

REVIEW OPEN ACCESS

# Traditional Respiratory Remedies From Anatolia: Ethnobotanical Insights and Bioactive Properties

Golshan Zare<sup>1</sup> | Yağmur Diker<sup>1</sup> | Irem Tatlı Çankaya<sup>1</sup> | Emran Habibi<sup>2</sup>  | Satyajit D. Sarker<sup>2</sup> | Lutfun Nahar<sup>2</sup>

<sup>1</sup>Faculty of Pharmacy, Department of Pharmaceutical Botany, Hacettepe University, Ankara, Türkiye | <sup>2</sup>Centre For Natural Products Discovery (CNPD), School of Pharmacy and Biomolecular Sciences, Liverpool John Moores University, Liverpool, UK

**Correspondence:** Irem Tatlı Çankaya ([itatli@hacettepe.edu.tr](mailto:itatli@hacettepe.edu.tr)) | Emran Habibi ([E.habibi@ljmu.ac.uk](mailto:E.habibi@ljmu.ac.uk)) | Lutfun Nahar ([profnahar@outlook.com](mailto:profnahar@outlook.com); [l.nahar@ljmu.ac.uk](mailto:l.nahar@ljmu.ac.uk))

**Received:** 19 November 2025 | **Revised:** 17 May 2026 | **Accepted:** 20 May 2026

**Keywords:** Anatolia | ethnobotany | folk medicine | medicinal plants | phytotherapy | respiratory diseases | traditional healing

## ABSTRACT

Respiratory disorders, ranging from acute viral infections such as influenza and bronchitis to chronic inflammatory conditions including chronic obstructive pulmonary disease, asthma, emphysema, and pneumonia, represent a major global health burden, affecting millions annually. Traditional Anatolian folk medicine has long relied on plant-based remedies to manage these conditions, offering a valuable reservoir of therapeutic knowledge. Ethnobotanical data on Anatolian medicinal plants are integrated to evaluate their therapeutic relevance through a mechanistic perspective. A meta-analysis of 187 ethnobotanical studies published since 1991 was conducted, with 110 meeting strict inclusion criteria. The dataset includes 508 plant taxa, with prominent families such as Rosaceae, Lamiaceae, Asteraceae, and Malvaceae. Key species include *Cydonia oblonga*, *Glycyrrhiza glabra*, *Juniperus oxycedrus*, *Matricaria chamomilla*, *Pinus* spp., *Plantago* spp., *Rubus* spp., *Sambucus nigra*, and *Urtica dioica*. A clear divergence in treatment strategies is evident. Essential oil- and anthocyanin-rich taxa are associated with acute conditions via antimicrobial activity and  $\gamma\delta$  T-cell modulation. In contrast, mucilage- and iridoid-rich species are linked to chronic conditions, where mucosal protection and regulation of NF- $\kappa$ B and COX-2 pathways represent central mechanisms. A coherent framework for evidence-based respiratory therapeutics emerges from ethnobotanical evidence integrated with mechanistic insights and updated toxicological evaluation. This review defines the mechanistic and ethnopharmacological landscape of plant-based interventions targeting respiratory disorders.

## 1 | Introduction

Respiratory diseases exert a significant impact on the airways and lungs, representing a major global health burden. These conditions span a spectrum of ailments ranging from self-limiting infections, such as the common cold and flu, to severe chronic pathologies like asthma, pneumonia, and other acute respiratory syndromes. As infectious and inflammatory respiratory conditions rank among the leading causes of illness and mortality worldwide [1], there is an escalating interest in alternative and complementary therapies. This interest is particularly promi-

nent in regions where extraordinary biodiversity converges with deep-rooted traditional knowledge [2].

Anatolia, the centerpiece of the Turkish landscape, is recognized for its extensive plant life, distinctive landscapes, and diverse climates. The region possesses a rich history marked by various civilizations that have utilized medicinal plants for healing purposes [3, 4]. Türkiye, being the most extensive country in area, is home to approximately 12 000 plant species, with 3649 classified as endemic [5]. The biodiversity of Anatolia encompasses three notable hotspots: the Mediterranean, Caucasian, and

This is an open access article under the terms of the [Creative Commons Attribution](https://creativecommons.org/licenses/by/4.0/) License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2026 The Author(s). *Chemistry & Biodiversity* published by Wiley-VHCA AG.

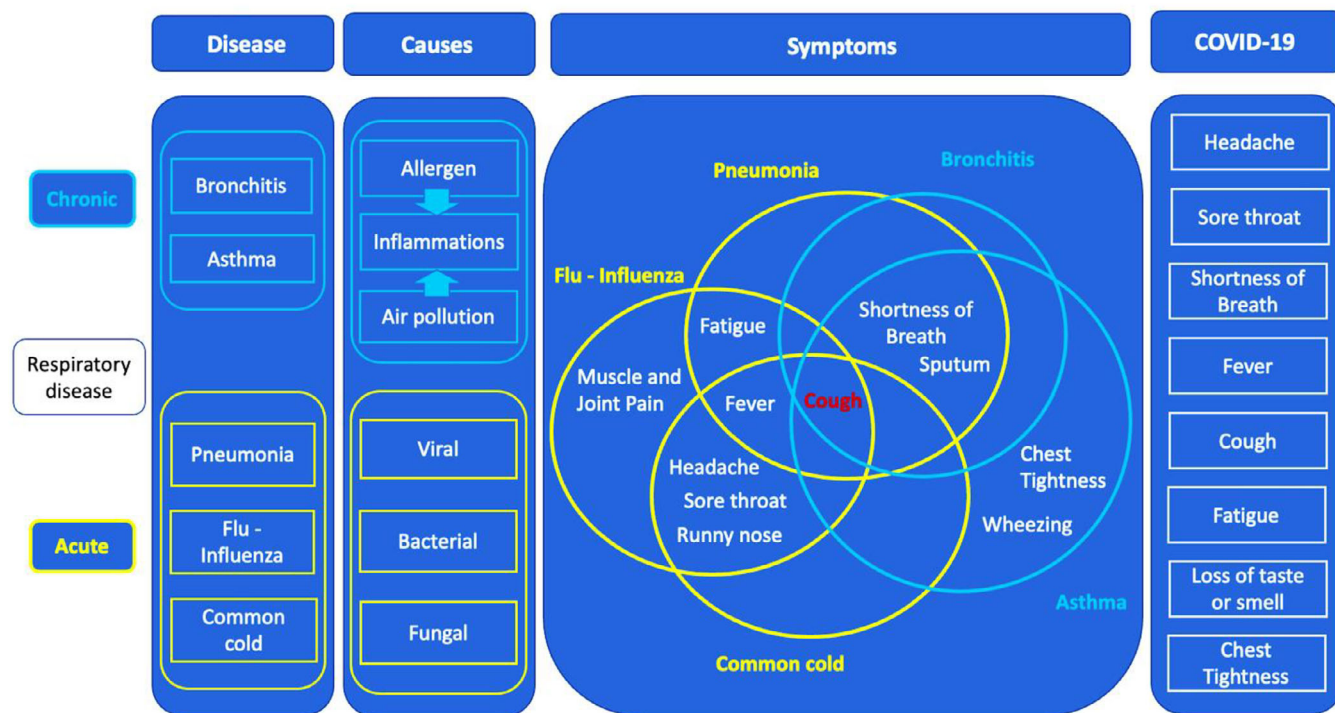


FIGURE 1 | The types of respiratory disorders.

Iran–Anatolian regions. These hotspots contribute significantly to a comprehensive tradition of medicinal practices [3, 6]. Historically, the inhabitants of Anatolia relied on plants for both nutritional and medicinal needs [7]. The geographical position of Anatolia, bridging Europe and Asia, has facilitated the exchange of medicinal knowledge among diverse cultures [8].

