TRADITIONAL AND INTEGRATIVE MEDICINE

Trad Integr Med, Volume 10, Issue 1, Winter 2025

Original Research

Ethnobotanical Research on Medicinal Plants Used for Respiratory Diseases: Results of a Survey in Fez, Morocco

Mikou Karima*

Laboratory of Functional Ecology and Environment Engineering, Faculty of Science and Technology, University Sidi Mohammed Ben Abdellah, Fez, Morocco

Received: 24 Aug 2024 **Revised:** 31 Dec 2024 **Accepted:** 14 Jan 2025

Abstract

This work reports the results of an ethnobotanical survey conducted among the inhabitants of Fez, Morocco, on the traditional use of medicinal and aromatic plants in the treatment of respiratory system diseases. The respiratory conditions treated, in descending order of citation, are flu, bronchitis, cold, cough, pharyngitis, and asthma. Thirty-seven species grouped into 20 families were cited as effective for treating these various conditions. The Lamiaceae family, represented by 10 species, is the most frequently cited family. For treating flu, *Matricaria chamomilla* is the most commonly used; for colds, *Zingiber officinale* and *Crocus sativus* seem to be the most effective; for treating bronchitis, *Eucalyptus globulus* is the most commonly used; for pharyngitis and cough, *Origanum vulgare* is the most significant. Meanwhile, for asthma, *Linum usitatissimum* and *Iris germanica* are the most effective. Principal Component Analysis (PCA) shows that these diseases form two groups: one composed of flu, bronchitis, and cold; and the other composed of asthma, pharyngitis, and cough. The plants associated with the first group are *Salvia rosmarinus*, *Sambucus nigra*, *Thymus vulgaris*, and *Matricaria chamomilla*; while the plants associated with the second group of diseases, represented by asthma, pharyngitis, and cough, are *Glycyrrhiza glabra*, *Allium cepa, Origanum vulgare, Salvia officinalis*, *Linum usitatissimum*, and *Iris germanica*.

Keywords: Ethnobotanical survey; Traditional medicine; Medicinal and aromatic plants; Respiratory diseases; Fez

http://doi.org/10.18502/tim.v10i1.18223

Citation: Karima M. **Ethnobotanical Research on Medicinal Plants Used for Respiratory Diseases: Results of a Survey in Fez, Morocco.** Trad Integr Med 2025;10(1):48-58. http://doi.org/10.18502/tim.v10i1.18223

*Corresponding Author: Mikou Karima
Laboratory of Functional Ecology and Environment Engineering, Faculty of Science and Technology, University Sidi Mohammed Ben Abdellah, Fez, Morocco
Email: Karima.mikou@usmba.ac.ma

Introduction

Medicinal and aromatic plants remain a source of medicinal care, particularly in developing countries [1]. In Morocco, previous studies [2,3,4,5,6] have shown that traditional plant-based medicine still holds a place in the healthcare system. Numerous biological properties, such as antioxidant, antiseptic, anti-inflammatory, and anti-allergic effects, are indeed attributed to plants. These various properties are primarily due to secondary metabolites with therapeutic value. Consequently, the exploration of the plant world is increasingly important in the search for active plant extracts or interesting molecules. In this context, traditional therapies and practices can be useful; they can guide us towards new sources of effective treatments. However, scientific evaluation of these traditional data is essential in the search for new information on the potential medicinal use of plants. For this purpose, partial and fragmented floristic and ethnobotanical studies have already been carried out in some regions of Morocco [7], aiming to gather information on ethnomedicinal knowledge and to highlight the role of phytotherapy in the healthcare system in these different regions. The multiplication of these ethnobotanical studies on a national scale will allow the collection of more information on Moroccan medicinal plants, enhance their value, and preserve certain knowledge acquired by the local population. In a previous work [6], we showed that seventy-five species grouped into 41 families were recorded to treat 34 diseases, among which those affecting the respiratory system. This article aims, through a survey of people who use plants for their medical care, to:

i. Compile a list of medicinal and aromatic plants used for the treatment of respiratory system-related pathologies. This objective involves creating an inventory of medicinal and aromatic plants commonly used by populations to treat respiratory diseases, including information on the different parts of the plant used and the types of respiratory pathologies they are believed to treat. This approach will highlight plants that are particularly popular in the study region, thereby enriching the database on traditional plant use. It will also open the door to more detailed studies, potentially leading to the discovery of effective and natural treatments for respiratory conditions, especially in areas where access to modern medical care is limited.

ii. Establish, for each pathology, the different medicinal plants used and, using statistical data analysis, identify the most frequently mentioned plants in the treatment of each respiratory pathology. This will allow researchers to focus their efforts on these plants in order to validate their effectiveness and study their mechanisms of action.

iii. Justify the use of certain plants through a bibliographic review of the available scientific data. This will support traditional practices by providing scientific validation for the medicinal properties of the plants used. It will enhance the credibility of alternative medicines and promote a more integrated approach between modern and traditional medicine.

iv. Open a research pathway on the most commonly used and effective plants in traditional medicine by focusing on the extraction and identification of metabolites (such as flavonoids, alkaloids, terpenoids, etc.) responsible for the plant's therapeutic effects. The study could reveal the pharmacological properties of these compounds, such as their anti-inflammatory, antimicrobial, antioxidant, or bronchodilator effects.

Materials and Methods

Information collection

The information on the use of medicinal plants for healthcare was collected from the inhabitants of the city of Fez over three years. The city of Fez is located in the center of the Sais plain in northern Morocco (Latitude: 33.9787, Longitude: -4.9823 33° 58′ 43″ North, 4° 58′ 56″ West).

Survey by Questionnaire

The survey was conducted with a sample of 500 randomly selected individuals, consisting of men and women aged between 20 and 70 years. The use of a random sampling technique ensured an equitable selection of participants. An initial closed questionnaire quantified the number of individuals using medicinal plants. A second questionnaire was administered to those individuals who reported using plants. This questionnaire was designed to gather information on the plants used for treating respiratory system-related pathologies, the treated disease, the plant used, the part of the plant, and the preparation method of the different medicinal plants.

The taxonomic identification of species was performed in the laboratory by botanists using reference books and plant catalogs [8,9].

