Journal of Experimental Biology and Agricultural Sciences

http://www.jebas.org

**ISSN No. 2320 – 8694**

# Ethnopharmacological study of medicinal plants used in the treatment of skin diseases in the Western Middle Atlas region (Morocco)

Fatiha El Azzouzi[1*], Soukaina Chaouqi[2], Meryem Makkaoui[3], Hanae Briguiche[1], Lahcen Zidane[1]

[1]Plant, Animal Productions and Agro-industry laboratory, Sciences Faculty, Ibn Tofail University, B.P.133 14000, Kenitra, Morocco
[2]Organic Chemistry, Catalysis and Environment Laboratory, Sciences Faculty, Ibn Tofail University, BP 242, 14000, Kenitra, Morocco
[3]Microbiology and Molecular Biology Laboratory, Faculty of Sciences, Mohamed V University, PO Box 1014, Rabat, Morocco

Received – September 04, 2023; Revision – December 21, 2023; Accepted – January 22, 2024
Available Online – March 15, 2024

DOI: http://dx.doi.org/10.18006/2024.12(1).93.105

KEYWORDS

Ethnopharmacology

Medicinal plants

Skin diseases

Western Middle Atlas

**ABSTRACT**

An investigation was conducted among 360 people from the local population of the Western Middle Atlas of Morocco to identify medicinal plants used for treating skin diseases. Various parameters, including Relative Frequency of Citation (RFC), Family Use Value (FUV), Plant Part Value (PPV), Informant Consensus Factor (ICF), and Fidelity Level (FL), were used for data collection and assessment. During the investigation, 45 medicinal plant species belonging to 33 families were documented, with the most important family being Euphorbiaceae (FUV = 0.292). The highest ICF value (ICF=0.991) was mentioned for skin cancer. The poultice was found to be the primary method for preparing the majority of remedies (51%). Leaves were the most commonly used plant part (PPV = 0.476), and *Allium sativum* L. was the most widely used species (RFC = 0.302). These findings are a preliminary step towards conserving and popularising these plant species, promoting sustainable practices in traditional medicine, safeguarding biodiversity, and integrating these valuable botanical resources into modern healthcare systems.

* Corresponding author
E-mail: azzouzi.fatiha89@gmail.com (Fatiha El Azzouzi)

Peer review under responsibility of Journal of Experimental Biology and Agricultural Sciences.

Production and Hosting by Horizon Publisher India [HPI] (http://www.horizonpublisherindia.in/).

## 1 Introduction

Plant species are highly diverse and abundant, and they play a crucial role in maintaining ecosystem balance and providing essential natural resources for human survival and development (Spichiger et al. 2000). Medicinal plants, in particular, are an invaluable inheritance for mankind, especially for underprivileged societies in developing countries that rely on them for their main healthcare needs and sustenance (Salhi et al. 2010). According to the World Health Organization (WHO), around 80% of populations in developing countries, including African countries, depend on traditional medicine as their primary source of medicines (World Health Organization 2019; SasiPriya 2020). In Morocco, the Mediterranean climate promotes the growth of approximately 4800 plant species of vascular flora (Fennane and Rejdali 2018), giving rise to a long tradition of utilizing medicinal plants derived from diverse civilizations, including Africans, Arabs, Andalusians, and Berbers (Bellakhdar 2006).

Skin diseases are a significant public health issue, encompassing a range of pathologies. Over the past 30 years, the frequency of these diseases has significantly increased worldwide, including in emerging countries (Stambouli 2018; Grenez 2019). Skin diseases are common across all age groups, and they hold a significant place in the consultation profile in Africa, encompassing mycotic, parasitic, bacterial, and viral infections (Orion and Wolf 2014). The biological properties of plants for treating dermatological ailments are promising, with some highlighted through various studies, while others are still the subject of research worldwide. Several studies have identified medicinal plant species with beneficial properties in treating skin diseases. In Turkey, Erarslan et al. (2020) identified 191 medicinal species with properties useful for skin diseases. Similarly, Tsioutsiou et al. (2022) reported the utilization of 967 taxa with various medicinal properties in the South Balkan and East Mediterranean regions. Makgobole et al. (2023) identified 211 plant species implicated in treating multiple skin conditions in West Africa. Ajjoun et al. (2022) documented a total of 401 plants in Morocco. This study aims to conduct an ethnopharmacological survey on the medicinal plants traditionally used for managing skin diseases in various regions of the Western Middle Atlas of Morocco. The study seeks to record and analyze the range of medicinal plants used in treating skin diseases in the study region, to preserve valuable herbal knowledge acquired by the local population, and to contribute to various scientific fields, including phytochemical and pharmacological research.

## 2 Materials and Methods

### 2.1 Study area description

The study sites are situated in the Beni Mellal-Khenifra region, located at the center of Morocco. This region is known for its diverse geographical, cultural, and economic aspects. The study region comprises various provinces, such as Beni Mellal, Khenifra, Azilal, Fquih Ben Salah, and Khouribga (HCP 2017) (Figure 1).

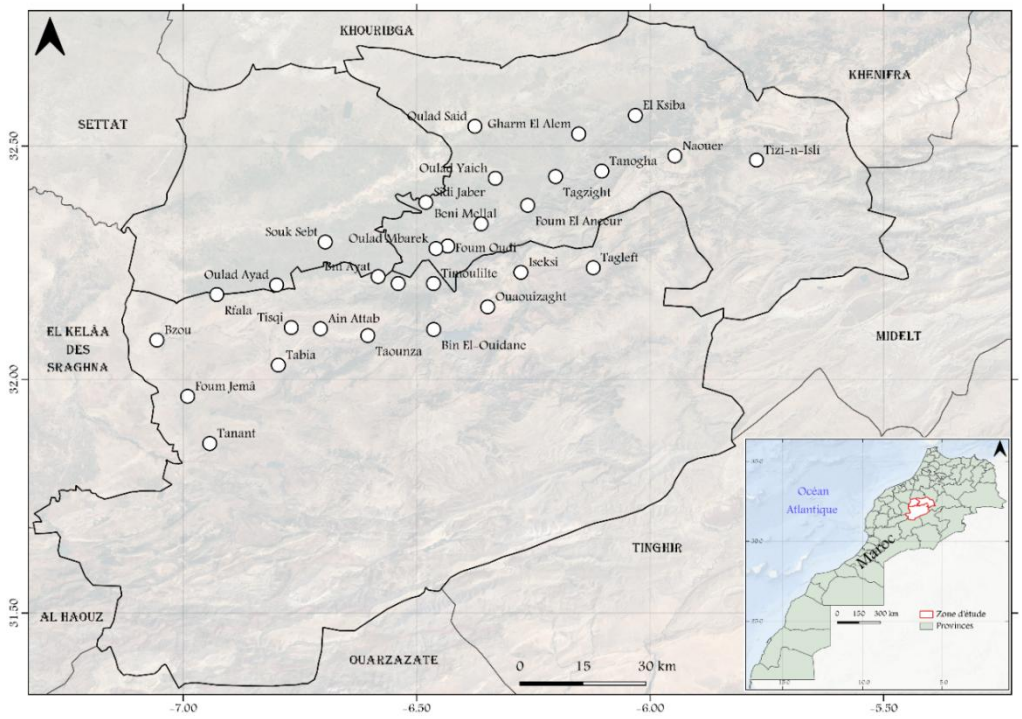


Figure 1 The map of the study area showing the locations of the survey points

The Beni Mellal-Khenifra region in Morocco is home to the important Oued OumErrabiaa River and covers a large part of its upstream catchment area. The region experiences varying levels of rainfall and temperatures, with different climates across the plain and mountain areas. The vegetation in the region reflects the Mediterranean bioclimatic staging, but traditional agro-pastoral practices and forest management have greatly influenced the landscape (Taïbi et al. 2015). The region's population is estimated to be 2,520,776 people, which is 7.45% of the overall population (HCP 2017). The region has great tourism potential, with popular sites such as Ain Asserdoun, the panoramic castle of Beni Mellal, the summering centre of Elksiba, the waterfalls of Ouzoud, Tamga Cathedral, the AitBougamaz valley, and various mountain trails attracting many tourists every year (Direction Régionale de Beni Mellal-Khenifra 2019).