Among the earliest significant contributions to pharmaceutical botany from Anatolia is the work of Pedanius Dioscorides, particularly his text *De Materia Medica*. This text has served as a crucial reference for the use of medicinal plants from ancient times through the Middle Ages and the Renaissance [9]. The historical context provided by Dioscorides, along with the rich biodiversity of the region, has fostered a robust system of traditional medicine that frequently employs medicinal plants to address respiratory issues [10, 11]. The unique biodiversity, combined with the traditional wisdom in Anatolia, presents invaluable resources for Türkiye and surrounding nations that share similar cultural and botanical characteristics [12]. Critically, the exploration of these plants' phytochemical profiles has the potential to lead to the discovery of novel treatments for respiratory diseases [13]. Bridging traditional practices with contemporary scientific validation requires a clear categorization of respiratory syndromes, as summarized in Figure 1, which illustrates the prevalence and interrelationships of various respiratory disorders.

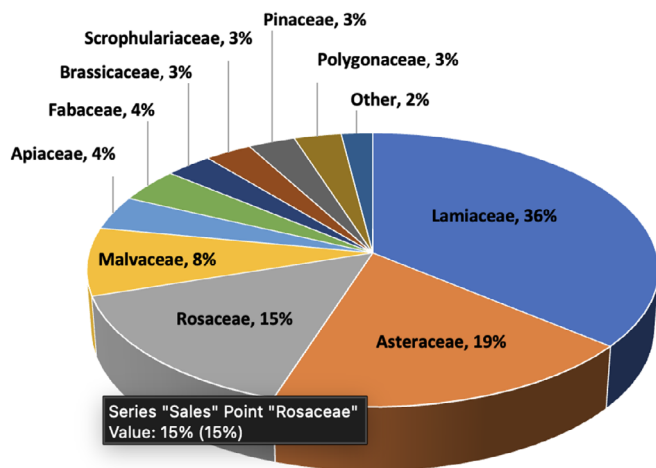
The objective of this review is to critically document and categorize the medicinal plants traditionally utilized in Anatolian folk medicine for respiratory diseases, encompassing conditions such as asthma, colds, flu, pneumonia, tuberculosis, and other respiratory ailments. By compiling ethnobotanical records and analyzing relevant scientific literature, this review seeks to emphasize plants with potential therapeutic benefits [3, 14]. In addition,

this review promotes further research into the effectiveness and safety of these plants, contributing to an essential resource for incorporating traditional healing practices into modern health-care strategies. Ultimately, this work highlights the imperative of preserving and utilizing the natural wealth of Anatolia for the effective management of respiratory health.

## 2 | Methodology for Literature Search

A systematic approach was employed to gather information on medicinal plants used in Anatolian folk medicine for respiratory diseases. Data were collected from multiple scientific databases, including Google Scholar, Science Direct, and Scopus. Specific search keywords such as “Ethnobotany,” “Türkiye,” “Anatolia,” “Traditional medicine,” “Folk medicine,” and “Medicinal plants” were utilized to identify relevant studies [15]. A total of 187 articles were initially assessed for eligibility. Of these, 12 articles were excluded because they were not related to folk medicinal use. The remaining 175 articles were further evaluated according to the predefined inclusion criteria, specifically the availability of information on plant parts used, administration, and therapeutic effects. Among these, 110 articles met the inclusion criteria and were included in the final analysis. The remaining 65 studies were excluded because they did not report information on at least one of these criteria or, although all parameters were present, the data provided in the tables could not be clearly tracked or reliably cross-referenced.

Ethnobotanical and folk medicinal studies were systematically searched using specific keywords related to respiratory symptoms. The search strategy included terms such as “asthma,” “cold,” “cough,” “fever,” “flu,” “shortness of breath,” “pneumo-



**FIGURE 2** | The number of species per family related to medicinal plants for treating respiratory diseases.

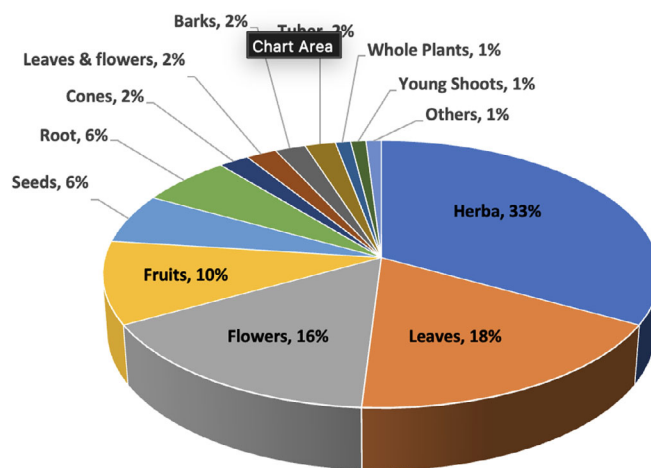
nia,” and “tuberculosis” to identify plants commonly used for the treatment of respiratory conditions [15, 16]. Plant species identified through these keywords were compiled into a structured table according to plant parts used, mode of administration, therapeutic effects, and regions of use. The citation frequency of plant species in ethnobotanical studies was assessed to identify those most relevant to respiratory diseases.

Taxonomic classifications have been confirmed using authoritative references, including the Flora of Türkiye and the East Aegean Islands and World Flora Online website, ensuring accuracy [3, 5, 17]. The terminology for plant parts and therapeutic effects was standardized for coherence throughout the literature. This methodological framework allows for a transparent and structured analysis of available literature, thereby enhancing the understanding of ethnobotanical practices related to respiratory health in Türkiye. Additionally, it also provides a reproducible foundation for evaluating traditional knowledge within a scientific context.

### 3 | Literature Search Results

A total of 187 ethnobotanical research papers published since 1991 were identified through the literature search. The selected studies resulted in a rich dataset comprising 770 records corresponding to 508 plant species across 236 genera and 77 families. The data summarizing the number of species per family related to medicinal plants for the treatment of respiratory diseases are illustrated in Figure 2. Notably, a significant proportion (78%) of these species originated from the Asteraceae, Lamiaceae, Malvaceae, and Rosaceae families. This distribution highlights the critical role of these families in traditional medicinal practices to treat respiratory ailments in Anatolia. The data were further categorized to extract species with notable citation frequencies.

A comprehensive list of species with over 10 citations has been compiled and summarized in Table 1 Appendix. Emphasizing high-frequency species provides insights into which plants hold the most value in traditional practices for respiratory health. Additionally, geographical representation was considered, with



**FIGURE 3** | Frequency of different plant parts used for the treatment of respiratory diseases.

nearly all provinces in Türkiye represented across the selected studies. A map illustrating the districts of folk medicine practices throughout Türkiye [8].

This review emphasizes the wealth of ethnobotanical knowledge within Anatolia, showcasing the integration of local flora and the different plant parts used for the treatment of respiratory diseases, which is summarized in Figure 3. The findings emphasize the significance of these traditional practices and the necessity for further research to explore the pharmacological properties and therapeutic benefits of these widely used plant species.

## 4 | A–Z Plants Used for Respiratory Diseases in Anatolia

The following section provides an alphabetical list of plants, categorized by plant families, to facilitate access to the extensive data compiled in this review. These plants have been used in Anatolian folk medicine for treating respiratory diseases. This arrangement allows for easy identification of specific plant species and associated details, including scientific name, family, and reported uses.

### 4.1 | Asteraceae

The Asteraceae family, also known as the aster family, is the largest family of flowering plants. In Türkiye, it encompasses 140 genera [3]. Members of this family are renowned for their various medicinal properties, largely attributed to common compounds such as polyphenols, flavonoids, and diterpenoids [18]. Notably, sesquiterpene lactones are key compounds within this family, exhibiting anti-inflammatory, antibacterial, antifungal, and cytotoxic activities [19].