Data analysis

To analyze the data collected during the survey, the software SPSS version 11 was used. It enabled the distinction of the diseases treated and the medicinal species used for each disease. Factorial analysis of the results grouped the plants based on the treated pathologies and the citation frequencies. The citation frequency was determined as follows:

Citation Frequency = [(Number of citations / Total number of citations) x 100].

In addition to factorial analysis, specific statistical tests such as chi-square tests were applied to examine associations between categorical variables; while correlation coefficients were used to assess the strength

and direction of the relationship between the frequency of plant use and the types of diseases treated.
The Principal Component Analysis (PCA) was performed using a data matrix with medicinal plants as rows and respiratory diseases as columns. Each cell in this matrix represents the frequency of association between a plant and a disease. The first two principal components, which explain the majority of the variance, were selected for interpretation.

Results

Respiratory pathologies and medicinal plants used

The various respiratory pathologies treated by medicinal plants by the surveyed population are shown in figure 1. The flu is the most cited, with a citation frequency of 31%. Asthma is the least cited disease, representing only 5% of all treated pathologies.
Table 1 lists the different medicinal species used for treating respiratory system-related pathologies. It also specifies the citation frequency of each species and the part of the plant used. Thirty-seven species grouped into 20 families were cited as effective in treating respiratory system disorders. Figure 2 indicates the importance of each plant family. The Lamiaceae family, represented by 10 species, is the most cited, followed by the Apiaceae family with 3 species. The Zingiberaceae, Asteraceae, Myrtaceae, Amaryllidaceae, and Iridaceae families are each represented by 2 species; while other families are cited with each represented by a single species.
Figure 3 illustrates the relationships between respiratory diseases and their respective uses within the framework of PCA. Axis F1 primarily groups diseases associated with plants frequently used for colds, flu, and bronchitis; while Axis F2 mainly groups diseases associated with asthma, pharyngitis, and cough.
The grouping of respiratory diseases treated by plants shows that these diseases form two homogeneous groups. One group consists of flu, bronchitis, and the common cold; the second group includes asthma, pharyngitis, and cough. Diseases that are close to each other on the graph likely share similar characteristics. Asthma, pharyngitis, and cough are close to each other, suggesting they may share certain symptoms or mechanisms. Flu and bronchitis are farther from the other points, indicating they have distinct characteristics compared to the other mentioned diseases.
These results demonstrate a clear segmentation in the use of medicinal plants, suggesting a specialization of certain plants for specific diseases.
Figure 4 provides information on the plants used to treat these different respiratory diseases. These figures show that for treating the flu, *Matricaria chamomilla* is most frequently used. *Zingiber officinale* appears to be more effective for treating the common cold; bronchitis is better treated by Eucalyptus; cough by *Cuminum cyminum* and *Allium cepa*; pharyngitis by *Glycyrrhiza glabra* and *Matricaria chamomilla;* and finally, *Iris germanica* and *Allium sativum* seem to be effective for treating asthma.
The grouping of plant species used in the treatment of respiratory disorders, established using PCA, is represented by figure 5, where it can be seen that the plants form four groups.
Figure 6 shows how the different medicinal plants are associated with the active variables, which are the respiratory diseases. It can be seen that cough, pharyngitis, and asthma are strongly correlated. The plants

