siliqua* (62), *Cicer arietinum* (198), *Glycyrrhiza glabra* (48), *Lens culinaris* (109), *Medicago sativa* (72), *Ononis natrix* (315), *Trigonella foenum graecum* (92), *Quercus ilex* (10), *Pelargonium roseum* (14), *Ajuga iva* (30), *Lavandula officinalis* (25), *Lavandula multifida* (44), *Marrubium vulgare* (16), *Origanum compactum* (49), *Salvia rosmarinus* .(38), *Thymus satureioides* (98), *Thymus zygis* (71), *Vitex agnus-castus* (55), *Laurus nobilis* (48), *Punica granatum* (139),	73	6723	0.989

	Hibiscus sabdariffa (128), *Ficus carica* (64), *Eugenia caryophyllata* (119), *Pinus halepensis* (3), *Hordeum vulgare* (16), *Poa bulbosa* (8), *Zea mays* (12), *Portulaca oleracea* (98), *Emex spinosa* (118), *Rumex crispus* (84), *Nigella sativa* (28), *Ranunculus muricatus* (4), *Rhamnus alaternus* (300), *Ziziphus lotus* (36), *Rubia peregrina* (148), *Illicium verum* (11), *Daphne gnidium* (1), *Vitis vinifera* (110), *Asphodelus ramosus* (1), *Aframomum melegueta* (165), *Curcuma longa* (320), *Zingiber officinale* (158).			
liver cancer	*Ammodaucus leucotrichus* (120), *Centaurea maroccana* (162), *Cichorium intybus*(78), *Cladanthus arabicus* (285), *Cynara cardunculus*(210), *Cynara humilis*(125), *Cynara scolymus* (96), *Rhaponticum acaule* (246), *Scolymus hispanicus* (68), *Warionia saharae* (26), *Berberis hispanica* (86), *Cassia fistula* (4), *Ceratonia siliqua* (62), *Centaurium erythraea* (111), *Lavandula multifida* (44), *Punica granatum* (139), *Eugenia caryophyllata* (119), *Nigella sativa* (28), *Rhamnus alaternus* (300), *Curcuma longa*(320).	20	2643	0.992
Detoxifying	*Raphanus sativus* (50), *Ceratonia siliqua* (62), *Pelargonium roseum* (14), *Evernia prunastri* (7), *Armeria mauritanica* (2).	5	135	0.970

Biological spectrum

In treating liver illnesses, the therophytes (30.23%) dominate the biological spectrum of all 86 species. The substantial presence of therophytes may be explained, on the one hand, by the fact that they are annual species with short life cycles that are often better suited to frequently disturbing settings (Benkhnigue *et al.* 2022; Bouhache *et al.* 2002). In contrast, these species are readily available, prolific, and simple to harvest. Phanerophytes maintain second place (19.77%), followed by chamephytes (15.12%), geophytes 13.95%; hemicryptophytes occupy the fifth place with 12.79%, nanophanerophytes come in sixth place and contribute to 6.98%. At the same time, hydrophytes are represented by only 1.16% % (Fig. 5).

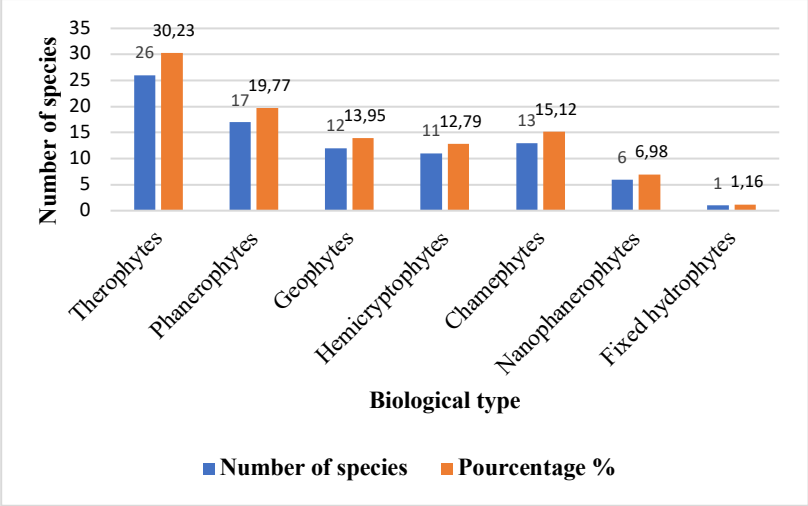

Figure 5. Distribution of the medicinal flora of the Al-Haouz Rehamna region according to their biological types