### 2.2 Methodology

An ethnobotanical examination was conducted between 2013-2014 in the Western Middle Atlas to collect and document traditional practices associated with medicinal plants used to treat skin diseases. The survey involved 360 participants who were interviewed using a pre-determined questionnaire. The survey was carried out using random stratified sampling, allowing for a comprehensive floristic inventory to be obtained and ethnobotanical surveys to be conducted across various regions within the specified area. During the interviews, discussions were conducted in local languages and Arabic. The survey recorded information such as the gender, age, academic level, and marital status of the participants, as well as the local names of the plants used, the plant parts utilized, the preparation methods, the method of administration, and the ailments treated. Several field trips were organized to the research areas, which successfully captured digital photographs and assigned local names to the medicinal plants for producing herbarium sheets. The taxonomic identification was carried out using Moroccan floras T1, T2, and T3, and herbarium specimens (Fennane et al. 1999; Fennane et al. 2007; Fennane et al. 2014) and catalogues (Bellakhdar 1997; Hmamouchi 2001). The obtained results were analyzed using descriptive statistics in the form of percentages through computer software (SPSS Statistics 21 and Excel 2016). The participants' demographic data were analyzed using simple descriptive statistical methods using frequencies and percentages. The ethnopharmacological data were analyzed using various methods, including Family Use Value (FUV), Relative Citation Frequency (RFC), Fidelity Level (FL), Informant Consensus (ICF), and Plant Part Value (PPV).

#### 2.2.1 Family Use Value (FUV)

The FUV index measures the significance of a plant family in a community by considering the number of species utilized from that family. FUV is calculated using the formula FUV = UVs/Ns, as described in Sreekeesoon and Mahomoodally (2014), where UVs use values of the species, and Ns: total number of species within each family.

#### 2.2.2 Relative Frequency of Citation (RFC)

The RFC index measures how often a plant is identified as a remedy by people providing information. It is calculated by dividing the number of informants who mention a particular plant by the total number of informants. This formula is expressed as RFC = FC / N (0 < RFC > 1), where FC is the number of informants mentioning the use of the species, and N is the number of informants participating (Tardío and Pardo-De-Santayana 2008).

#### 2.2.3 Fidelity Level (FL)

The FL is a classification system used to determine the effectiveness of collected plant species in treating specific disorders. It was calculated by finding the percentage of people who suggest using a particular plant for a specific purpose. The calculation uses the formula FL = (Ip / Iu) x 100. Where Ip represents the number of informants who mentioned using a particular plant for a particular purpose, and Iu represents the total number of informants who mentioned the plant for any use (Alexiades and Sheldon 1996; Sreekeesoon and Mahomoodally 2014).

#### 2.2.4 Informant Consensus Factor (ICF)

This index ascertains the extent of community agreement regarding the utilization of a specific plant (Heinrich et al. 1998); it was computed based on the formula ICF = Nur – Nt / Nur – 1, where Nur is represented as the number of illnesses used in each category, and Nt is the full sum of species mentions reported within each category.

#### 2.2.5 Plant Part Value (PPV)

The PPV is a metric that we employed to indicate the usage prevalence. Its calculation was conducted as follows: PPV= $RU_{plant\ part}$/RU, where $RU_{plant\ part}$ is the sum of utilizations for each plant component, and RU is the total instances of plant part utilization (Gomez-Beloz 2002).

## 3 Results and Discussion

### 3.1 Participant demographic details

A total of 360 participants, consisting of 220 females and 140 males, were interviewed for this study. The results indicated that herbs effectively treat health issues of both genders in the Western Middle Atlas region. However, women showed more knowledge of

plant species and their usage, accounting for 61.11% of the respondents compared to 38.89% for men. The prevalence of women in this study is explained by their careful attention to disease prevention and adherence to traditional practices. It is worth noting that women traditionally provide food and healthcare to their families during times of illness. These findings are consistent with other ethnobotanical studies conducted on a national level (Benkhnigue et al. 2010; Salhi et al. 2010; El Hafian et al. 2014; Khenissi and Rouabhia 2021; Bentabet et al. 2022).

A significant percentage of the respondents in the research site were over the age of 60 (39.72%), followed by those aged between 40-60 years (31.11%) and between 20-40 years (23.33%). Only a small percentage of respondents were under the age of 20 (5.83%) (Table 1). The higher involvement of elderly respondents may be because they possess traditional knowledge and understanding passed down through generations. However, there is a decline in the transmission of knowledge about medicinal plants, which can be attributed to younger people's disbelief in the efficacy of herbal medicine. This disbelief is influenced by modernization and foreign cultural influences. As a result, traditional medical wisdom is unlikely to disappear as there is no consistent intergenerational exchange between older and younger individuals. These observations are consistent with findings from other regions in Morocco (Anyiam 1995; Benlamdini et al. 2014; El Hafian et al. 2014; Bounoua and Djoudi 2022; Chaachouay et al. 2022).

According to the gathered data, married individuals (72.77%) use medicinal plants more than singles (27.22%). This trend can be attributed to the fact that married people can avoid or reduce the costs associated with seeing doctors and buying pharmaceuticals. In addition, those who live in rural areas (81.88%) are more familiar with using plants to manage skin diseases. These findings are consistent with El Hilah et al. (2015) and Chaachouay et al. (2022) research. Regarding the education level of the participants, more than half of them (59.72%) were uneducated. 28.33% had attended primary school, while 9.89% had completed secondary school education. Interestingly, interviewees with advanced educational backgrounds showed minimal use of medicinal plants (3.05%). Therefore, the utilization of medicinal plants decreases with an increase in educational achievement. This conclusion is consistent with the findings of studies conducted by Lahsissene et al. (2009), El Hilah et al. (2015), Bouzid et al. (2017), and Achour et al. (2022).

### 3.2 Quantitative analysis

#### 3.2.1 Predominant families and their FUV

The study in the area revealed that people used 45 different plant species from 33 families to treat skin disorders. The study included scientific names, local names, the parts of plants used, the method of preparation, local medicinal uses and various details like FC, RFC, FL, and FUV particulars, all mentioned in Table 2.