Among the Asteraceae family, essential oils of certain genera, including *Artemisia*, *Tanacetum*, and, to a lesser extent, *Anthemis* species, have been reported to contain thujone, a monoterpene ketone associated with its central nervous system toxicity. Thujone exerts its effects primarily through antagonism of GABA-A

**TABLE 1** | The list of species used for respiratory disease in Anatolia with 10 or more citations.

Family	Plant names	Turkish name	Monography	Number of citations
Rosaceae	<i>Rosa canina</i> L.	Kuşburnu	European Pharmacopoeia, Commission E Monographs	[64]
Rosaceae	<i>Cydonia oblonga</i> Miller	Ayva	—	[44]
Urticaceae	<i>Urtica dioica</i> L.	Isırgan	European Pharmacopoeia, WHO Monographs, Commission E Monographs, ESCOP Monographs	[29]
Lamiaceae	<i>Mentha longifolia</i> (L.) Hudson	Pünk	—	[26]
Cupressaceae	<i>Juniperus oxycedrus</i> L.	Katranardıcı	—	[22]
Santalaceae	<i>Viscum album</i> L.	Ökseotu	Commission E Monographs	[22]
Malvaceae	<i>Malva sylvestris</i> L.	Ebegümeçi	European Pharmacopoeia, Commission E Monographs, ESCOP Monographs	[19]
Plantaginaceae	<i>Plantago major</i> L.	Sinirotu	—	[19]
Malvaceae	<i>Tilia tomentosa</i> Moench (syn: <i>Tilia argentea</i> Desf. ex DC.)	Gümüşi Ihlamur	—	[17]
Asteraceae	<i>Tussilago farfara</i> L.	Öksürükotu	Commission E Monographs	[17]
Plantaginaceae	<i>Plantago lanceolata</i> L.	Damarlıca	European Pharmacopoeia, Commission E Monographs, ESCOP Monographs	[16]
Asteraceae	<i>Matricaria chamomilla</i> L.	Alman Papatyası	European Pharmacopoeia, WHO Monographs, Commission E Monographs, ESCOP Monographs	[15]
Juglandaceae	<i>Juglans regia</i> L.	Ceviz	Commission E Monographs	[14]
Lamiaceae	<i>Teucrium polium</i> L.	Acıyavşan	—	[14]
Pinaceae	<i>Pinus sylvestris</i> L.	Sarıçam	European Pharmacopoeia	[14]
Rosaceae	<i>Rubus sanctus</i> Schreber	Böğürtlen	—	[14]
Pinaceae	<i>Pinus nigra</i> J. F. Arnold	Karaçam	—	[14]
Asteraceae	<i>Cota tinctoria</i> (L.) J.Gay ( <i>Anthemis tinctoria</i> L.)	Boyacı Papatyası	—	[13]
Lamiaceae	<i>Mentha x piperita</i> L.	Nane	European Pharmacopoeia, WHO Monographs, Commission E Monographs, ESCOP Monographs	[13]
Caprifoliaceae	<i>Sambucus nigra</i> L.	Ağaç Mürver	European Pharmacopoeia, WHO Monographs, Commission E Monographs, ESCOP Monographs	[12]

(Continues)

TABLE 1 | (Continued)

Family	Plant names	Turkish name	Monography	Number of citations
Fabaceae	<i>Glycyrrhiza glabra</i> L.	Meyan	European Pharmacopoeia, WHO Monographs, Commission E Monographs	[12]
Lamiaceae	<i>Mentha spicata</i> L.	Eşek Nanesi	—	[12]
Pinaceae	<i>Pinus brutia</i> Ten.	Kızılçam	—	[12]
Hypericaceae	<i>Hypericum perforatum</i> L.	Kantaron	European Pharmacopoeia, WHO Monographs, Commission E Monographs, ESCOP Monographs	[11]
Lamiaceae	<i>Origanum vulgare</i> L.	Karakınık	European Pharmacopoeia, Commission E Monographs	[11]
Malvaceae	<i>Tilia platyphyllos</i> Scop. (Syn: <i>Tilia rubra</i> DC.)	Kafkas Ihlamuru	—	[11]
Asteraceae	<i>Bellis perennis</i> L.	Koyungözü	—	[10]
Lamiaceae	<i>Melissa officinalis</i> L.	Oğulotu	European Pharmacopoeia, WHO Monographs, Commission E Monographs, ESCOP Monographs	[10]
Lamiaceae	<i>Salvia rosmarinus</i> Spenn. (syn: <i>Rosmarinus officinalis</i> L.)	Biberiye	European Pharmacopoeia, WHO Monographs, Commission E Monographs	[10]
Lamiaceae	<i>Thymus longicaulis</i> C.Presl	Dağ Kekiği	—	[10]
Lamiaceae	<i>Thymus sipyleus</i> Boiss.	Sipil Kekiği	—	[10]
Malvaceae	<i>Alcea pallida</i> (Willd.) Walds. &Kit.	Hatmi Çiçeği	—	[10]

receptors, leading to a reduction in inhibitory neurotransmission. Wide variability in thujone levels across species and geographic origins forms the basis for the EMA/HMPC emphasis on rigorous monitoring of dosage and chemotypes in herbal preparations to mitigate neurotoxic risks [20].

#### 4.1.1 | *Anthemis* (Chamomile)

The genus *Anthemis* is primarily recognized for its content of sesquiterpene lactones, flavonoids, and phenolic acids [21, 22]. However, pharmacological data on *A. nobilis* are limited and mainly focus on the antibacterial and antioxidant effects of its essential oil [23]. Various plant extracts, tinctures, salves, and teas derived from aerial and root parts are utilized in Europe for their antibacterial as well as for treating inflammation [22].

No health hazards or side effects are known in conjunction with the proper administration of chamomile flower preparations at specified therapeutic dosages. The herbal substance possesses a small potential for sensitization and use in individuals with a

known hypersensitivity to the active substance and to other plants of the Asteraceae family is contraindicated [24].

#### 4.1.2 | *Artemisia* (Wormwood)

The genus *Artemisia* in Türkiye includes *A. absinthium* L. and 22 other species [3], predominantly found in eastern and central Anatolia. Wormwood has a lengthy history as an antimalarial agent [25]. Important bioactive constituents in this genus include mainly caffeoylquinic acids, rutin, 3-feruloylquinic acid, and other phenolics, tannins, and essential oil components such as  $\beta$ -pinene and thujone derivatives. These phytochemicals serve as the molecular foundation for the plant's antipyretic, antibacterial, and anti-inflammatory activities [26–28].

The essential oil of *A. absinthium* exhibits activity against both sensitive and resistant strains of *Staphylococcus aureus*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa* [29]. Ethanol extracts obtained from the flowers and leaves of *Artemisia absinthium* and *A. annua*, which are rich in polyphenolic compounds, have been shown to exert significant anti-inflammatory activity by

modulating the canonical NLRP3 inflammasome pathway. This modulation suppresses caspase-1 activation and Gasdermin D (GSDMD) pore formation, thereby reducing the release of key pro-inflammatory cytokines, including IL-1 $\beta$  and IL-18, which play critical roles in severe respiratory inflammation. In addition, these extracts decrease the levels of NF- $\kappa$ B p65, a central transcription factor involved in inflammatory signaling, thereby interrupting the amplification cycle of inflammatory mediator production [28, 30].

#### 4.1.3 | *Bellis* (Common Daisy)

*Bellis perennis* is native to Europe and western Asia, with introductions to North and South America [31]. This species is rich in anthocyanins, saponins, triterpenes, and polyphenols, including flavonoids such as quercetin, apigenin, and kaempferol, as well as tannins [31–33]. *B. perennis* demonstrates antimicrobial, antioxidant, and anti-inflammatory activities [34]. In traditional and folk medicine, it is utilized to treat headaches, common cold, and upper respiratory tract infections [10, 34, 35].

The extracts exhibit a broad-spectrum antibacterial action, showing particularly high efficacy against Gram-positive bacteria (such as *Staphylococcus aureus*, *Staphylococcus epidermidis*, and *Streptococcus pyogenes*) and specific Gram-negative bacteria (like *Enterobacter cloacae*). The powerful anti-inflammatory action of the plant is mediated by its ability to severely inhibit the cellular production of nitric oxide (NO). While normal levels of NO are vital, high rates are heavily implicated in the pathophysiology of inflammation-based diseases. Phytochemicals in the plant extract drastically prevent LPS-induced NO secretion in macrophages, thereby halting the progression of the inflammatory response [35]. Abacterial mechanism relies on disrupting bacterial homeostasis; this is especially effective against Gram-positive bacteria because their cell wall consists of only a single layer, making them highly sensitive to the inhibitory penetration of phenolic compounds [34, 35].