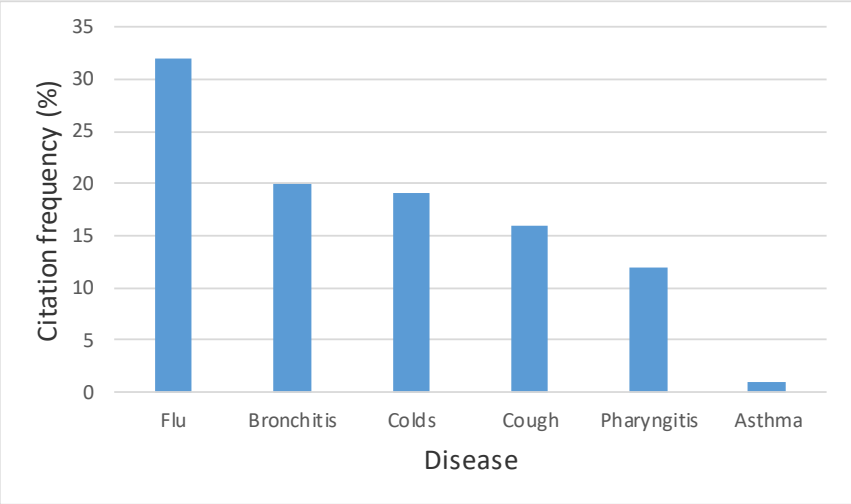


Figure 1. Citation frequency of respiratory diseases treated by medicinal plants

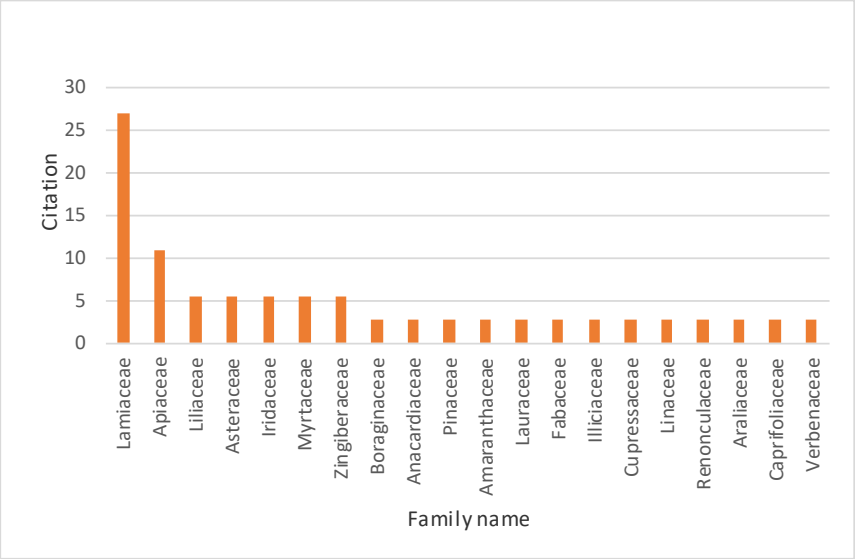


Figure 2. Families of plants cited for the treatment of respiratory diseases

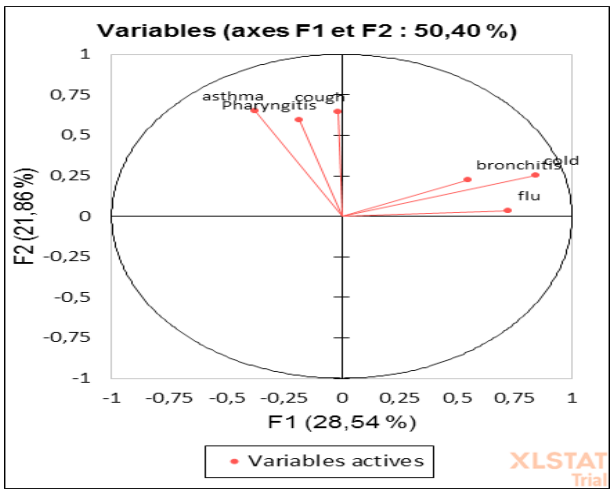


Figure 3. Respiratory disease groups

associated with this group are *Glycyrrhiza glabra*, *Allium cepa*, *Origanum vulgare*, *Salvia officinalis*, and *Linum usitatissimum*.

The plants associated with the group of diseases represented by bronchitis, flu, and the common cold include *Salvia rosmarinus*, *Sambucus nigra*, *Thymus vulgaris*, *Cuminum cyminum*, and *Matricaria chamomilla*.

Discussion

The study demonstrated that traditional phytotherapy persists, with numerous plants used to treat ailments related to the respiratory system. However, while the flu, bronchitis, the common cold, and cough show a relatively high citation frequency, asthma has the lowest frequency (0.91%). Asthma is a chronic inflammatory disease of the airways. It is a multifactorial syndrome whose expression depends on acquired factors often related to the environment. In regions with a dry climate, the prevalence of asthma is the lowest. The study area, Fez, located near the Middle Atlas inland and benefiting from a climate with significant temperature variations, may have a climate where the disease is not frequent.

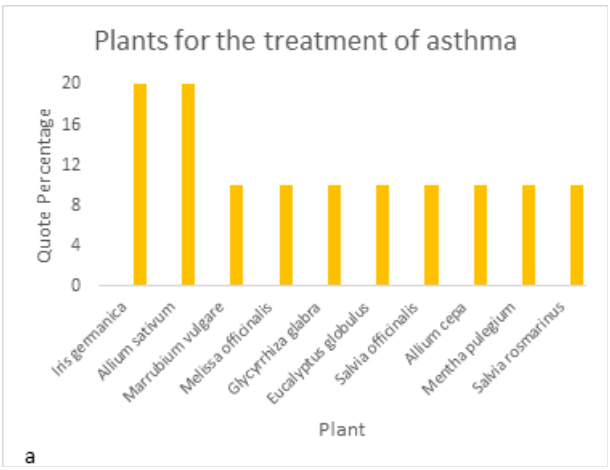
Nonetheless, some plants are cited as effective for treating asthma, such as *Glycyrrhiza glabra* and *Linum usitatissimum*, which are particularly rich in mucilage, the beneficial effect of which on the respiratory system has already been demonstrated [10].

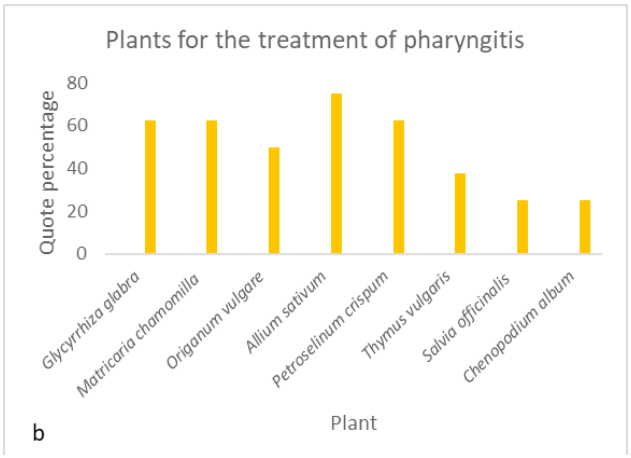
Used Species

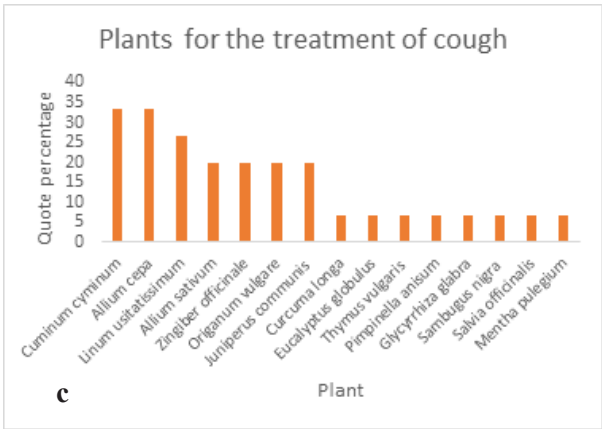
Regarding the species used by the inhabitants of Fez, they are grouped into 20 families, with the most cited being the Lamiaceae family. This family was also found to be the most cited for the treatment of digestive pathologies [6]. Many properties are attributed to the Lamiaceae, notably anti-inflammatory, antiviral, antibacterial, anti-allergic, and antioxidant properties [11,12,13,14]. These various properties are due to their chemically interesting constituents from a pharmacological point of view. These include tannins, coumarins, mucilage, flavonoids, and phenolic acids such as rosmarinic acid from oregano or thyme [15].

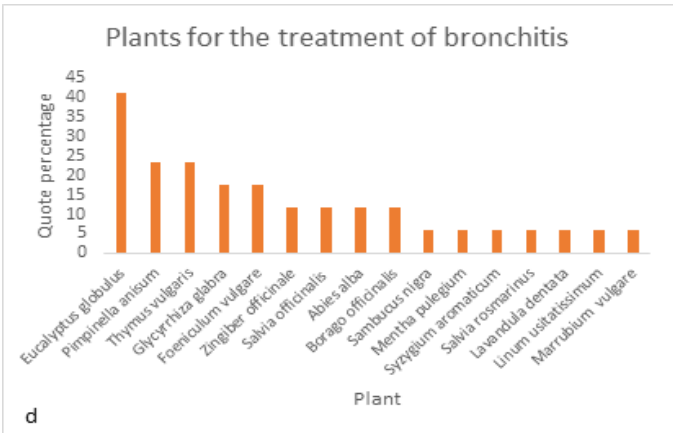
Additionally, this family is characterized by the presence of essential oils, which have found a significant place in therapeutics due to their wide range of biological activities [16,17,18,19]. Essential oils are natural antiseptics that are absorbed through the respiratory or digestive tract and increase the activity of the cilia of the bronchial mucosa cells; thus, facilitating the evacuation of bronchial mucus.