The Solanaceae family had the highest number of species represented (5 species), followed by Asteraceae and Lamiaceae (3 species each). Other families, such as Cucurbitaceae, Amaryllidaceae, Rhamnaceae, and Poaceae (2 species each), were also well-represented. The remaining families had only one species represented (Figure 2). Among the reported families, Euphorbiaceae (FUV=0.292), Verbenaceae (FUV=0.275), and Cupressaceae (FUV=0.272) were the three most frequently enumerated families based on the FUV index. This notable prevalence can be explained by the extensive presence of these families in the Western Middle Atlas region owing to ecological conditions. These findings contradict the results of Ajjoun et al. (2022) and Nasab et al. (2022), where Asteraceae and Lamiaceae were found to be the most frequently cited families for treating skin disorders.

Table 1 Demographic characteristics of interviewees in the Western Middle Atlas of Morocco

| Variables | Category | Total | Percentages (%) |
|---|---|---|---|
| Gender | Female | 220 | 61.11 |
| | Male | 140 | 38.89 |
| Age groups | < 20 | 21 | 5.83 |
| | [20-40] | 84 | 23.33 |
| | [40-60] | 112 | 31.11 |
| | >60 | 143 | 39.72 |
| Marital status | Married | 262 | 72.77 |
| | Single | 98 | 27.22 |
| Academic level | Illiterate | 215 | 59.72 |
| | Primary | 102 | 28.33 |
| | Secondary | 32 | 8.89 |
| | University | 11 | 3.05 |
| Living environment | Rural | 289 | 81.88 |
| | Urban | 71 | 19.72 |

Table 2 Summary of medicinal flora for treating skin diseases in the Western Middle Atlas region (Morocco)

| Family | Scientific name | Vernacular name | Part used | Preparation | Local medicinal uses | FC | RFC | FL | FUV |
|---|---|---|---|---|---|---|---|---|---|
| Amaryllidaceae | *Allium cepa* L | Lbesla | Bulb | Poultice | The bulb is ground with leaves of *lawsonia inermis* L. and olive oil to remove burn scars. | 51 | 0.141 | 100 | 0.221 |
| | *Allium sativum* L | Touma | Bulb | Poultice | Poultices of garlic triturated with olive oil are used to grow hair and treat eczema. | 109 | 0.302 | 73.4 | |
| Aizoaceae | *Aizoon canariense* L | El-ghassoule | Leaves | Poultice | A mixture of powder and olive oil paste is used to cure Eczema. | 23 | 0.064 | 100 | 0.064 |
| Anacardiaceae | *Pistacia atlantica* Desf | L-Btem | Bark | - | The resin is applied externally to heal wounds | 22 | 0.061 | 100 | 0.061 |
| Apiaceae | *Ammi majus* L | Trillan | Seeds | Poultice | Paste of seeds mixed with roots of *Anacyclus pyrethrum* L. and honey is applied against vitiligo | 89 | 0.247 | 100 | 0.247 |
| Apocynaceae | *Nerium oleander* L | Ddefla | Leaves/ Bark | Powder/ Poultice | Powder of leaves is used to cure burns and eczema. Bark is crushed to paste and applied externally in case of alopecia. | 77 | 0.214 | 51.5 | 0.214 |
| Arecaceae | *Chamaerops humilis* L | El-Ghaz/ Doum | Roots | Powder | The roots heated with fire are used in local application against warts. | 12 | 0.033 | 100 | 0.033 |
| Asparagaceae | *Agave americana* L | Ssabra/ Sayber | Leaves | Powder | Powder of leaves associated to *Agave americana*, *Lepidium sativum*, *Opuntia ficus-indica* (L.) Mill., is used against skin cancer | 79 | 0.219 | 100 | 0.219 |
| Asteraceae | *Anacyclus pyrethrum* L | Taqendicht/ Iguntas | Roots | Powder | Powder of *Anacyclus pyrethrum* L. blended with honey is used to heal vitiligo. | 42 | 0.116 | 100 | 0.162 |
| | *Artemisia herba-alba* Asso. | Chih/ Ifzi | Leaves | Poultice | Fresh leaves are crushed to paste and applied externally in case of pimples | 39 | 0.108 | 100 | |
| | *Carlina gummifera* (L) Less. | Addad | Roots | Poultice | The roots macerated in water are used against vitiligo. | 94 | 0.261 | 100 | |
| Cistaceae | *Cistus ladanifer* L | Touzalt | Leaves | Poultice | Paste of leaves mixed with *Lawsonia inermis* L. is used to moisturize dry hair. | 19 | 0.052 | 100 | 0.052 |
| Cucurbitaceae | *Citrullus colocynthis* (L) *Schrad* | El-hdej | Fruit | Poultice | Paste of cooked fruit mixed with tar is used to cure eczema. | 22 | 0.061 | 100 | 0.133 |
| | *Cirtullus vulgaris* (L) Schrad | Dellah | Fruit | Crude | The water of watermelon is used to cure burns. | 74 | 0.205 | 100 | |
| Cupressaceae | *Tetraclinis articulata (Vahl) Masters* | El Ârâr | Leaves/ Roots | Poultice | Powder of leaves blended with Castor oil is applied to arrest hair fall. Roots are used as antifungal. Thick tar is used against eczema. | 98 | 0.272 | 54.1 | 0.272 |

| Family | Scientific name | Vernacular name | Part used | Preparation | Local medicinal uses | FC | RFC | FL | FUV |
|---|---|---|---|---|---|---|---|---|---|
| Fabaceae | *Ceratonia siliqua* L | Kharroub/ Tikida | Leaves/ Fruit | Crude/ Powder | Fresh leaf is applied externally on warts. Powder from fruit is applied externally in case of eczema. | 36 | 0.100 | 100 | 0.100 |
| Fagaceae | *Quercus suber* L | Dbagh/ Tûnwat/ El Ballût | Bark/ Fruit | Poultice | A paste made from a combination of powder and olive oil is applied externally for wounds. Paste of Powder mixed with the leaves of *Rosmarinus officinalis* L.is used to cure burns. | 37 | 0.103 | 64.8 | 0.103 |
| Juglandaceae | *Juglans regia* L | L-Gergaâ/ Sswak | Bark | Powder | Powder of barks is used against inflammatory dermatosis. | 68 | 0.189 | 100 | 0.189 |
| Lamiaceae | *Lavandula dentata* L | Lkhzama | Leaves | - | Its essential oil is applied to cure cracked heels. | 12 | 0.033 | 100 | 0.068 |
| Linaceae | *Marrubium vulgare* L | Merriwta/ Ferkizout | Leaves | Poultice | Fresh leaves are crushed to paste and applied externally in case of wounds. | 32 | 0.089 | 100 | 0.080 |
| | *Rosmarinus officinalis* L | Yazir | Leaves | Decoction | Decoction of fresh leaves is used to strengthen the hair. | 30 | 0.083 | 100 | |
| | *Linum usitatissimum* L | Zerri't El-Kettan | Seeds | Poultice | The seeds macerated in olive oil are used as a poultice to stimulate hair growth. | 29 | 0.080 | 100 | |
| Lythraceae | *Lawsonia inermis* L | El-henna | Leaves | Poultice | Powdered leaves mixed with crushed bulbs of *Allium cepa* L., and olive oil are used to treat burn scars. | 56 | 0.155 | 100 | 0.155 |
| Moraceae | *Ficus carica* L | Karmous | Fruit | Latex | Latex is applied externally to treat warts. | 21 | 0.058 | 100 | 0.058 |
| Musaceae | *Musa x paradisiaca* L | Banane | Fruit | Crude | Peels are recommended to cure warts. | 19 | 0.053 | 100 | 0.053 |
| Myrtaceae | *Myrtus communis* L | Rayhane | Leaves | Poultice | Fresh leaves, mixed with alum powder and tar of *Cedrus atlantica*, are applied externally against eczema. | 23 | 0.064 | 100 | 0.064 |
| Nitrariaceae | *Peganum harmala* L | L-Harmel | Seeds | Poultice | Combined with the seeds of *Lepidium sativum* and the leaves of *Tetraclinis articulata*, powdered and crushed in olive oil, are used to heal wounds. A mixture of powder and olive oil paste is used to enhance hair growth and make it shinier. | 64 | 0.178 | 67.1 | 0.178 |
| Oleaceae | *Olea europaea* L | Zitoun | Leaves | Powder | Powder from Leaves is applied externally in case of wounds. | 17 | 0.047 | 100 | 0.047 |
| Pinaceae | *Pinus pinaster* Aiton | Tayda/ Dbibigha | Bark | Powder | Powder of barks associated to *Lawsonia inermis* L. is used to cure burns. | 62 | 0.172 | 100 | 0.172 |