#### 4.1.4 | *Matricaria* (Chamomile)

The genus *Matricaria*, belonging to the Anthemideae tribe, comprises six species. *Matricaria chamomilla* var. *chamomilla* and *M. chamomilla* var. *recutita* (German chamomile) are extensively distributed in Türkiye, while *M. aurea* and *M. matricarioides* have limited distributions [3]. More than 120 constituents have been identified in the flowers, with essential oils containing flavonoids, coumarins, mucilages, mono- and oligosaccharides, and terpenoids such as  $\alpha$ -bisabolol, farnesene, chamazulene, and spathulenol [35, 36]. Major phenolic compounds identified include coumarins, phenylpropanoids, apigenin, luteolin, glucosides, quercetin, and rutin [37].

The essential oil of *Matricaria* exhibits antimicrobial activity against *S. aureus* and *Candida* species, traditionally utilized for treating acute otitis externa [38]. Evidence from *in vivo* studies using extracts of *M. chamomilla* indicates anti-inflammatory effects with reductions in inflammation and white blood cell infiltration [39]. The intragastric route for delivering *M. chamomilla*

polysaccharides has been shown to normalize immune responses to air cooling and enhance them during immersion cooling. This immune-modulating activity is attributed to the stimulating effects of these polysaccharides on immune-regulating cells, which increase sensitivity in effector cells and signaling pathways [40].

## 4.2 | Cupressaceae

The Cupressaceae family is characterized by resinous, monoecious, or dioecious trees and shrubs, and this family belongs to Pinophyta, commonly known as conifers, which represents an ancient group of land plants characterized by their perennial, evergreen, cone-bearing, woody structures. These plants dominate expansive regions, particularly in the Northern Hemisphere, and constitute the largest and most economically significant component group of gymnosperms [41].

All conifer members have evolved specialized anatomical structures that facilitate the production and sequestration of hydrophobic oleoresins (resin) in substantial quantities. This adaptation renders them rich sources of terpenoids and essential oils [42]. Pharmacological research has demonstrated that these essential oils possess a wide range of biological activities, including antimicrobial, anti-inflammatory, antifungal, antiviral, antioxidant, and anticancer properties [43–45].

In Anatolia, *Juniperus* (27 citations) and *Cupressus* (6 citations) are the main genera used for treating coughs, colds, asthma, and bronchitis. The genus *Juniperus* is represented by eight species in Türkiye [3, 5], including *J. communis* L., *J. drupacea* Lab., *J. excelsa* M. Bieb., *J. foetidissima* Willd., and *J. oxycedrus* L. The local populations utilize these species for various respiratory conditions. Different parts of the *Juniperus* plants, including their aerial parts, bark, branches, cones, and berries, are employed, along with essential oils extracted from the berries either by water or steam distillation. The wood tar obtained through dry distillation is used to treat a range of ailments, including asthma, respiratory disorders, coughs, colds, and fevers [46–49].

#### 4.2.1 | *Juniperus* (Juniper)

*Juniperus oxycedrus* is the most frequently employed species within the family, with its berries, wood, and volatile oils used to treat respiratory diseases such as bronchitis, coughs, colds, flu, shortness of breath, asthma, tuberculosis, and pneumonia. Many therapeutic activities attributed to this plant are due to its antibacterial properties, particularly those derived from its essential oils. The literature indicates that the essential oil of *J. excelsa*, especially containing  $\alpha$ -pinene as an active compound, has displayed antifungal and antimicrobial activities against various tested strains, including *Haemophilus influenzae* [50, 51].

Volatile constituent compounds include lignans, coumarins, sesquiterpenes, abietane, labdane, pimarane-type diterpenes, flavonoids, and tannins, in addition to phenylpropanoids [52, 53]. These members are traditionally employed in folk medicine in numerous countries, primarily due to their anti-inflammatory and analgesic properties [49]. Research conducted by Orhan et al.

(2012) on four Turkish *Juniperus* species found that extracts of *J. oxycedrus* and *J. foetidissima* berries exhibited significant anti-inflammatory activity, while the *n*-butanol sub-extract of *J. oxycedrus* demonstrated promising antinociceptive activity [47]. These findings point toward the value of resins and essential oils extracted from *Juniperus* species for further medicinal exploration.

### 4.3 | Fabaceae

*Glycyrrhiza glabra* (Liquorice) is an important species worldwide, extensively used in pharmaceuticals and foods, especially as a sweetener and flavor enhancer [54, 55]. In Anatolia, its root is traditionally employed to treat various respiratory infections, including bronchitis, common colds, coughs, and asthma, primarily acting as an effective expectorant. Different species of this genus are also popular in the Far East, traditional Chinese medicine (TCM), and India [54, 56].

*G. glabra* possesses powerful antioxidant [56], and antimicrobial activity, along with notable anti-inflammatory effects in the upper respiratory tract. The pharmacological activities of *G. glabra* are attributed to its saponins, alkaloids, and phenolic content, which includes glycyrrhizin, 18 $\beta$ -glycyrrhetic acid, glabridin A and B, and isoflavones [57–59]. The therapeutic effects of this plant in respiratory diseases are mainly associated with glycyrrhizin, which helps expel congestion in the upper respiratory tract and accelerates tracheal mucus secretion [60].

Liquorice is beneficial for sore throats by stimulating gastric mucus secretion, akin to carbenoxolone, a derivative of glycyrrhetic acid with a steroid-like structure [59, 60]. *G. glabra* also exhibits significant antiviral activity against pathogens such as *Haemophilus influenzae*, vesicular stomatitis virus, and influenza A [57]. Mechanistically, glycyrrhizin interacts with host cell membranes to diminish endocytic activity and viral penetration. In addition, glycyrrhizin also modulates the inflammatory response by preventing the degradation of I $\kappa$ B, thereby activating T-lymphocyte proliferation and suppressing host cell apoptosis [57]. These antiviral, expectorant, immunomodulatory, and anti-inflammatory properties of *G. glabra* support its role as a promising candidate for integrated respiratory diseases.

### 4.4 | Hypericaceae

*Hypericum perforatum* (common name: St. John's Wort) belongs to the Hypericaceae family and is recognized as one of the oldest medicinal plants used for wound healing. It ranks among the most consumed medicinal plants worldwide [61]. Research has documented its efficacy for bronchial asthma, and historical accounts spotlight its applications among indigenous people in America for treating fever, cough, and various ailments [62]. This genus encompasses a broad spectrum of biochemicals, including flavonoids, such as hyperoside, quercitrin, isoquercitrin, rutin, quercetin, kaempferol, luteolin, and myricetin. The aerial parts of the plant, including flowers and buds, also contain biflavones, phloroglucinols like hyperforin and adhyperforin, procyanidins, tannins, coumarins, amino acids, and phenylpropanes [63].

While the antidepressant effects of *Hypericum* have received substantial attention [64], the herb also demonstrates various biological activities, including wound healing, anti-inflammatory effects, antifungal properties, antimycobacterial effects, and antiviral activities [65–67]. *Hypericum perforatum* extracts are more effective against Gram-positive bacteria than Gram-negative strains, with alcoholic extracts demonstrating superior efficacy in comparison to aqueous extracts [67, 68]. Hypericin exhibits antibacterial, antiviral, and anti-inflammatory activities [68]. Moreover, hyperforin has been reported to exert an inhibitory effect against excessive inflammation.

### 4.5 | Lamiaceae

The Lamiaceae family is a globally distributed group of profound medicinal and economic importance (Table 1). Türkiye is home to 782 members of the Lamiaceae family, and 346 of these species are unique to the area [69]. These aromatic plants are characterized by complex secondary metabolites, primarily terpenoids stored in essential oils, which underpin their extensive use in traditional medicine for conditions ranging from general exhaustion to chronic respiratory ailments like asthma [70–72]. Phytochemical analyses have identified flavonoids, terpenoids, essential oils, and fatty acids as the major constituents of Lamiaceae, with thymol and carvacrol being particularly noteworthy for their health benefits [73]. Monoterpenoid-rich essential oils from aromatic plants, particularly in the Lamiaceae family, exhibit strong antibiofilm activity by inhibiting bacterial adhesion and early-stage biofilm formation in both Gram-positive and Gram-negative bacteria [74].