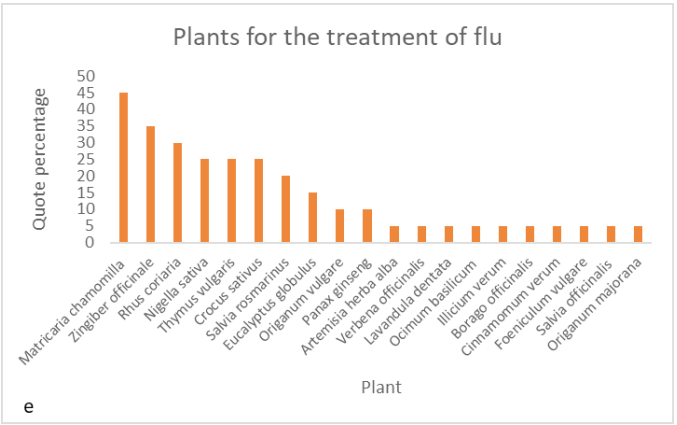
Chamomile (*Matricaria chamomilla*) is among the frequently used plants for treating respiratory diseases; it is particularly effective for treating flu and the











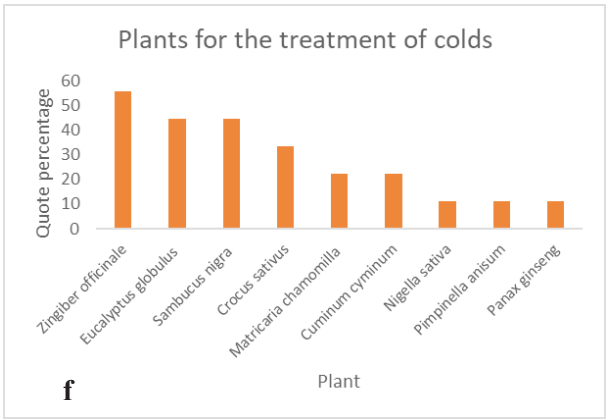


Figure 4. Plants cited for the treatment of asthma (a); pharyngitis (b); cough (c); bronchitis (d); flu (e) and colds (f)

Table 1. Plants for respiratory diseases

Plant Name	Family	Citation	Organ used	Method of preparation
Borago officinalis L.	Boraginaceae	2.70	Leaf, Flowering top	Infusion
Rhus coriaria L.	Anacardiaceae	16.21	Fruit	Infusion
Abies alba Mill.	Pinaceae	5.40	Leaf	Inhalation
Allium cepa L.	Liliaceae	16.21	Bulb	Infusion Juice
Allium sativum L.	Liliaceae	13.51	Bulb	Powder
Artemisia herba-alba Asso	Asteraceae	8.70	Leaf, Flowering top	Infusion, Decoction
Chenopodium album L.	Amaranthaceae	5.40	Leaf, Flowering top	Infusion
Cinnamomum verum J.Presl	Lauraceae	2.70	bark	Decoction
Crocus sativus L.	Iridaceae	21.62	Flower Stigmata	Infusion
Cuminum cyminum L.	Apiaceae	18.91	Graine	Infusion, Maceration
Curcuma longa L.	Zingibéraceae	2.70	Rhizome	Infusion
Eucalyptus globulus Labill.	Myrtaceae	43.24	Leaf	Infusion, Inhalation
Foeniculum vulgare Mill.	Apiaceae	10.81	Root, Stem, Leaf, Seed	Infusion
Glycyrrhiza glabra L.	Fabaceae	13.51	Rhizome	Decoction
Illicium verum Hook.f.	Illiciaceae	2.70	Fruit	Infusion
Iris germanica L.	Iridaceae	5.40	Rhizome	Infusion
Juniperus communis L.	Cupressaceae	8.10	Fruit	Infusion, Decoction,
Lavandula dentata L.	Lamiaceae	5.40	Leaf, Flowering top	Maceration, Infusion, Inhalation
Linum usitatissimum L.	Linaceae	13.51	seed	Infusion,
Marrubium vulgare L.	Lamiaceae	5.40	Leaf, Flowering top	Powder Decoction
Matricaria chamomilla L.	Asteraceae	29.72	Flower	Infusion Decoction
Melissa officinalis L.	Lamiaceae	2.70	Leaf	Infusion
Mentha pulegium L.	Lamiaceae	5.40	Leaf, Stem, Flowering top	Infusion
Nigella sativa L.	Renonculaceae	16.21	seed	Powder
Ocimum basilicum L.	Lamiaceae	2.70	Leaf	Infusion, Decoction
Origanum majorana L.	Lamiaceae	70.27	Stem, Flower Leaf	Infusion
Panax ginseng C.A.Mey.	Araliaceae	8.10	Flower Rhizome	Decoction, Powder
Pimpinella anisum L.	Apiaceae	16.21	Seed	Infusion, Maceration
Salvia officinalis L.	Lamiaceae	18.21	Leaf	Infusion, Decoction
Salvia rosmarinus Spenn.	Lamiaceae	16.21	Leaf, Flowering top	Infusion
Sambucus nigra L.	Caprifoliaceae	16.21	Flower	Infusion
Syzygium aromaticum (L.) Merr. & L.M.Perry	Myrtaceae	2.70	Flower buds	Powder
Thymus vulgaris L.	Lamiaceae	35.135	Flowering top	Infusion
Verbena officinalis L.	Verbenaceae	2.70	Leaf	Infusion
Zingiber officinale Roscoe	Zingiberaceae	45.94	Rhizome	Decoction, Powder
Origanum vulgare L.	Lamiaceae	13.51	Flowering top	Infusion
Petroselinum crispum (Mill.) Fuss	Apiaceae	13.51	Stem, Leaf	Decoction