| Family | Scientific name | Vernacular name | Part used | Preparation | Local medicinal uses | FC | RFC | FL | FUV |
|---|---|---|---|---|---|---|---|---|---|
| Plantaginaceae | *Plantago major* L | El-messassa | Leaves | Crude | Fresh leaf is applied externally on boils. | 59 | 0.164 | 100 | 0.164 |
| Plumbaginaceae | *Plumbago europeae* L | Timrabdine | Leaves | Crude | Fresh leaves are applied externally on warts and alopecia. | 69 | 0.192 | 55.1 | 0.192 |
| Poaceae | *Hordeum vulgare* L | Ch'ir | Seeds | Poultice | Paste of powder mixed with rose water is applied against acne. | 12 | 0.033 | 100 | 0.036 |
| | *Triticum durum* Desf | Zraâ | Seeds | Poultice | Powder of *Triticum durum* and *Prunus amygdalus* stokes var. amara DC. mixed with honey is used to lighten the skin. | 21 | 0.058 | 100 | |
| Rhamnaceae | *Rhamnus alaternus* L | Tisknane | Bark | Poultice | Paste of powder mixed with milk is applied to cure burns. | 24 | 0.067 | 100 | 0.069 |
| | *Ziziphus lotus* (L.) Lam | Nnbeg/ Ssedra | Leaves | Crude | Fresh leaves are applied externally against eczema. | 26 | 0.072 | 100 | 0.042 |
| Rosaceae | *Prunus amygdalus* stokes var. amara DC | Luz Harr | Fruit | Poultice | The mixture of powder and olive oil paste is employed to moisturize the face, strengthen the hair, and thicken eyebrows. | 15 | 0.042 | 100 | |
| Solanaceae | *Capsicum annuum* L | Felflahlouwa / Tehmira | Fruit | Powder | Powder of fruits is used against burns and wounds. | 35 | 0.098 | 51.4 | 0.095 |
| | *Capsicum frutescens* L | Soudaniya | Fruit | Poultice | *Capsicum frutescens* L. and *Allium sativum* L. are crushed together and applied against Alopecia areata. | 41 | 0.114 | 100 | |
| | *Nicotiana tabacum* L | Tabac | Leaves | Powder | Powder from leaves is applied externally against skin disorders. | 47 | 0.130 | 100 | |
| | *Solanum elaeagnifolium* Cav | El-Âwssage | Leaves | Poultice | A blend of powder and water paste is utilized to heal eczema. | 20 | 0.055 | 100 | |
| | *Solanum nigrum* L | Bouqnini | Leaves | Crude | Fresh leaves are applied externally against eczema. | 29 | 0.080 | 100 | |
| Theacea | *Camellia thea* Link | Atây | Leaves | Powder | Paste of powder mixed with honey is applied externally to cure burns and wounds. | 37 | 0.103 | 64.8 | 0.103 |
| Thymelaeaceae | *Daphne gnidium* L | Lezzâz | Leaves | Poultice | Powder of leaves blended with Castor oil is applied to arrest hair fall. | 48 | 0.133 | 100 | 0.133 |
| Verbenaceae | *Verbena officinalis* L | Baymout | Leaves | Poultice, powder, squash | Leaves associated to *Mentha rotundifolia*Ehrh.are crushed to paste and then applied externally to cure wounds. Combined with *Cynara humilis* L., *Camellia thea* Link. and the chicken bone in powder are used against burns. Crushed leaf is applied to cure foot corn. | 99 | 0.275 | 44.4 | 0.275 |
| Zygophyllaceae | *Zygopgyllumgaetulum* | El-Aggaya | Seeds | Powder | Powder of seeds blended with olive oil is applied against acne | 12 | 0.033 | 100 | 0.036 |

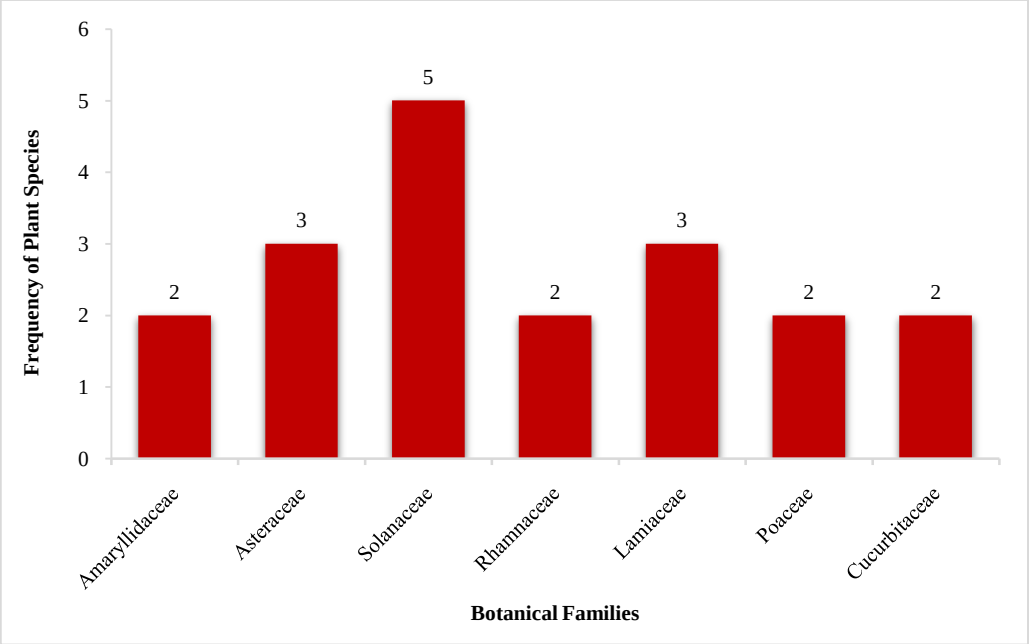


Figure 2 shows the prevalence of plant families that effectively treat skin disorders. Only families with more than one species are shown

### 3.2.2 Spectrum of medicinal flora and their RCF values

The study calculated each plant species' Relative Frequency of Citation (RFC) to determine their local importance. The RFC values ranged between 0.033 and 0.302. The highest RFC value was recorded for *A. sativum* (0.302), followed by *E. resinifera* Berg. (RFC=0.292) and *V. officinalis* L. (RFC=0.272). On the other hand, the lowest RFC values (RFC=0.033 each) were found for three plant species, namely *Chamaerops humilis* L., *Lavandula dentata* L., and *Hordeum vulgare*. These plants were cited by a significant number of informants, indicating their high RFC. Further analysis through phytochemical and pharmaceutical research is required to explore the active constituents of these plant species, which could be utilized for drug extraction (Vitalini et al. 2013). The study also highlights the importance of conservation initiatives for these plant species, as their prevalent use may pose a threat of overharvesting and endanger their populations.