Several members of the Lamiaceae family, such as those in the genus *Salvia*, have demonstrated antiviral properties through both *in vitro* and *in vivo* studies. Compounds like carnosol, caffeic acid, prunellin, salvianolic acids, and various polyphenolics exhibit antiviral activity against a range of enveloped and unenveloped viruses, including HIV, and respiratory syncytial virus (RSV) [75, 76].

Lamiaceae members such as *Salvia* and *Mentha* species exhibit marked chemical variability in their essential oils. Some chemotypes of *Salvia* contain thujone. Regulatory evaluations have highlighted uncertainties in the safety of thujone-containing herbal products, particularly for vulnerable groups such as children and pregnant women, leading to a precautionary approach toward their use. Similarly, *Mentha* essential oil, although widely regarded as safe at therapeutic doses, has been associated with respiratory depression in young children and rare cases of systemic toxicity following excessive exposure. These findings underscore the importance of dose regulation and population-specific risk assessment for both *Salvia*- and *Mentha*-derived preparations [77–81].

#### 4.5.1 | *Mentha* (Wild Mint)

As the third most cited genus for respiratory disorders in Anatolia (receiving 52 citations), *Mentha* (represented by 10 species in Türkiye) is a cornerstone of folk medicine (Table 1). Various parts of the plant are utilized for their antimicrobial effects while also addressing headaches [5, 82].

*Mentha* species exert their biological and therapeutic effects mainly through essential oils, which are complex mixtures of volatile compounds, predominantly terpenoids, synthesized and stored in glandular trichomes [83]. *Mentha* essential oils' chemical composition varies among species and chemotypes, and major essential oils include menthol, menthone, cineole, limonene, carvone, pulegone, linalool, piperitone, and piperitenone oxide [84]. *M. piperita* is rich in menthol and menthone, *M. spicata* is dominated by carvone and limonene, and *M. pulegium* contains high pulegone levels, raising hepatotoxicity concerns [85–87]. Geographic origin and genetic diversity further influence chemotype formation and biological efficacy. Although their multi-target actions highlight their promise as complementary therapeutics, chemical variability remains a major limitation, underscoring the need for standardized preparations with defined profiles [88].

*Mentha* essential oils exhibit strong antioxidant, anti-inflammatory, antimicrobial, and analgesic activities [84]. Their antioxidant and anti-inflammatory effects contribute to the mitigation of oxidative stress and chronic inflammation by scavenging free radicals and modulating inflammatory pathways [87], partly through cyclooxygenase inhibition and suppression of pro-inflammatory mediators [86]. The antimicrobial activity is mainly attributed to monoterpenes disrupting microbial membranes and essential cellular functions [89], and *Mentha* extracts inhibit pathogens, including *Pseudomonas aeruginosa*, *Shigella flexneri*, *Klebsiella pneumoniae*, and *Staphylococcus aureus* [84].

*Mentha* extracts also show respiratory benefits by improving surfactant activity, stimulating respiratory muscle strength, and increasing end-tidal oxygen levels [84, 90]. They have demonstrated potential in respiratory infections and asthma models, alleviating histamine- and ovalbumen-induced bronchial asthma [91] and improving lung function after short-term nebulization [92]. Moreover, their use has been associated with reduced respiratory risks related to urban air pollution [93].

#### 4.5.2 | *Origanum* (Oregano)

*Origanum*, with 27 species in Türkiye, is a genus of high commercial and therapeutic value [5]. Certain species, such as *O. onites* L. (bilyalikekik) and *O. vulgare* (karakımık), hold significant commercial value and are widely utilized as spices [10]. The aerial parts of *O. vulgare* and *O. onites*, particularly during their flowering phase, are commonly employed in the mediterranean region to alleviate acute symptoms of cough, cold, and flu. The essential oils produced by these species predominantly contain carvacrol and thymol [7, 94]. Traditionally, infusions derived from the aerial parts of *Origanum* have been used for various medicinal purposes, including antimicrobial, expectorant, analgesic, antitussive, and sedative [95, 96].

The pharmacological potency of *Origanum* is largely attributed to the synergistic action of carvacrol, thymol, and rosmarinic acid [97]. Essential oils and extracts obtained from *Origanum* exhibit a broad spectrum of biological activities, including antimicrobial, antiviral, antioxidant, and anti-inflammatory effects [98–100].

Considerable chemotypic variability has been reported in *O. vulgare*, with essential oils characterized by different dominant constituents such as thymol, carvacrol, sabinene and its hydrates, germacrene D,  $\beta$ -caryophyllene, and ocimenes, which contribute to variations in biological activity.

These bioactive compounds primarily disrupt bacterial membrane integrity, leading to increased permeability and leakage of vital intracellular components. Beyond membrane disruption, their multi-target profile includes inhibition of membrane-associated ATPases, suppression of efflux pumps, and interference with bacterial motility. Their ability to destroy existing biofilms is especially important in treating persistent respiratory infections. Furthermore, the ability of thymol and carvacrol may act synergistically with conventional antibiotics, offering a promising strategy to combat the escalating global challenge of antimicrobial resistance [100, 101].

Beyond their antimicrobial potential, *Origanum*-derived products display marked antioxidant and anti-inflammatory activities, mediated in part by modulation of cytokine production and inflammatory pathways [97]. In traditional and complementary medicine, oregano essential oil and extracts are used for their antiseptic and expectorant effects, in digestive disorders, as mouth and throat rinses, and in inhalations for upper respiratory tract inflammation [74].

#### 4.5.3 | *Teucrium* (Germander)

The genus *Teucrium* comprises 34 species in Türkiye [5]. Among them, *Teucrium polium* L. has been widely used in traditional medicine for over 2000 years for the management of cough, chronic bronchitis, common cold, and influenza. Its therapeutic efficacy is primarily attributed to a diverse phytochemical profile, including flavonoids (notably rhoifolin), terpenoids (thymol, carvacrol,  $\alpha$ -humulene), and  $\beta$ -caryophyllene, which collectively ameliorate airway hyperresponsiveness and obstructive symptoms [103–105].

Experimental models have demonstrated that *T. polium* extracts attenuate pulmonary inflammation and prevent bronchial epithelial remodeling, a key factor in chronic airway disease. Mechanistically, the extract restores immune homeostasis by increasing levels of IFN- $\gamma$  and IL-12A, while suppressing Th2 cell differentiation and Th17-mediated neutrophilic inflammation [103, 104]. In addition, rhoifolin, a polyphenolic compound isolated from *T. polium*, has been investigated for its potential to mitigate cigarette smoke-induced pulmonary injury [105].

Moreover, the flavonoid-rich fractions of *T. polium* exhibit antiviral activity, notably inhibiting the infectivity of the human influenza virus in *in vitro* investigations [103, 106]. However, despite these promising findings, the potential for hepatotoxicity and nephrotoxicity with prolonged use necessitates careful dose standardization and safety evaluation [102]. Overall, *T. polium* may represent a promising phytotherapeutic candidate for allergic and chronic respiratory disorders.

#### 4.5.4 | *Thymus* (Thyme)

The genus *Thymus*, represented by approximately 40 taxa in Türkiye, is a cornerstone of mediterranean ethnomedicine for respiratory disorders [5, 10]. The aerial parts and leaves are commonly prepared as infusions and decoctions and are extensively utilized in traditional Turkish medicine. Its essential oil, often rich in thymol, carvacrol, caryophyllene, and rosmarinic acid, possesses antioxidant, antibacterial, anti-inflammatory, and anti-biofilm properties [107]. While *T. sipyleus* inhalation is traditionally favored for sinusitis, *T. vulgaris* is clinically recognized for its mucolytic, antiseptic, anti-inflammatory, antitussive, bronchodilatory, and antimicrobial effects [108–111].