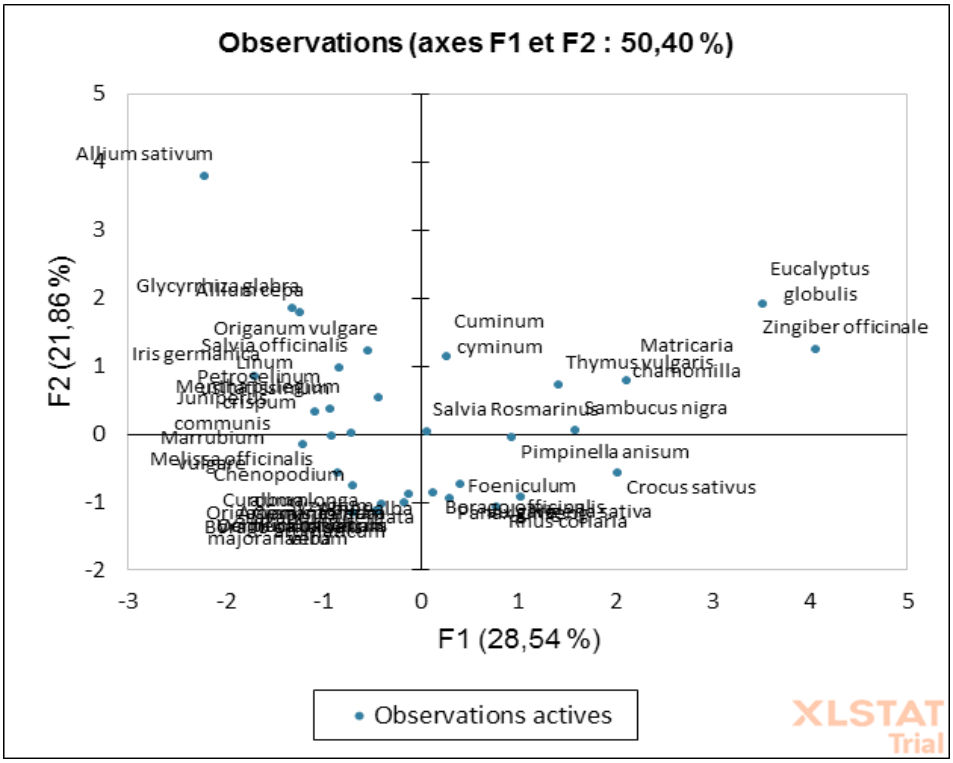


Figure 5. Groups of plants cited for the treatment of respiratory diseases

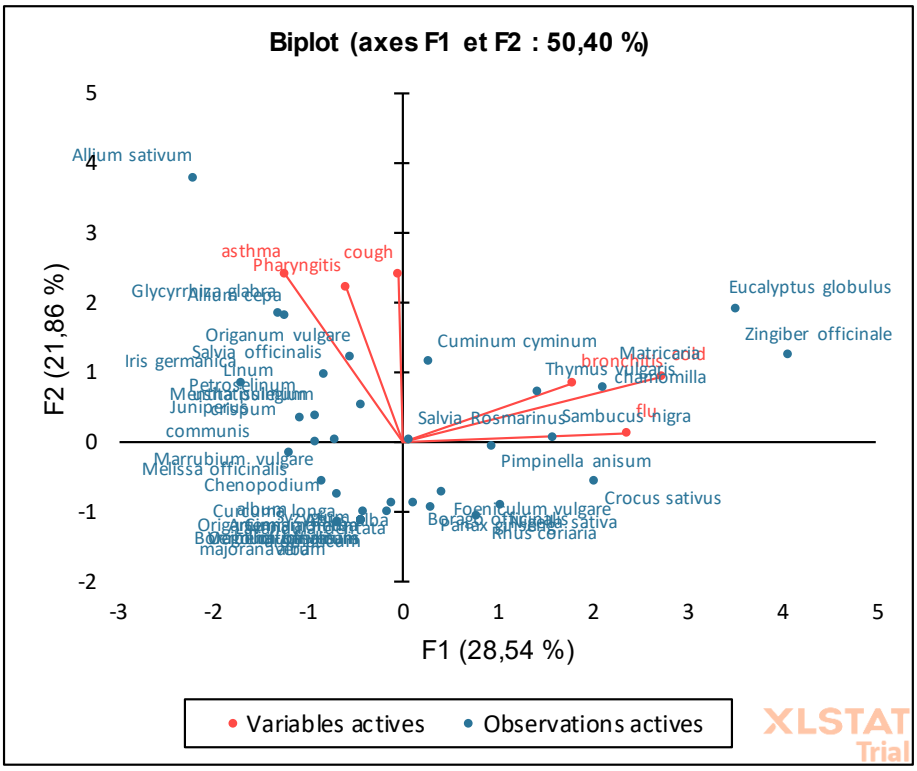


Figure 6. Relationships between different medicinal plants and respiratory diseases

Table 2. Groups of plants used for the treatment of respiratory diseases

Group 1	Group 2	Group 3	Group 4
Matricaria chamomilla	*Foeniculum vulgare*	*Allium cepa*	*Cinnamomum verum*
Eucalyptus globulus	*Nigella sativa*	*Allium sativum*	*Marrubium vulgare*
Zingiber officinale	*Crocus sativus*	*Glycyrrhiza glabra*	*Melissa officinalis*
Thymus vulgaris	*Rhus coriaria*	*Origanum vulgare*	*Illicium verum*
Sambucus nigra	*Pimpinella anisum*	*Salvia officinalis*	*Chenopodium album*
Cuminum cyminum	*Panax ginseng*	*Iris* x *germanica*	*Lavandula dentata*
Salvia rosmarinus		*Mentha pulegium*	*Abies alba*
		Juniperus communis	*Artemisia herba-alba*
		Petroselinum crispum	*Syzygium aromaticum*
		Linum usitatissimum	*Curcuma longa*
			Ocimum basilicum
			Verbena officinalis
			Origanum majorana
			Borago officinalis

common cold. Its numerous uses are consistent with its reported virtues in the literature. It is anti-inflammatory, healing, spasmolytic, anti-allergic [14], antibacterial, antifungal, calming, sleep-inducing, and antiemetic [20]. Additionally, it has been attributed anticancer properties due to the action of its apigenin [21]. Furthermore, chamomile's essential oils and extracts have shown interesting antioxidant, antibacterial, antifungal, anticancer, antidiabetic, antiparasitic, anti-inflammatory, antidepressant, antipyretic, anti-allergic, and analgesic activities [22].