### 3.2.3 Fidelity Level Index (FL)

Data assessment revealed that the FL value ranged from 40.9% to 100%. Among the collected plant species, 35 demonstrated an FL value of 100%. These plant species are used for managing inflammatory skin disorders and are distributed among 16 species, including *Aizoon canariense* L., *Chamaerops humilis* L., *Artemisia herba-alba* Asso., *Citrullus colocynthis* (L.) Schrad., *Ceratonia siliqua* L., and *Juglans regia* L. Four other species, namely *Allium cepa* L., *Lawsonia inermis* L., *Pinus pinaster* Aiton, and *Rhamnus alaternus* L., are used for treating burns, while three species, namely *Ammi majus* L., *Anacyclus pyrethrum* L., and *Carlina gummifera* (L.) Less are used for treating vitiligo. Additionally, *Pistacia atlantica* Desf., *Marrubium vulgare* L., and *Olea europaea* L. are used for treating wounds. During the survey, the use of *Agave americana* L. in treating skin cancer and *Capsicum frutescens* L. in treating alopecia was also recorded (Table 2). These findings can be attributed to these plant species' medicinal usefulness and indigenous value. The lowest FL value was noted for *Euphorbia resinifera* Berg., which could be because the populace widely utilizes it due to its numerous therapeutic effects. This species is exclusive to Morocco. Many researchers have documented the pharmacological activity of *Euphorbia resinifera* extracts, including antioxidant (Boutoub et al. 2020; Benrahou et al. 2022), antitumoral (Talbaoui et al. 2020; Hmidouche et al. 2023), antibacterial (Moujanni et al. 2017; Talbaoui et al. 2020; Benjamaa et al. 2020), and antifungal activities (Ourhzif et al. 2022).

### 3.2.4 Categories of diseases and their ICF values

The research has identified seven categories of diseases: inflammatory skin diseases, wounds, burns, vitiligo, scalp disorders, skin cancer, and cosmetic care. The ICF values range from 0.963 to 0.991. The categories with high ICF values are skin cancer (0.991), vitiligo (0.988), burns (0.976), scalp disorders (0.975), inflammatory skin diseases (0.972), cosmetic care (0.968), and wounds (0.963) (Table 3). This indicates that the traditional utilization of medicinal plants is reliably known among respondents (Lin et al. 2002). Furthermore, it shows that there is widespread sharing of traditional insights into managing skin diseases and alleviating chemotherapy side effects in skin cancer cases among people within the study area.

Table 3 Ethnobotanical ICF values by skin disease category

| Category | Plant species used and number of citations | Total number of | | |
|---|---|---|---|---|
| | | Species | Use citations | ICF |
| Inflammatory skin diseases (warts, eczema, acne, pimples, boils) | *Allium sativum* L. (80), *Aizoon canariense* L. (23), *Nerium oleander* L. (32), *Citrullus colocynthis* (L.) Schrad. (22), *Tetraclinis articulata (Vahl) Masters.* (45), *Euphorbia resinifera Berg.* (43), *Ceratonia siliqua* L. (36), *Myrtus communis* L. (23), *Ziziphus lotus* (L.) Lam. (26), *Solanum elaeagnifolium* Cav. (20), *Solanum nigrum* L. (29), *Quercus suber* L. (22), *Verbena officinalis* L. (62), *Chamaerops humilis* L. (12), *Ficus carica* L. (21), *Musa x paradisiaca*L. (19), *Plumbago europeae* L. (38), *Artemisia herba-alba* Asso. (39), *Juglans regia* L. (68), *Lavandula dentata L. (12)*, *Plantago major* L. (59), *Hordeum vulgare* L. (12), *Nicotiana tabacum* L. (47), *Verbena officinalis* L. (25) | 24 | 815 | 0.972 |
| Wounds | *Pistacia atlantica* Desf. (22), *Quercus suber* L. (24), *Marrubium vulgare* L. (32), *Peganum harmala* L. (21), *Olea europaea* L. (17), *Capsicum annuum* L. (17), *Camellia thea* Link. (13), *Verbena officinalis* L. (44). | 8 | 190 | 0.963 |
| Burns | *Allium cepa* L. (51), *Nerium oleander* L. (23), *Cirtullus vulgaris* (L.) Schrad. (74), *Quercus suber* L. (13), *Lawsonia inermis* L. (56), *Pinus pinaster* Aiton. (62), *Rhamnus alaternus* L. (24), *Capsicum annuum* L. (18), *Camellia thea*Link. (24), *Verbena officinalis* L. (30). | 10 | 378 | 0.976 |
| Cosmetic care | *Cistus ladanifer* L. (19), *Linum usitatissimum* L. (29), *Peganum harmala* L. (43), *Triticum durum* Desf. (21), *Prunus amygdalus* stokes var. amara DC. (15). | 5 | 127 | 0.968 |
| Vitiligo | *Ammi majus* L. (89), *Anacyclus pyrethrum* L. (42), *Carlina gummifera* (L.) Less. (94), *Euphorbia resinifera* Berg. (32) | 4 | 257 | 0.988 |
| Scalp disorders | *Allium sativum* L. (29), *Nerium oleander* L. (22), *Euphorbia resinifera* Berg. (30), *Plumbago europeae* L. (31), *Capsicum frutescens* L. (41), *Tetraclinis articulata* (Vahl.) Masters. (53), *Rosmarinus officinalis* L. (30), *Daphne gnidium* L. (48) | 8 | 284 | 0.975 |
| Skin cancer | *Agave americana* L. (79), *Euphorbia resinifera* Berg. (31) | 2 | 110 | 0.991 |

### 3.3 Plant parts used in remedy formulation

According to the survey, people living in the Western Middle Atlas region use different parts of medicinal plants to cure ailments. The most commonly used parts are leaves (PPV=0.476), followed by fruits (PPV = 0.122), barks (PPV = 0.108), seeds (0.105), roots (PPV= 0.084), and bulbs (0.078) (Figure 3). The reason for the preference for leaves is their easy availability, simple preparation, and the fact that they contain secondary metabolites responsible for the plant's bio-properties. Leaves are also important for photosynthesis. Similar findings have been observed in studies conducted in Morocco (El Azzouzi et al. 2018; Chaachouay et al. 2023; Idm'hand et al. 2023) and across Africa (Yetein et al. 2013; Etienne et al. 2021; Falana et al. 2023) where leaves are the primary part of the plant used for preparing herbal remedies.