Type of plants used

Spontaneous species dominated the other types and contributed 54.65% of the total number of species harvested, followed by cultivated species (31.40%), with species imported from other countries (e.g., Asia, India, Egypt) occupying third place with 12.79%. In comparison, naturalized species are represented by only two species (1.16%) (Fig. 6). Priority should be given to the protection of naturally occurring species since their overexploitation via overharvesting threatens their populations.

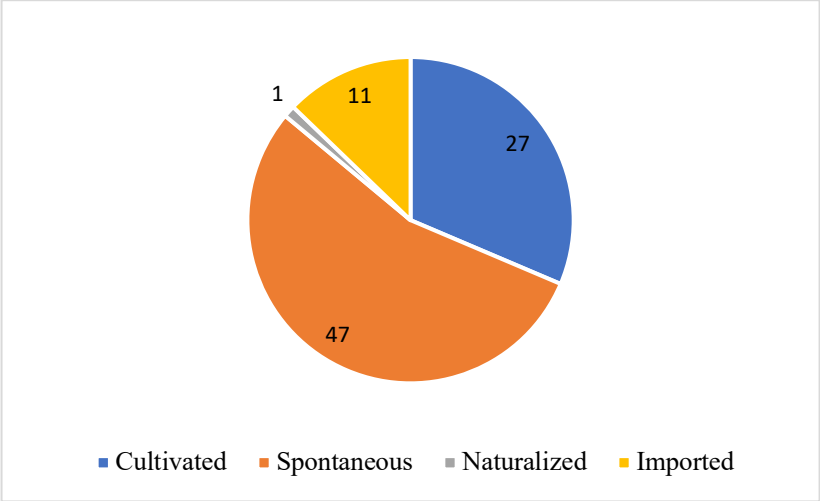

Figure 6. Distribution of plants used against liver diseases according to their degree of spontaneity.

Parts of medicinal plants used to treat liver diseases

Based on the PPV index (value of the part of the plant), the leaf was the most used part in local phytotherapy against liver diseases in the studied region with a PPV= 0.183; then comes the seed (PPV= 0.165), the root (PPV=0.147), the flower (PPV= 0.137) and the leafy stem (PPV= 0.128). The other parts (bulb, rhizome, stem, bark, and fruit) had a PPV index below 0.1 (Fig. 7). The great frequency of usage of leaves may be explained on the one hand by their simplicity of harvesting and, on the other hand, by their high concentration of active phytochemicals, which play an essential role in disease treatment (Ahmad *et al.* 2009). They are the primary source of alkaloids, heterosides, and essential oils (Ould El hadj *et al.* 2003).