Garlic (*Allium sativum*) is also frequently used. The numerous beneficial effects of this plant have already been enumerated [11]. Its main interest lies in its antiseptic and antiviral properties, as well as its antihypertensive and lipid-lowering effects [23]. The various virtues of garlic are attributed to its active compounds, including allicin, which has immunostimulant properties [24], and selenium, which has demonstrated antioxidant power [25,26]. Moreover, hydrogen sulfide (H2S), which characterizes garlic, has been recognized as a gaseous signaling molecule similar to nitric oxide and carbon monoxide; it also has beneficial health effects [27].

For *Salvia rosmarinus* and *Salvia officinalis*, studies have shown that these two plants are important sources of phytochemicals with significant pharmacological potential [28]. As for oregano (*Origanum vulgare*), its effectiveness is well demonstrated. Grondona et al. (2014) [29] have shown that this plant exhibits antibacterial, antioxidant, and chemopreventive properties and could play an important role as a bioprotective agent.

The surveyed population for the treatment of asthma cites licorice (*Glycyrrhiza glabra*). Studies have indeed shown that this plant has an action on the broncho-pulmonary system; it also promotes increased mucus secretion in the stomach, ensuring better protection of the gastric mucosa, along with anti-inflammatory, immunostimulant, antibacterial, and antiviral effects [30]. Licorice also impacts cholesterol and blood lipid metabolism. Its flavonoids have anticancer effects [31]. Licorice contains numerous active principles, such as glycyrrhizic acid, coumarins, flavonoids, alkaloids, saponins, phytoestrogens, etc. [32]. These many phytoconstituents confer numerous pharmacological activities on this plant, justifying its multiple uses.

Iris (*Iris* x *germanica*) is also among the plants cited for treating asthma. This plant has a long history of use, primarily in medieval Persia, for treating a wide variety of diseases. Various bioactive compounds, including flavonoids, triterpenes, sterols, phenolic compounds, ceramides, and benzoquinones, have been identified in this plant. Pharmacological studies show that the plant possesses several biological and therapeutic effects [33].

Elderberry (*Sambucus nigra*), which is also associated with the group of diseases (flu, common cold, bronchitis), has been extensively researched for centuries. These studies have revealed positive effects on colds and respiratory tract inflammation [34]. Other tests have shown favorable results for treating sinusitis and flu [35].

Thyme (*Thymus vulgaris*) is among the plants effective for flu, common cold, and bronchitis. Indeed, *T. vulgaris* has been used in traditional medicine to treat bronchitis, asthma, and other respiratory diseases. Vigo et al. [36] demonstrated the inhibitory effect of the net production of NO by extracts of this plant. This effect is due to the NO-scavenging activity and/or the inhibitory effect of *T. vulgaris* extracts on the expression of the nitric oxide synthase gene, thus inhibiting the production of NO, which plays an important role in the pathogenesis of inflammatory diseases.

Correlations between plants and the diseases they

treat are well illustrated. For instance, thyme and chamomile are commonly used to treat bronchitis and colds due to their antiseptic properties. These same properties are also recognized in garlic, which is often employed to treat pharyngitis. Furthermore, the use of plants can be influenced by the availability of local resources and cultural traditions specific to each region. Regarding plants used to treat asthma, which are less frequently mentioned, one hypothesis could be that this gap results from underreporting in oral traditions or a more frequent reliance on modern medicine for this condition. A more in-depth analysis would be required to confirm or refute this hypothesis.

The choice of plants is also strongly influenced by their local availability, where access to modern resources may be limited, and populations often turn to available plants. Differences in the selection of medicinal plants can be attributed to several factors, including local plant accessibility, cultural beliefs, and knowledge passed down through generations. These elements not only influence the frequency of use of certain plants, but also their perception as effective treatments. A comparative study between different regions could be conducted to further explore the impact of social and cultural factors on the use of medicinal plants.

This analysis highlights the variable richness of the cited plants in bioactive metabolites with significant biological activities, which partially justify their use and effectiveness in the treatment or relief of respiratory diseases.

For *Allium sativum*, the main active compound, allicin, is well-known for its antimicrobial and anti-inflammatory properties. Studies have shown its positive effects on inflammation and fibrosis associated with pulmonary arterial hypertension [37]. Additionally, its impact on ion transport across respiratory epithelial tissue and its potential as an expectorant have also been demonstrated [38]. These properties play a key role in preventing and treating respiratory infections.

For *Glycyrrhiza glabra*, research has highlighted its effectiveness in treating respiratory infections [39]. Glycyrrhizin, a compound recognized for its anti-inflammatory, immunomodulatory, and antiviral effects, makes this plant particularly effective in alleviating symptoms of respiratory diseases such as cough, bronchitis, and respiratory tract inflammation. Significant data also demonstrate that glycyrrhizin and licorice extract exhibit multiple beneficial activities against key characteristics of SARS-CoV-2 [40]. Moreover, glycyrrhizin has shown an inhibitory effect on pulmonary arterial hypertension through the pharmacological inhibition of the High-mobility group box-1 (HMGB1) protein [41].

While these findings clearly establish the relationship between chemical compounds and biological activities for certain plants, providing a better understanding of their mechanisms of action, it is important to acknowledge that detailed data are not always available for other plants. Future studies systematically exploring the biological and chemical mechanisms of the cited plants will further strengthen the scientific validation of their use.

Plant parts used

Regarding the plant parts used, various parts of the plants were cited, including both underground parts (bulb, root, and rhizome) and aerial parts (stem, leaf, flower, fruit, and seed). The active principles responsible for the biological activity of a plant and its therapeutic interest are not distributed uniformly across all plant organs. A thorough knowledge of the plant organ with the appropriate biological activity is essential. Leaves, as the site of photosynthesis, can serve as the preferred storage organ for the metabolites responsible for the therapeutic interest of many plants.