### 3.4 Cure preparations practices

Various preparation methods, such as infusion, decoction, cataplasm, powder, and maceration, are used to enhance the ease of administration of the active compounds in plants. Details about the modes of preparation for each plant have been integrated into Table 2. The study found that the majority of cures were prepared through poultice (51%), followed by powder (27%) and crude (13%). The combined percentage of other preparation methods did not exceed 9% (Figure 4). Numerous ethnobotanical surveys have documented diverse methods of preparing medicinal plants for treating skin disorders, including powders, pastes, and decoctions (Begum and Nath 2000; Malik et al. 2019; Chaachouay et al. 2022). The most widely used method of preparation among patients in this study was the poultice, which could be attributed to its convenient preparation method for treating skin ailments. This finding aligns with the results of a prior study conducted by Saising et al. (2022).

### 3.5 Origin of information regarding medicinal plants

During the ethnobotanical survey, 69% of the interviewees stated that they relied on the advice and experiences of their immediate surroundings to obtain knowledge about the healing properties of plants. This highlights the importance of the intergenerational transfer of folk practices. A smaller percentage (23%) obtained knowledge from herbalists, while 7% gained information through personal experiences. Only 1% sought information from doctors. The surroundings and shared experiences of others remain the primary influential channels for conveying information about the healing properties of plants. Therefore, it is important to consider the curative power of plants not just as a tradition but as a field of science that should be studied and improved to be applied safely and effectively by healthcare professionals.

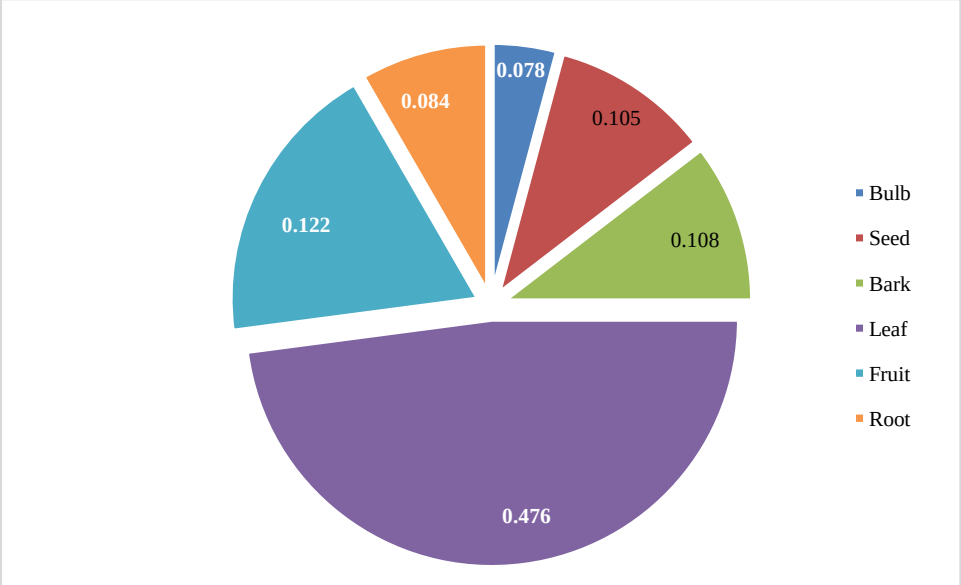


Figure 3 Parts used in the skin disease treatment (PPV index)

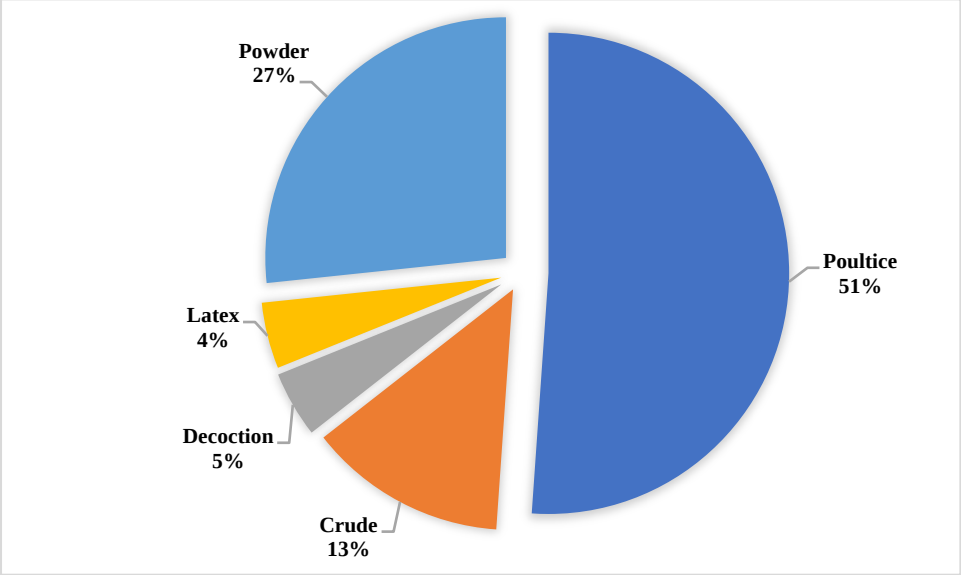


Figure 4 Incidence of different types of medicines used for treating skin disorders

## Conclusion

This study documents the use of traditional medicinal plants by the people of the Western Middle Atlas region for treating various skin diseases. The research identified 45 plant species from 33 families, with Solanaceae, Lamiaceae, and Asteraceae being the most commonly used. *Allium sativum* L. (RFC = 0.302) and *Euphorbia resinifera* Berg were the plants with the highest citation rates. (RFC = 0.292), and *Verbena officinalis* L. (0.275). The most commonly used part of the plant was the foliage (PPV of 0.476), and the most frequently used preparation method was a poultice (51%). The majority (69%) of the informants learned about the medicinal use of plants for skin diseases through the experiences of others. This study highlights the importance of utilizing Moroccan natural resources and traditional knowledge. The findings can serve as a foundation for future studies on the listed plants' biological and phytochemical properties to manage skin diseases.

## Acknowledgments

We are indebted to all the habitats of our study area for their help during the ethnobotany field surveys. Please accept our sincere thanks and gratitude to all those who helped in our work.

**Conflict of interest**

No financial or competing interests were disclosed by the authors.

**References**

Achour, S., Chebaibi, M., Essabouni, H., Bourhia, M., Ouahmane, L., et al. (2022). Ethnobotanical study of medicinal plants used as therapeutic agents to manage diseases of humans. *Evidence-Based Complementary and Alternative Medicine*, *2022*. DOI: https://doi.org/10.1155/2022/4104772.

Ajjoun, M., Kharchoufa, L., Merrouni, I. A., & Elachouri, M. (2022). Moroccan medicinal plants traditionally used for the treatment of skin diseases: from ethnobotany to clinical trials. *Journal of Ethnopharmacology*, *297*, 115532. DOI: 10.1016/j.jep.2022.115532.

Alexiades, M. N., & Sheldon, J.W. (1996). Selected Guidelines for ethnobotanical research: A field Manual. The New York Botanical Garden, Bronx. NY 99-133.

Anyinam, C. (1995). Ecology and ethnomedicine: exploring links between current environmental crisis and indigenous medical practices. *Social science & medicine*, *40*(3), 321-329. DOI: https://doi.org/10.1016/1277-9536(94)E0098-D.

Begum, D., & Nath, S. C. (2000). Ethnobotanical review of medicinal plants used for skin diseases and related problems in Northeastern India. *Journal of herbs, spices & Medicinal plants*, *7*(3), 55-93. DOI : https://doi.org/10/1300/J044v07n03_07.