*Thymus* essential oil exhibits pronounced chemical polymorphism; while many populations are dominated by thymol and carvacrol along with their precursors *p*-cymene and  $\gamma$ -terpinene, other chemotypes may feature 1,8-cineole,  $\alpha$ -terpineol, geranial, neral,  $\alpha$ -pinene, intermedeol, or  $\beta$ -caryophyllene [108, 109]. These oils exhibit strong antimicrobial activity against several respiratory pathogens, including *Staphylococcus aureus*, *Streptococcus pyogenes*, *Moraxella catarrhalis*, and methicillin-resistant *S. aureus*, and effectively inhibit biofilm formation in opportunistic pathogens such as *P. aeruginosa* and *S. epidermidis* [108]. Anti-inflammatory effects are also reported, primarily through inhibition of the 5-LOX enzyme, which reduces production of leukotrienes and prostaglandins [108, 109, 111].

Clinically, *T. vulgaris*-based inhalation therapy has been reported to improve mucus clearance, oxygen saturation, and airway pressure in mechanically ventilated patients [110]. Toxicological data further indicate a favorable safety profile; for instance, methanol extracts of *T. longicaulis* show no acute toxicity at doses up to 2000 mg/kg and exhibit minimal cytotoxic and genotoxic effects on healthy cells [111, 112].

### 4.6 | Malvaceae

The Malvaceae family is represented in Türkiye by 10 genera and 46 species, with many genera having a single species [3]. Among these, five different genera, *Alcea*, *Althaea*, *Hibiscus*, *Lavatera*, and *Malva*, are commonly utilized by Anatolian people for treating respiratory diseases. The family Malvaceae, particularly *Malva sylvestris* (common mallow) and *Alcea rosea* (hollyhock), is rich in bioactive secondary metabolites. Members of the order Malvales are characterized by abundant mucilage deposits composed mainly of high-molecular-weight acidic polysaccharides such as glucuronic acid, galacturonic acid, rhamnose, and galactose. The family also exhibits a characteristic flavonoid profile including malvin (malvidin-3,5-diglucoside), gossypin, hypolaetin, apigenin, and quercetin [113].

#### 4.6.1 | *Malva* (Mallow)

The leaves and flowers of *Malva* are widely employed for treating an extensive array of conditions, including bronchitis, cough, sore throat, throat infections and common colds, in Türkiye [114]. This genus contains mucilage, glucose, and pectin, which are constituents responsible for its therapeutic effects, particularly

their anti-complementary, softening, and cough suppression activities [115, 116].

Their mucilage forms a protective bio-adhesive layer on irritated mucosal tissues, helping to soothe the respiratory tract and reduce dry cough, while also exhibiting anti-complementary and immunomodulatory effects [115, 116]. Experimental studies have shown that their extracts can regulate immune responses by influencing cytokines such as IL-4, IL-12, and IFN- $\gamma$  and by inhibiting the COX pathway, thereby reducing inflammation [117]. In addition, these species contain antioxidant compounds such as ascorbic acid,  $\alpha$ -tocopherol, and polyphenols, which act as radical scavengers and inhibit lipid peroxidation. The terpenoid malvone A further contributes to plant defense by exhibiting antimicrobial activity against pathogens such as *Verticillium dahliae* [115, 116].

#### 4.6.2 | *Alcea*

The flowers of *Alcea biennis* and *Althaea officinalis* are well-known for their high mucilage content, and they are commonly utilized for alleviating throat pain and coughs associated with colds, as well as for conditions such as inflammation and asthma [118, 119]. Although the pharmacopeia includes detailed monographs on the root of *Alcea*, its flowers are more frequently used in traditional practices and warrant further research to validate their health benefits fully.

#### 4.6.3 | *Tilia* (Lime Tree)

The genus *Tilia* (formerly placed in Tiliaceae), is characterized by drooping inflorescences with bract-adnate peduncles. The dried inflorescences, particularly those from *T. tomentosa* (syn. *T. argentea* Desf. ex DC., 14 citations) and *T. platyphyllos* Scop. (syn: *T. rubra* DC. 11 citations), They are widely utilized as herbal tea to treat bronchitis, colds, coughs, and flu, and as an expectorant in Anatolia. Both the commission of European and British monographs endorse the use of *T. cordata* and/or *T. platyphyllos* flowers for upper respiratory catarrh, common colds, irritable coughs, hypertension, and restlessness [120, 121].

*Tilia tomentosa* contains flavonoids, predominantly quercetin glycosides, such as rutin, quercitrin, and isoquercitrin, kaempferol glycosides like tiliroside, and phenolic acids, such as caffeic, *p*-coumaric, and chlorogenic acids [122]. Mucilages in the bracts are largely made up of galactomannans, phenolic acids, and proanthocyanidins, while a minor proportion of volatile oil components, including farnesol, farnesyl acetate, geraniol, and eugenol, contribute to the characteristic faint odor of the drug [123].

Infusions of *T. cordata* and *T. argentea* demonstrated pronounced anti-inflammatory activity mediated by flavan-3-ol derivatives, supporting their use in common cold, pharyngitis, and tonsillitis [124, 125]. Furthermore, immunomodulatory pectins identified in silver linden flowers were shown to stimulate the production of ROS and NO, indicating activation of immune-related pathways associated with inflammation control [125].

Lime flowers represent an important source of mucilage, which forms adhesive polysaccharide–hydrocolloid layers on irritated mucosal surfaces. This mechanical shield exerts a soothing effect that alleviates cough and catarrhal irritation. The pharmacological effects of *Tilia* extracts are attributed to the combined action of flavonoids and polysaccharides, which modulate inflammatory mediators, regulate oxidative stress responses, and enhance local immune defense [126, 127].

#### 4.7 | Pinaceae

The Pinaceae family, which belongs to the Conifers, is the most abundant and is especially prevalent in the Northern hemisphere. It includes genera such as *Abies* (firs), *Picea* (spruces), and *Pinus* (pines). In Türkiye, the genera *Pinus* (36 citations), *Abies* (7 citations), *Picea* (2 citations), and *Cedrus* (1 citation) are used by local people [3].

*Pinus* is the most frequently utilized genus for respiratory conditions, including asthma, bronchitis, and pulmonary diseases. Its young branches, cones, and resins are traditionally administered as decoctions, ointments, therapeutic baths, or inhalation therapies [128–131].

The primary constituents of pine essential oil include  $\alpha$ -pinene, camphene,  $\beta$ -pinene,  $\delta$ -3-carene,  $\beta$ -myrcene, limonene,  $\beta$ -phellandrene,  $\alpha$ -terpinolene,  $\beta$ -caryophyllene, germacrene D, and  $\delta$ -cadinene [132]. Essential oils derived from the needles mainly consist of pinene, carene, and limonene, whereas those obtained from the cones are characterized by the presence of caryophyllene and carene [131].

Essential oils derived from pine twigs exhibit significant anti-inflammatory activity, surpassing the effects of oils extracted from the needles or cones [133]. It is suggested that  $\alpha$ -pinene significantly influences cytokine regulation, while *Abies koreana* oil, rich in bornyl acetate, limonene, and  $\alpha$ -pinene, inhibits the production of IL-1 $\beta$ , IL-6, and TNF- $\alpha$  in LPS-stimulated macrophages [134]. The anti-inflammatory activity of *Pinus mugo* essential oils is attributed to major compounds  $\alpha$ -pinene, limonene, and  $\delta$ -3-carene, which assist in downregulating neutrophil activity [135].

Pycnogenol, a commercial product standardized from the bark of *Pinus pinaster* Aiton. It is clinically recognized for its ability to suppress pro-inflammatory cytokine actions and inhibit viral replication [136]. Clinical studies cross various phases demonstrate that Pycnogenol mitigates asthmatic responses and protects against allergic airway inflammation [135, 137–139]. Notably, the rich polyphenolic content of Turkish native species, such as *Pinus brutia*, *P. nigra*, *P. pinea*, and *P. sylvestris*, suggests they may serve as potent local alternatives to the French *P. pinaster* [136].

#### 4.8 | Plantaginaceae

The genus *Plantago* is commonly utilized in traditional medicine for catarrhs and inflammatory disorders affecting the oral and pharyngeal mucosa, sore throats, common colds, coughs, bronchitis, and inflammation of the mouth and pharynx [140]. Species

such as *Plantago lanceolata* and *Plantago major* are rich sources of phenolics like alkaloids, caffeic acid, flavonoids, iridoid glycosides, vitamins, various organic acids, fatty acids, and carotenes [141–143], along with mucilage, polysaccharides, and terpenoids [144].