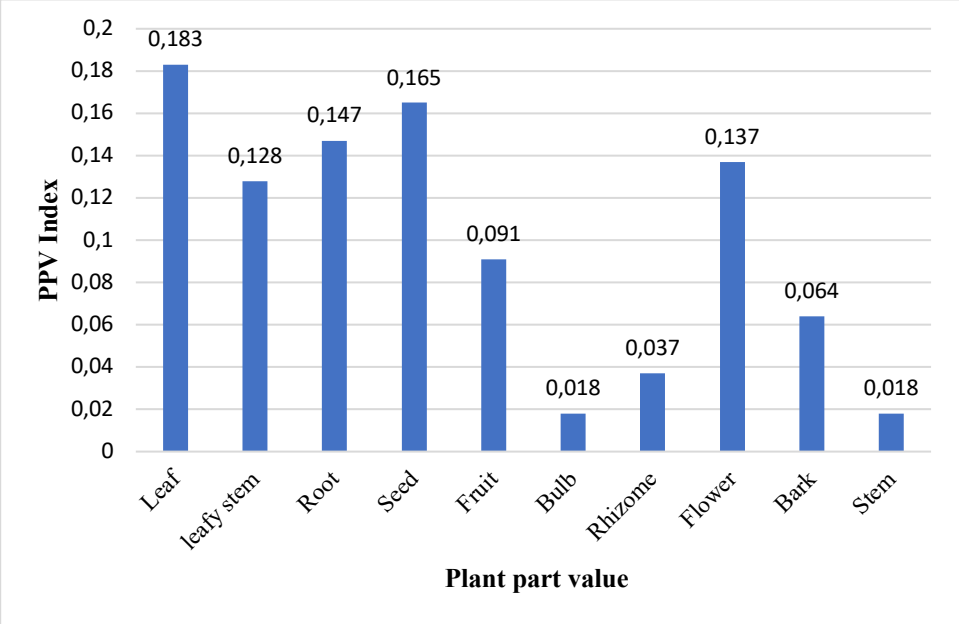

Figure 7. Plant parts used to treat Hepatic disorders in the study area.

Method of preparation and use, dosage and dose

Concerning the mode of preparation, we found that the majority of the persons in this study used mainly two modes to prepare anti-hepatic recipes: decoction (34.88%) and powder (23.26%) (Fig. 8). The scopes of the therapeutic formulae are administered to the patients was in most cases orally via water or by trituration with honey. These results are close to those of Sangare *et al.* (2013), who made a similar study on hepatotropic plants and the traditional use of *Gomphrena celosioides* Mart. (Amaranthaceae) in Benin. Apoultice at the abdominal level and fumigation were rarely used and were reserved for certain toxic plants whose toxicity was well known by the local people. The choice of oral administration may be justified because hepatic disorders are associated with internal organs. To aid absorption, all compounds must travel through the digestive system to reach the target

cells (Tra Bi *et al.* 2008). In addition, some users choose to supplement the medication with a diet high in vitamins derived from natural sources, such as oranges, bananas, and apples. They encourage ill individuals to avoid eating beans and eggs.

Regarding dosage, the majority of individuals (88.14%) utilized non-precise dosages (pinch, tablespoon, handful), whereas a minority (11.86%) used exact quantities. These findings corroborate prior ethnobotanical research undertaken in different parts of Morocco (Benkhnigue *et al.* 2010; 2016; Najem *et al.* 2018).

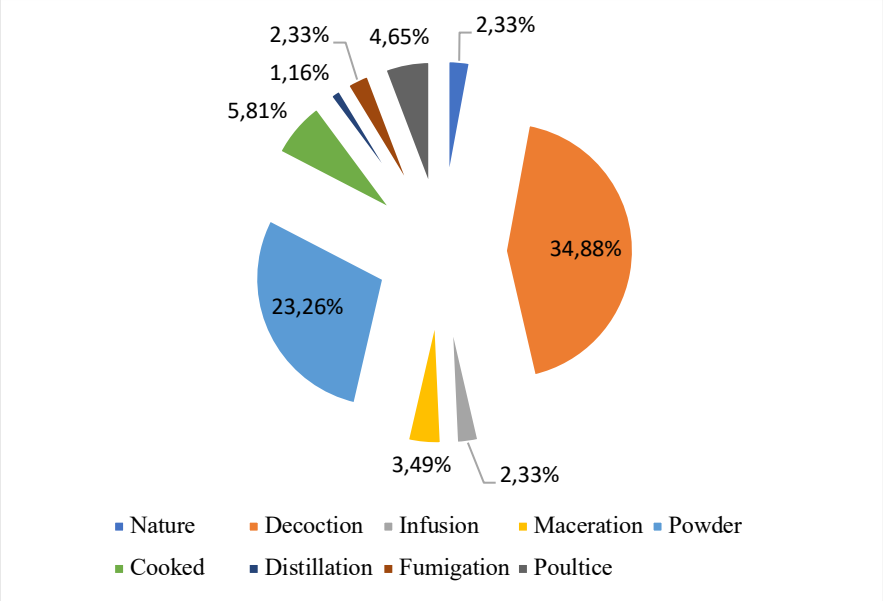

Figure 8. Frequency of the different methods of preparation.

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

Any modernization or optimization of the yields of medicinal plants does not seem feasible to us without the knowledge and assimilation of traditional practices in this field. In this perspective, we focused on the declaration of the interviewees concerning the toxicity caused by the use of certain plants.