Bellakhdar, J. (1997). La pharmacopée marocaine traditionnelle. Médecine arabe ancienne et Savoirs populaires. Editions Le Fennec, Casablanca/ Ibis Press. 764 p. Paris.

Bellakhdar, J. (2006). Plantes médicinales au Maghreb et soins de base: précis de phytothérapie moderne. Éditions le Fennec.

Benjamaa, R., Moujanni, A., Terrab, A., Eddoha, R., Benbachir, M., et al. (2020). Relationship among antibiotic residues and antibacterial activity of the endemic spurge honey (*Euphorbia resinifera* O. Berg) from Morocco. *Emirates Journal of Food and Agriculture*, *32*(11), 795-807. DOI: 10.9755/ejfa.2020.V32.i11.2190.

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 Botanica Barcinonensia*, *53*, 191-216.

Benlamdini, N., Elhafian, M., Rochdi, A., & Zidane, L. (2014). Etude floristique et ethnobotanique de la flore médicinale du Haut Atlas oriental (*Haute Moulouya). Journal of applied biosciences*, *78*, 6771-6787. DOI: 10.4314/jab.v78i0.17.

Benrahou, K., El Guourrami, O., Mrabti, H. N., Cherrah, Y., & Faouzi, M. E. A. (2022). Investigation of antioxidant, hypoglycemic and anti-obesity effects of Euphorbia Resinifera L. *Journal of Pharmacopuncture*, *25*(3), 242. DOI: 10.3831/KPl.2022.25.3.242.

Bentabet, N., Rajaa, R., & Sakina, N. (2022). Enquête ethnobotanique et inventaire des plantes médicinales utilisées dans le traitement des maladies dermatologiques dans la ville d'Ain Temouchent. *Journal of Applied Biosciences*, *170*(1), 17704-17719.

Bounoua, A., & Djoudi, Y. (2022). *Etude ethnobotanique, phytochimique et activités biologiques de l'extrait méthanolique d'une plante médicinale* (Master dissertation).

Boutoub, O., El-Guendouz, S., Estevinho, L. M., Paula, V. B., et al. (2020). Antioxidant activity and enzyme inhibitory potential of *Euphorbia resinifera* and *E. officinarum* honeys from Morocco and plant aqueous extracts. *Environmental Science and Pollution Research*, *28*, 503-517. DOI: 10.1007/s11356-020-10489-6.

Bouzid, A., Chadli, R., & Bouzid, K. (2017). Étude ethnobotanique de la plante médicinale *Arbutus unedo* L. dans la région de Sidi Bel Abbés en Algérie occidentale. *Phytothérapie*, *15*(6), 373-378.DOI : 10.1007/s10298-016-1027-6.

Chaachouay, N., Benkhnigue, O., & Zidane, L. (2022). Ethnobotanical and Ethnomedicinal study of medicinal and aromatic plants used against dermatological diseases by the people of Rif, Morocco. *Journal of Herbal Medicine*, *32*, 100542. DOI :https://doi.org/10.1016/j.hermed.2022.100542.

Chaachouay, N., Belhaj, S., El Khomsi, M., Benkhnigue, O., & Zidane, L. (2023). Herbal remedies used to treat digestive system ailments by indigenous communities in the Rif region of northern Morocco. *Vegetos*, 1-18. DOI: https://doi.org/10.1007/s42535-023-00606-4.

Direction Régionale de Beni Mellal-Khenifra. (2019). Monographie Régionale sur le secteur de l'Habitat et de la Politique de la ville au niveau de la Région de Beni Mellal-Khenifra. Pp. 87.

El Azzouzi, F., Asserar, N.,Zaouai, F., Benkhnigue, O., Hachi, M., & Zidane, L. (2018). Ethnomedicinal evaluation of medicinal plants used against gastrointestinal disorders in the western middle atlas region (Morocco). *Annual Research & Review in Biology*, 1-11. DOI: 10.9734/ARRB/2018/43599.

El Hafian, M., Benlandini, N., Elyacoubi, H., Zidane, L., & Rochdi, A. (2014). Etude floristique et ethnobotanique des plantes médicinales utilisées au niveau de la préfecture d'Agadir-Ida-

Outanane (Maroc). *Journal of Applied Biosciences*, *81*(2014), 7198-7213.

El Hilah, F., Ben Akka, F., Dahmani, J., Belahbib, N., et al. (2015).Etude ethnobotanique des plantes médicinales utilisées dans le traitement des infections du système respiratoire dans le plateau central marocain. *Journal of Animal & Plant Sciences*, *25*(2), 3886-3897.

Erarslan, Z. B., Ecevit-Genç, G., & Kültür, Ş. (2020). Medicinal plants traditionally used to treat skin diseases in Turkey–eczema, psoriasis, vitiligo. *Journal of Faculty of Pharmacy of Ankara University*, *44*(1), 137-166. DOI: https://doi.org/10.33483/jfpau.586114.

Etienne, O. K., Dabé, D. O. G. A., Bernadine, O. B. A. M., & Noël, Z. G. (2021). Plantes médicinales utilisées dans le traitement des maladies microbiennes dans la région du hambol, nord de la Côte d'Ivoire. *Journal of Animal & Plant Sciences*, *47*(1), 8412-8425.DOI :https://doi.org/10.35759/JAnmPlSci.v47-1.6.

Falana, M. B., Nurudeen, Q. O., Salimon, S. S., & Abubakar, I. B. (2023). Ethnopharmacological Survey of Medicinal Plants Used in the Management of Skin-Related Conditions in Ilorin, North-Central, Nigeria. *Traditional and Integrative Medicine*, *8*(1), 56-76. DOI: https://doi.org/10.18502/tim.v8i1.12404.

Fennane, M., Tattou, M. I., Mathez, J., Ouyahya, A., et al. (1999). Flore pratique du Maroc: manuel de détermination des plantes vasculaires. Volume 1 : Pteridophyta, *Gymnospermae*, *Angiospermae* (*Lauraceae-Neuradaceae*). Travaux de l'Institut Scientifique, série botanique, 36, Rabat, pp. 588.

Fennane, M., Ibn Tattou, M., Outahya, A., & El Oualidi, J. (2007). Flore pratique du Maroc, manuel de détermination des plantes vasculaires. Volume 2 : Angiosperme (Leguminsoseae-Lentibulariaceae). Travaux de l'Institut Scientifique, série botanique, 36, Rabat, pp. 636.

Fennane, M., Ibn Tattou, M., & El Oualidi, J. (2014). Flore pratique du Maroc, Manuel de détermination des plantes vasculaires. Volume 3 : (Leguminsoseae-Lentibulariaceae). Travaux de l'Institut Scientifique, série botanique, N°40, Rabat, 794p.

Fennane, M., & Rejdali, M. (2018). Moroccan vascular plant Red Data Book: A basic tool for plant conservation. *Flora Mediterranea*, *28*(1), 339-350. DOI : 10.7320/FlMedit28.339.

Gomez-Beloz, A. (2002). Plant use knowledge of the WinikinaWarao: the case for questionnaires in ethnobotany. *Economic Botany*, *56*(3), 231-241.

Grenez, E. P. (2019). Phytothérapie-exemples de pathologies courantes à l'officine: Fatigue, Insomnie, Stress, Constipation, Rhume, Douleur et Inflammation. Mémoire de diplôme de docteur en pharmacie. Université de Lille Faculté de Pharmacie de Lille.