Owing to its demulcent properties, *Plantago* leaf preparations have been recognized by EMA for the symptomatic relief of oral and pharyngeal irritation associated with cough. Clinical evidence underscores the efficacy of *Plantago* syrups: a study on 593 patients reported 80% reductions in chest pain and a 67% decrease in cough severity [145]. In acute bronchitis, *P. major* has been shown to significantly reduce cough frequency and sputum production [146]. The mucilage components form a protective layer over mucosal surfaces, thereby reducing irritation and suppressing the cough reflex [147].

Evidence also supports a role for *Plantago* in asthma management, particularly through bronchodilatory and anti-inflammatory mechanisms. Clinically, *P. major* seeds used as adjunct therapy in patients with refractory asthma were associated with improvements in pulmonary function parameters and significant reductions in wheezing, cough, and dyspnea [148]. Mechanistically, these extracts exert bronchodilatory effects via calcium channel blockade and muscarinic/histamine receptor inhibition [142]. *In vivo* studies indicate that *Plantago* restores alveolar epithelial integrity and reduces mucus hypersecretion (MUC5AC) by suppressing NF- $\kappa$ B and PI3K/Akt signaling pathways [149, 150].

Additionally, *Plantago* exhibits broad-spectrum antimicrobial and antiviral properties. Pectin polysaccharides are effective against *S. pneumoniae*, while acteoside has been reported to inhibit respiratory syncytial virus (RSV) replication, a finding of particular relevance for severe lower respiratory infections in children [151, 152]. The available evidence suggests that *Plantago* species exhibit anti-inflammatory, antispasmodic, antitussive, and antiviral properties, which are particularly relevant in respiratory disorders such as cough, bronchitis, and asthma. The synergy between mucosal-protective mucilages and inflammation modulating phenolics supports *Plantago* as a potent adjunctive agent in respiratory therapy.

#### 4.9 | Rosaceae

The Rosaceae family is represented by 35 genera in Türkiye [3] and is primarily recognized for its fruits and traditional therapeutic applications. All members of this family are cultivated globally, highlighting their importance across various cultures. The biological properties of Rosaceae members are significantly influenced by various phytochemicals, particularly terpenoids and phenolic compounds, including flavonoids [153]. Phenolic compounds play a crucial role in a wide range of biochemical activities, acting as free radical scavengers and antioxidants [153], as well as exhibiting anti-inflammatory properties [154].

The findings align with previous research, which identified *Rosa* (10 taxa), *Crataegus* (9 taxa), *Rubus* (7 taxa), *Cerasus* (5 taxa), and *Sorbus* (4 taxa) as the most frequently utilized taxa for respiratory diseases in Anatolia [155]. This review highlights commonly

mentioned taxa, such as *R. canina*, *C. oblonga*, and *Rubus sanctus*, with a focus on their medicinal and chemical properties. These Rosaceae members are considered safe, as no toxic or adverse effects have been reported at recommended therapeutic dosages.

#### 4.9.1 | *Cydonia* (Quince)

*Cydonia oblonga* is a small tree or large shrub native to the Caucasian region and extensively cultivated in Türkiye for its fruits [3]. Different parts of *C. oblonga* have traditionally been utilized for respiratory diseases such as asthma, cough, and bronchitis [156]. Among the diverse secondary metabolites identified, including carotenoids, pectin, triterpenes, volatile terpenoids, dibenzofurans, long-chain fatty acids, and phenolics are the predominant phytochemical constituents of the plant. Among the phenolic constituents, caffeoylquinic acid derivatives are the most frequently reported compounds [157]. Various parts of the plant, including the fruits, fruit peel, seeds, leaves, and flowers, have been utilized for different purposes. To date, most studies have focused on the seeds because of their high mucilage content and associated pharmaceutical applications [158].

In Türkiye, the leaves of *C. oblonga* are traditionally used internally for the treatment of respiratory disorders. The leaves have historically been employed in the management of cough, cold, and fever [159, 160]. Several studies have investigated the phytochemical composition of *C. oblonga* leaves, and their significant antioxidant potential has also been documented [160–163].

The extracts from the leaves and fruit peel of *C. oblonga* demonstrate anti-inflammatory activity, with studies indicating that fruit peel extracts inhibit the release of inflammatory mediators, such as cytokines (TNF- $\alpha$ ) and interleukins (IL-8), while promoting the release of interleukin-10 and interleukin-6 from mast cells [164]. These properties could hold significant potential for therapeutic applications in managing inflammatory conditions. However, despite their confirmed phytochemical richness, pharmacological studies specifically investigating the therapeutic effects and underlying mechanisms of *C. oblonga* leaves remain limited.

#### 4.9.2 | *Rosa* (Rose)

*Rosa canina* (dog rose) is widely consumed for treating respiratory diseases and colds in Anatolia (Table 1) [165]. The pseudo-fruits, referred to as rose hips, consist of a U-shaped receptacle filled with numerous achenes. Traditionally, these pseudo-fruits are employed for the prevention and treatment of colds, influenza-like infections, and pulmonary ailments, primarily due to their high vitamin C content [166].

Its therapeutic profile is characterized by a high concentration of Vitamin C, combined with a diverse array of bioactive compounds including phenolics, flavonoids, tocopherols, and carotenoids [167–169]. Its anti-inflammatory activity has also been confirmed *in vivo*, as the aqueous extract significantly reduced inflammation in the formalin-induced paw edema model in rats [171–174]. Mechanistically, fatty acids such as linoleic and  $\alpha$ -linolenic acid inhibit COX-1 and COX-2 enzyme activities, while specific galac-

tolipids suppress neutrophil chemotaxis in human blood [175, 176]. In addition, triterpenic acids (e.g., oleanolic and ursolic acid) have been reported to downregulate IL-6 production, contributing to the plant's significant immunomodulatory effects [177].

Moreover, *R. canina* has been widely used in the treatment of various inflammatory conditions due to its vitamin C and fatty acid content [178, 179]. As a natural vitamin C source, *R. canina* is frequently utilized to help prevent acute respiratory infections and to reduce the duration and severity of certain infections. Vitamin C is critical for immune function, with its deficiency linked to heightened susceptibility to infections [180]. Overall, *R. canina* may enhance resistance to infections and inflammatory conditions through its antioxidant, anti-inflammatory, and immunomodulatory properties. Therefore, rather than acting solely as a symptomatic treatment, *R. canina* appears to function primarily as a supportive therapeutic agent, particularly in the prevention and management of acute respiratory infections.

#### 4.9.3 | *Rubus* (Raspberry and Blackberry)

The genus *Rubus* comprises nine species in Türkiye [3] and is primarily recognized for its fruit. Leaves, fruits, roots, and young shoots of various species, including *R. sanctus* Schreb, *R. canescens* DC., *R. discolor* Weihe & Nees, *R. idaeus* L., *R. serpens* Weihe ex Lej. & Courtois, and *R. ulmifolius* Schott, are commonly utilized by local populations.

Its diverse chemical profile includes approximately 260 compounds, with ellagitannins, ellagic acid, and anthocyanins identified as the primary drivers of its antibacterial and immunomodulatory properties [181–183]. In addition, *Rubus* polysaccharides, which represent a group of macromolecular compounds, have exhibited diverse biological activities in both *in vitro* and *in vivo* studies, including antioxidant, immunomodulatory, and anti-inflammatory effects [184].

In both European and Anatolian traditional medicine, *Rubus* preparations are recognized for their antiviral and antipyretic activities, particularly in treating tonsillitis and pharyngitis [185, 188]. Mechanistically, flavonoid-rich fractions and branch extracts from *R. ulmifolius* demonstrate broad-spectrum viral inhibition and mucosal protection [187–189].