The pharmacological analysis of the plants identified 21 species with toxicity, traditionally used against liver diseases in the region: *Allium sativum* L. (Gatsing *et al.* 2005; Filliat 2012); *Petroselinum sativum* Hoffman. (Perelman and Kuttin 1988); *Thapsia transtagana* Brot. (Bellakhdar 1997; Hammiche *et al.* 2013); *Drimia marítima* (L.) Stearn. (Hamouda *et al.* 2016); *Artemisia herba-alba* Asso. (Bellakhdar 1997); *Carlina gummifera* (L.) Less.; (Masri *et al.* 2009); *Brassica rapa* L. (Hammiche *et al.* 2013); *Lepidium sativum* L. (Bellakhdar 1997); *Corrigiola telephiifolia* Pourret (Lakmichi *et al.* 2011); *Citrullus colocynthis* (L.) Schrad. (Hammiche *et al.* 2013); *Tetraclinis articulata* (Vahl.) Masters. (Zahir and Rahmani 2020); *Glycyrrhiza glabra* L. (Hmamouchi 1999); *Medicago sativa* L. (Bellakhdar 1997); *Trigonella foenum graecum* L. (Ouzir *et al.* 2016); *Quercus ilex* L. (Sijelmassi 2011); *Lavandula officinalis* Chaix. ex Villars. (Sijelmassi 2011); *Origanum compactum* Bentham. (Hmamouchi 1999); *Rosmarinus officinalis*.L. (Hmamouchi 1999); *Portulaca oleracea* L. (Shafi and Tabassum 2013); *Nigella sativa* L. (Bellakhdar 1997); *Daphne gnidium* L. (Bellakhdar 1997; Sijelmassi 2011). Among these species, only six were well known locally: *Thapsia transtagana* Brot, *Drimia maritima* (L.) Stearn, *Carlina gummifera* (L.) Less, *Citrullus colocynthis* (L.) Schrad, *Marrubium vulgare* L., and *Daphne gnidium* L., while 15, were not known to be toxic. Ultimately, self-medication with these plants might be harmful. This is why pharmacological and toxicological studies should be encouraged to identify toxic molecules.

In addition, during the period of our field survey, the vast majority of users could not differentiate between the different types of liver diseases (hepatitis, jaundice, and liver cancer) and treated patients based on the characteristic symptoms associated with them (yellowish eye, yellowish body, fever, weakness of the body and anorexia. On the other hand, many patients did not respect the dosage and combined both types of medicine (traditional and modern), which may be another source of toxicity.

Conclusion

Liver diseases are a crucial public health problem for many industrialized and developing countries. This is due to changes in nutritional habits, lack of adapted dietary measures, alcoholism, and viral or drug-induced infections. In the region of Al-Haouz Rehamna, we conducted an ethnobotanical study to identify the medicinal species used against these diseases. This study reveals that the population of this region, which has accumulated actual know-how on the virtues of medicinal plants, often resorts to traditional medicine to treat liver diseases despite the revolution in medical technology.

In addition, the ethnobotanical surveys that we conducted among the population of this region allowed us to identify 86 species belonging to 37 families and divide them into 79 genera. Among these species, 21 are toxic. The leaf is the most used plant organ, and decoction is the most frequent method of use in traditional phytotherapy in this region. Among the species cited in this region, ten species are reported to be more effective against these pathologies (jaundice, hepatitis, and liver cancer), 4 of which have several citations higher than 300, namely: *Ridolfia segetum*, *Curcuma longa*, *Ononis natrix*, and *Rhamnus alaternus*.

This study aimed to discover other unknown species, know the traditional practices used in the study area, evaluate the risks resulting from certain toxic plants' use, safeguard the local heritage, and develop the Moroccan natural resources. However, it would be interesting to extend this study to other regions of Morocco to establish complete monographs.

Finally, it would be interesting validate the effectiveness of the plants cited in this investigation through suitable testing analyses so that the use of plants is more scientifically established, as well as to pursue and isolate new bioactive molecules that may hold preventative or curative effects against these disorders.

Declarations

Ethical Approval: All participants provided oral prior informed consent.
Consent to Participate: Not applicable.
Consent to Publish: Not applicable.
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Authors Contributions: OB: methodology, data collection, a compilation of literature sources, data analysis, assessment, interpretation, realization manuscript HK: Assisting with data and contributing significantly to data analysis. NC: analyzed the data and wrote the article, review and editing, LZ: Design for searching and identifying plant species. RWB: thorough revision of the manuscript and preparation of the final draft. The final paper was understood and approved by all the authors.

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