Contribution of PCA

PCA allowed the grouping of the cited diseases into two homogeneous groups. Diseases grouped together, such as asthma, pharyngitis, and cough, could often be confused or coexist in patients, necessitating similar diagnostic or treatment strategies. Diseases that are distant on the axes, such as the flu, may require a different approach in terms of both prevention and management. This analysis also provided an overview of the potential relationships between different respiratory diseases and the plants used for treatment, which can be a valuable tool for research and clinical practice.

These groupings provide a better understanding of the usage patterns of medicinal plants and their specific therapeutic applications. In particular, they highlight how certain plants, due to their chemical and biological properties, are preferentially used for respiratory diseases with similar mechanisms. The groupings obtained through PCA play a key role in data analysis and understanding the relationships between the plants studied. PCA allows for the synthesis of a large number of variables into a small number of dimensions (F1 and F2).

The use of PCA and plant grouping provides a rigorous analytical framework for the study, enabling reliable and actionable conclusions. They highlight how certain plants, due to their chemical and biological properties, are preferentially used for respiratory diseases with similar mechanisms. These techniques add value to the research by making complex data more understandable and usable. They can guide recommendations, for example, in selecting plants to prioritize for further research, clinical trials, or commercial

development.

Conclusion

The study demonstrated that traditional phytotherapy persists and is well utilized by the inhabitants of Fez. This finding, consistent with results obtained by other authors in different regions of Morocco, shows that medicinal plants remain a source of medical care in the study region. The bibliographic study of the chemical constituents and biological activity of the cited species can justify the observed traditional use and indicates a good knowledge of medicinal species by the city's inhabitants. This study allowed us to understand the traditional practices used in Fez, highlighting the value of promoting Moroccan natural resources.

It is, however, beneficial to extend such studies to other regions of the country to gather maximum information on medicinal species and establish comprehensive monographs. Additionally, it is essential to validate the efficacy of plants through appropriate experimental studies to ensure that plant usage is more scientifically grounded.

Future studies are essential. These studies could include clinical trials to evaluate the effectiveness of medicinal plants in treating respiratory diseases and to confirm the therapeutic properties observed in ethnobotanical data. Pharmacological studies are also of great importance; they would help clarify the mechanisms of action of the active compounds in plants to better understand their effects on the respiratory system.

The evaluation of the potential toxicity of these plants is also considered; it would ensure their safe use, especially when consumed regularly. Optimal doses and the duration of administration of medicinal plants should also be considered to assist doctors and researchers in ensuring the correct and safe use of medicinal plants.

It is also important to note that contextual factors such as cultural beliefs, socio-economic status, and access to healthcare can play a crucial role in the use of medicinal plants. Additionally, individuals with lower socio-economic status, or those living in rural or isolated areas, have limited access to modern healthcare and may more frequently turn to medicinal plants as an alternative. These elements should be taken into account in order to provide a more comprehensive understanding of the reasons why and the ways in which these plants are used in different contexts.

Finally, comparative analyses between different regions could be conducted to highlight the potential effects of climatic, social, and cultural conditions on the use and effectiveness of the cited plants. These future studies aim not only to scientifically validate the traditional uses of these plants but also to integrate this knowledge into modern therapeutic approaches. Such an approach could transform local knowledge into validated treatments.

Conflict of Interests

None.

Acknowledgments

None.

References

[1] Zizka A, Thiombiano A, Dressler S, Nacoulma BM, Ouédraogo A, et al.Traditional plant use in Burkina Faso (West Africa): a national-scale analysis with focus on traditional medicine. J Ethnobiol Ethnomed 2015;19:1-9.

[2] Hseini S, Kahouadji A. Etude ethnobotanique de la flore médicinale dans la région de Rabat (Maroc occidental). Lazaroa 2007;28:79-93

[3] Lahsissene H, Kahouadji A. Analyse ethnobotanique des plantes médicinales et aromatiques de la flore marocaine: cas de la région de Zaër. Phythothérapie 2010;8:202-209.

[4] Salhi S, Fadli M, Zidane L. Etudes floristique et ethnobotanique des plantes médicinales de la ville de Kénitra (Maroc). Lazaroa 2010;31:133-146

[5] Fadil M, Farah A, Haloui T. Étude ethnobotanique des plantes exploitées par les coopératives et les associations de la région Meknès-Tafilalet au Maroc. Phytothérapie 2015; 13:19-30.

[6] Mikou K, Rachiq S, Jarrar Oulidi A. Étude ethnobotanique des plantes médicinales et aromatiques utilisées dans la ville de Fès au Maroc. Phytothérapie 2016;14:35-43.

[7] Bellakhdar J. La pharmacopée marocaine traditionnelle.Médecine arabe ancienne et savoirs populaires. Press Saint Etienne. 1997 ; p 764.

[8] Bayer E, Buttler KP, Finkenzeller X. Guide de la flore méditérranénne. Editions Delachaux et Niestlé, Italie 1990; p 287.

[9] Fennane M, Ibn Tatou M, Mathez J. Flore pratique du Maroc. Edition Okad, Rabat 1999; p 558.

[10] Ameri A, Heydarirad G, Mahdavi Jafari J, Ghobadi A, Rezaeizadeh H, et al. Medicinal plants contain mucilage used in traditional Persian medicine (TPM). Pharm Biol 2015;53:615-623.

[11] Sijelmassi A. Les plantes médicinales du Maroc. Edition Le Fennec. 2000 ; p 285.

[12] Campanella L, Bonanni A, Favero G. Determination of antioxidant properties of aromatic herbs, olives and fresh fruit using an enzymatic sensor. Anal Bioanal Chem 2003;375:1011-1116.

[13] Dragland S, Senoo H, Wake K. Several culinary and medicinal herbs are important sources of dietary antioxidants. J Nutr 2003;133:1286-1290.

[14] Chandrashekhar VM, Halagali KS, Nidavani RB. Anti-allergic activity of German chamomile (Matricaria recutita L.) in mast cell mediated allergy model. J Ethnopharmacol 2011;137:336-340.

[15] Exarchou V, Nenadis N, Tsimidou M. Antioxidant activities and phenolic composition of extracts from greek oregano, greek sage, and summer savory. J Agric Food Chem 2002; 50:5294-5299.