Haut-Commissariat au plan. (2017).MonographieRégionale Beni Mellal-Khenifra, pp. 221.

Heinrich, M., Ankli, A., Frei, B., Weimann, C., & Sticher, O. (1998). Medicinal plants in Mexico: Healers' consensus and cultural importance. *Social Science & Medicine*, *47*(11), 1859-1871.

Hmamouchi, M. (2001). Les plantes médicinales et aromatiques marocaines. 2ème Edition. Impri Fédala (Mohammadia), pp. 108-109.

Hmidouche, O., Bouftini, K., Chafik, A., Khouri, S., Rchid, H., Rahimi, A., et al. (2023). Ethnomedicinal Use, Phytochemistry, Pharmacology, and Toxicology of Euphorbia resinifera O. Berg.(B): A Review. *Journal of Zoological and Botanical Gardens*, *4*(2), 364-395. DOI: https://doi.org/10.3390/jzbg4020029.

Idm'hand, E., Msanda, F., & Cherifi, K. (2023). Medicinal plants used for gastrointestinal disorders in Morocco. *Ethnobotany Research and Applications*, *26*(1), 1-29. DOI: http://dx.doi.org/10.32859/era.26.70.1-29

Khenissi, I., & Rouabhia, C. (2021). Etude ethnobotanique des plantes médicinales dans quelques communes de Tébessa (Master dissertation, Universite Laarbi Tebessi Tebessa).

Lahsissene, H., Kahouadji, A., & Hseini, S. (2009). Catalogue des plantes médicinales utilisées dans la région de Zaër (Maroc Occidental). Lejeunia, revue de botanique.

Lin, J., Puckree, T., & Mvelase, T. P. (2002). Anti-diarrheal evaluation of some medicinal plants used by Zulu traditional healers. *Journal of Ethnopharmacology*, *79*(1), 53-56. DOI: 10.1016/s0378-8741(01)00353-1.

Makgobole, M. U., Mpofana, N., & Ajao, A. A. N. (2023). Medicinal Plants for Dermatological Diseases: Ethnopharmacological Significance of Botanicals from West Africa in Skin Care. *Cosmetics*, *10*(6), 167. DOI : https://doi.org/10.3390/cosmetics10060167

Malik, K., Ahmad, M., Zafar, M., Ullah, R., et al. (2019). An ethnobotanical study of medicinal plants used to treat skin diseases in northern Pakistan. *BMC Complementary and Alternative Medicine*, *19*(1), 1-38. DOI: https://doi.org/10.1186/s12906-019-2605-6.

Moujanni, A., Partida, L., Essamadi, A. K., Hernanz, D., et al. (2017). Physicochemical characterization of unique unifloral honey: Euphorbia resinifera. *CyTA-Journal of Food*, *16*(1), 27-35. DOI: 10.1080/19476337.2017.1333529.

Nasab, F. K., Zare, M., Mehrabian, A., & Ghotbi-Ravandi, A. A. (2022). Ethnopharmacological survey of medicinal plants used to treat skin diseases among herbal shops in Jahrom, Iran. *Collectanea Botanica*, *41*, e001. DOI : 10.3989/collectbot.2022.v41.001.

Orion, E., & Wolf, R. (2014).Psychologic consequences of facial dermatoses. *Clinics in Dermatology*, *32*(6) :767-71. DOI: https://doi.org/10.1016/j.clindermatol.2014.02.016.

Ourhzif, E. M., Ricelli, A., Stagni, V., Cirigliano, A., Rinaldi, T., et al. (2022). Antifungal and Cytotoxic Activity of Diterpenes and Bisnorses quiterpenoides from the Latex of *Euphorbia resinifera* Berg. *Molecules*, *27*(16), 5234. DOI: https://doi.org/10.3390/ molecules27165234.

Saising, J., Maneenoon, K., Sakulkeo, O., Limsuwan, S., et al. (2022). Ethnomedicinal Plants in Herbal Remedies Used for Treatment of Skin Diseases by Traditional Healers in Songkhla Province, Thailand. *Plants*, *11*(7), 880.DOI: 10.3390/ plants11070880.

Salhi, S., Fadli, M., Zidane, L., & Douira, A. (2010). Floristic and ethnobotanical study of medicinal plants of Kénitra (Maroc). *Lazaroa*, *31*(1), 133-146.

Sasi Priya, S. (2020). Maeruaoblongifolia–What do we really know? Overview, Progress and Perspectives. *Journal of Peer Scientist*, *2*(1), e1000012.

Spichiger, R. E., Savolainen, V. V., Figeat, M., & Jeanmonod, D. (2002). Botanique systématique des plantes à fleurs. Presses Polytechniques et Universitaires Romandes. Francia.

Stambouli, O. B. (2018). La maladie dermatophytique : Une affection immunogénétique. *Revue Françaised' Allergologie*, *58*(3), 254.

Sreekeesoon, D. P., & Mahomoodally, M. F. (2014). Ethnopharmacological analysis of medicinal plants and animals used in the treatment and management of pain in Mauritius. *Journal of Ethnopharmacology*, *157*, 181-200.DOI: 10.1016/j.jep.2014.09.030.

Taïbi, A. N., El Khalki, Y., & El Hannani, M. (2015). Atlas régional de la région du Tadla-Azilal. Maroc, Université d'Angers (France) et Université du Sultan Moulay Slimane Béni Mellal.

Talbaoui, A., El Hamdaoui, L., Bouyahya, A., El Moussaouiti, M., et al. (2020). Chemical composition, in vitro cytotoxic, and antibacterial activities of Moroccan medicinal plants *Euphorbia resinifera* and *Marrubium vulgare*. *Biointerface Research in Applied Chemistry*, *10*(6), 7343-7355. DOI: 10.33263/ BARIAC106.73437355.

Tardío, J., & Pardo-de-Santayana, M. (2008). Cultural importance indices: a comparative analysis based on the useful wild plants of Southern Cantabria (Northern Spain). *Economic Botany*, *62*, 24-39.DOI : 10.1007/s12231-007-9004-5.

Tsioutsiou, E. E., Amountzias, V., Vontzalidou, A., Dina, E., Stevanović, Z. D., Cheilari, A., & Aligiannis, N. (2022). Medicinal Plants Used Traditionally for Skin Related Problems in the South Balkan and East Mediterranean Region—A Review. *Frontiers in Pharmacology*, *13*, 936047. DOI: https://doi.org/10.3389/ fphar.2022.936047.

Vitalini, S., Iriti, M., Puricelli, C., Ciuchi, D., et al. (2013). Traditional knowledge on medicinal and food plants used in Val San Giacomo (Sondrio, Italy)—An alpine ethnobotanical study. *Journal of Ethnopharmacology*, *145*(2), 517-529.DOI : 10.1016/j.jep.2012.11.024.

World Health Organization. (2019). WHO global report on traditional and complementary medicine.

Yetein, M. H., Houessou, L. G., Lougbégnon, T. O., Teka, O., et al. (2013). Ethnobotanical study of medicinal plants used for the treatment of malaria in plateau of Allada, Benin (West Africa). *Journal of Ethnopharmacology*, *146*(1), 154-163. DOI: https://doi.org/10.1016/j.jep.2012.12.022.