[16] Lamiri A, Lhaloui S, Benjilali B. Insectcidal effects of essential oils against hessian fly, Mayetiola Destructor (Say). Field Crops Res 2001;71:9-15.

[17] Cimanga K, Kambu K, Tona L. Correlation between chemical composition and antibacterial activity of essential oils of some

aromatic medicinal plants growing in the Democratic Republic of Congo. J Ethnopharmacol 2002;79:213-220.
[18] Gordien AY, Gray AI, Franzblau SG. Antimycobacterial terpenoids from Juniperus communis L. (Cuppressaceae). J Ethnopharmacol 2009;126:500-505.
[19] Ramos da Silva LR, Ferreira OO, Cruz JN, de Jesus Pereira Franco C, Oliveira Dos Anjos T, et al. Lamiaceae essential oils, phytochemical profile, antioxidant, and biological activities. Evid Based Complement Alternat Med 2021;2021:6748052.
[20] Neves JM, Matos C, Moutinho C. Ethnopharmacological notes about ancient uses of medicinal plants in Tras-os-Montes (northern of Portugal). J Ethnopharmacol 2009;124:270-283.
[21] Patel D, Shukla S, Gupta S. Apigenin and cancer chemoprevention: Progress, potential and promise (Review). Int J Oncol 2007;30:233-245.
[22] El Mihyaoui A, Esteves da Silva JCG, Charfi S, Candela Castillo ME, Lamarti A, et al. Chamomile (Matricaria chamomilla L.): a review of Ethnomedicinal use, phytochemistry and pharmacological uses. Life 2022;12:479.
[23] Ashraf R, Aamir K, Shaikh AR. Effects of garlic on dyslipidemia in patients with type 2 diabetes mellitus. J Ayub Med Coll Abbottabad 2005;17:60-64
[24] Mikou K, Rachiq S, Jarrar Oulidi A, Beniaich G. Ethnobotanical survey of medicinal and aromatic plants used by the people of Fez in Morocco. Phytothérapie 2015;49:538-551.
[25] Pennanen A, Tailin X, Hartikainen H. Protective role of selenium in plant subjected to severe UV irradiation stress. J Appl Bot 2022;76:66-76
[26] El-Saber Batiha G, Magdy Beshbishy A, G Wasef L, Elewa YHA, A Al-Sagan A, et al. Chemical constituents and pharmacological activities of garlic (Allium sativum L.): a review. Nutrients 2020;12:872.
[27] Andrés CMC, Pérez de la Lastra JM, Andrés Juan C, Plou FJ, Pérez-Lebeña E. Chemistry of hydrogen sulfide-pathological and physiological functions in mammalian cells. Cells 2023; 12:2684.
[28] Politi M, Ferrante C, Menghini L, Angelini P, Flores GA, et al. Hydrosols from rosmarinus officinalis, salvia officinalis, and cupressus sempervirens: phytochemical analysis and bioactivity evaluation. Plants 2022;11:349.
[29] Grondona E, Gatti G, López AG, Sánchez LR, Rivero V, et al. Bio-efficacy of the essential oil of oregano (Origanum vulgare Lamiaceae. Ssp. Hirtum). Plant Foods Hum Nutr 2014; 69:351-357.
[30] Wahab S, Annadurai S, Abullais SS, Das G, Ahmad W, et al. Glycyrrhiza glabra (Licorice): a comprehensive review on its phytochemistry, biological activities, clinical evidence and toxicology. Plants 2021;10:2751.
[31] Caroline ML, Muthukumar RS, A H HP, N N. Anticancer effect of plectranthus amboinicus and glycyrrhiza glabra on oral cancer cell line: an invitro experimental study. Asian Pac J Cancer Prev 2023;24:881-887.
[32] Kondo K, Shiba M, Nakamura R, T Morota T, Shoyama Y. Constituent properties of licorices derived from Glycyrrhiza uralensis, G. glabra, or G. inflata Identified by Genetic Information. Biol Pharm Bull 2007;30:1271-1277.
[33] Mahdinezhad MR, Hooshmand S, Soukhtanloo M, Jamshidi ST, Ehtiati S, et al. Protective effects of a standardized extract of Iris germanica on pancreas and liver in streptozotocin-induced diabetic rats. Res Pharm Sci 2020;16:71-78.
[34] Alrumaihi F, Almatroudi A, Allemailem KS, Rahmani AH, Khan A, et al. Therapeutic effect of bilsaan, sambucus nigra stem exudate, on the OVA-induced allergic asthma in mice. Oxid Med Cell Longev 2020;2020:3620192.
[35] Mahdinezhad MR, Hooshmand S, Soukhtanloo M, Jamshidi ST, Ehtiati S, et al. Protective effects of a standardized extract of Iris germanica on pancreas and liver in streptozotocin-induced diabetic rats. Res Pharm Sci 2020;16:71-78.
[36] Vigo E, Cepeda A, Gualillo O, Perez-Fernandez R. In-vitro anti-inflammatory effect of Eucalyptus globulus and Thymus vulgaris: nitric oxide inhibition in J774A.1 murine macrophages. J Pharm Pharmacol 2004;56:257-263.
[37] Sánchez-Gloria JL, Martínez-Olivares CE, Rojas-Morales P, Hernández-Pando R, Carbó R, et al. Anti-inflammatory effect of allicin associated with fibrosis in pulmonary arterial hypertension. Int J Mol Sci 2021;22:8600
[38] Qiu ZE, Xu JB, Chen L, Huang ZX, Lei TL, et al. Allicin facilitates airway surface liquid hydration by activation of CFTR. Front Pharmacol 2022;13:890284.
[39] Wahab S, Ahmad I, Irfan S, Siddiqua A, Usmani S, et al. pharmacological efficacy and safety of glycyrrhiza glabra in the treatment of respiratory tract infections. Mini Rev Med Chem 2022;22:1476-1494.
[40] Gomaa AA, Abdel-Wadood YA. The potential of glycyrrhizin and licorice extract in combating COVID-19 and associated conditions. Phytomed Plus 2021;1:100043.
[41] Feng W, Wang J, Yan X, Zhang Q, Chai L, et al. ERK/Drp1-dependent mitochondrial fission contributes to HMGB1-induced autophagy in pulmonary arterial hypertension. Cell Prolif 2021;54:e13048.

-