Despite *R. idaeus* [190] being the most extensively studied *Rubus* species in Türkiye, *R. sanctus* is the most commonly utilized species in traditional medicine for respiratory disorders. However, pharmacological studies on this species remain limited and have primarily focused on its antioxidant, antimicrobial, and anti-inflammatory activities [191–193]. Despite the widespread traditional use of *Rubus* species in respiratory conditions, their pharmacological mechanisms of action have not yet been fully elucidated. Therefore, comprehensive pharmacological and mechanistic studies are required to validate their traditional uses.

#### 4.10 | Santalaceae

*Viscum album* (common name: Mistletoe) is an evergreen, semi-parasitic plant from the Santalaceae family that grows on various

deciduous trees such as apple, oak, pine, and fir [194]. Preparations derived from this plant, such as fresh juice, tinctures, and decoctions, are employed to treat coughs and inflammation of lymphatic glands. Additionally, it is used as a sedative and analgesic remedy. Mistletoe is recognized for its diverse array of chemical components, including lectins, viscotoxin, triterpenes, flavonoids, peptides, such as viscumamide, amino acids, thiols, amines, and polysaccharides [195–197]. In addition to these toxic proteins, the plant extract contains numerous other functional phytochemicals, including flavonoids, peptides (such as viscumamide), specific enzymes, amino acids, thiols, amines, polysaccharides, cyclitols, lipids, phytosterols, triterpenes, and phenylpropanes.

The plant exerts a potent anti-inflammatory effect by dose-dependently inhibiting the cellular secretion of PGE<sub>2</sub>. Interestingly, *V. album* does not inhibit the mRNA transcription of the COX-2 gene; instead, it acts post-transcriptionally to drastically suppress the actual protein expression of COX-2 induced by inflammatory cytokines like IL-1 $\beta$ . Crucially, this mechanism is highly selective: the plant inhibits COX-2 without modulating the constitutive expression of COX-1. This selectivity makes it an attractive therapeutic alternative, as it bypasses the severe gastrointestinal side effects commonly caused by traditional NSAIDs that indiscriminately inhibit both COX-1 and COX-2 [198].

#### 4.11 | Urticaceae

*Urtica dioica* L. (stinging nettle), locally known as “Isırgan otu”, has a long-standing history in managing asthma, cough, and tuberculosis [199]. Both lipophilic and hydrophilic fractions of *U. dioica* contain bioactive constituents, and different plant parts (leaves, roots, and seeds) exhibit distinct phytochemical profiles. The aerial parts are characterized by a rich phenolic composition, whereas the roots contain comparatively higher levels of lectins and lignans [200, 201]. The stinging trichomes responsible for skin irritation contain various neurotransmitters and organic acids, including acetylcholine, histamine, formic acid, and serotonin [202].

*U. dioica* is included in authoritative monographs, which recognize its anti-inflammatory, immunomodulatory properties and support its safe use at recommended therapeutic doses [203, 204]. *In vivo* models confirm the efficacy of *U. dioica* against airway inflammation, with leaf extracts demonstrating significant antihistaminic and anti-allergic activities [205, 206]. Seed preparations have been reported to be more effective than leaf extracts in suppressing key pro-inflammatory cytokines (IL-4, IL-5, IL-13, and IL-33), thereby attenuating mucus hypersecretion and goblet cell hyperplasia [207].

*In vitro* investigations related to allergic rhinitis have demonstrated H<sub>1</sub> receptor antagonism and inverse agonism, along with inhibitory activity against COX-1, COX-2, and hematopoietic prostaglandin D<sub>2</sub> synthase [208, 209]. Beyond anti-inflammatory effects, *U. dioica* lectins exhibit broad-spectrum antiviral activity, particularly against influenza, RSV, and HSV [200, 210]. *U. dioica* agglutinin (UDA), a plant-specific lectin, has been shown to inhibit SARS coronavirus replication by up to 90% *in vitro* and

to confer protection against lethal infection in animal models [211]. *In silico* studies indicate that phytochemicals such as  $\beta$ -sitosterol, rutin, luteoxanthin, and violaxanthin may inhibit the ACE2 receptor, which plays a key role in viral entry into host cells [212]. However, the clinical application of *U. dioica* in respiratory care requires caution. The presence of bioactive amines (acetylcholine, histamine, and serotonin) in the plant's trichomes can induce acute tracheal smooth muscle contraction even at low concentrations. Consequently, its consumption is generally not recommended for patients with asthma or COPD due to potential bronchoconstrictive risks [213]. Moreover, robust, scientifically validated clinical trials establishing the long-term safety and efficacy of *U. dioica* in chronic inflammatory respiratory diseases remain limited.

#### 4.12 | Viburnaceae

In Anatolia, the flowers and herbs of *Sambucus nigra* (common name: Elderberry) are used internally as expectorants for treating coughs, colds, flu, bronchitis, shortness of breath, and asthma [214]. While the flowers contain higher concentrations of phenolic compounds compared to the fruits and leaves, both are rich in bioactive anthocyanins and flavonoids [215, 216]. However, the presence of cyanogenic glycosides, specifically sambunigrin and prunasin, necessitates caution; these compounds are most concentrated in the leaves, with lower levels found in the flowers and berries [217, 218].

Due to the presence of flavonoids, particularly anthocyanins, *S. nigra* flowers exhibit a broad array of activities, including antioxidant, anticarcinogenic, immune-stimulating, antipyretic, anti-inflammatory, antiallergic, antibacterial, and antiviral effects [216]. Berry extracts have demonstrated significant inhibitory effects against HIV, influenza A and B viruses, and the infectious bronchitis virus [219–221]. Polyphenolic constituents are considered effective factors in these antiviral activities.

Consumption of elderberry beverages stimulates the proliferation of  $\gamma\delta$ -T cells, which act as the first line of defense in the epithelium, thereby helping to alleviate symptoms associated with colds and flu [222]. These properties have led to the global commercialization of *S. nigra* supplements, such as Sambucol, available in various formulations for the management of colds, flu, and other infectious respiratory illnesses [223, 224].

### 5 | Discussion

Respiratory diseases are often preventable, and proactive interventions are generally more sustainable and cost-effective than reactive treatments. Controlling pathogenic causes such as bacteria and viruses, while enhancing immune function through specialized nutrition and phytotherapy, can significantly diminish the global impact of respiratory illnesses [16]. Many medicinal plants have been historically used to treat and prevent respiratory diseases. These plants are preferred due to their cost-effectiveness and ease of cultivation. Traditionally, medicinal plants have been favored for their accessibility and diverse therapeutic profiles, as they contain numerous therapeutic compounds that provide various benefits, including antioxidant, antibacterial,

antiviral, antitussive, antipyretic, immunomodulatory, and anti-inflammatory effects. The anti-inflammatory properties of these plants are particularly important in the management of respiratory disorders, as such conditions are often associated not only with microbial infections but also with inflammation of the airway mucosa [225]. While the historical clinical use of many taxa is well-documented [226, 227], the transition to evidence-based medicine requires a rigorous evaluation of their molecular targets.

### 5.1 | Acute Infectious Pathways and Broad-Spectrum Defense

The efficacy of Anatolian remedies against acute infections is largely driven by essential oils and phenolic complexes. Essential oils of Cupressaceae, Lamiaceae, and Pinaceae are fundamentally linked to broad-spectrum antibacterial activity [226, 228]. As synthesized in Figure 2, these volatile constituents provide a rapid defense against respiratory pathogens. In parallel, antiviral activity is predominantly associated with polyphenols and phenolic acids (e.g., rosmarinic, chlorogenic, and caffeic acids) and diverse alkaloids [229, 230].

Taxa such as *Rosa canina*, *Rubus* spp., *Sambucus nigra*, and *Cydonia oblonga* exert their effects through phenolics, flavonoids, anthocyanins, carotenoids, vitamins, and polysaccharides. These compounds confer antioxidant, anti-inflammatory, immunomodulatory, and antiviral effects, enhancing epithelial defenses and reducing oxidative stress and cytokine-mediated inflammation [159, 170, 171, 173, 176, 188]. Notably, *Sambucus nigra* distinguishes itself clinically through its ability to stimulate  $\gamma\delta$ -T cell proliferation, providing a dual-action approach: direct viral inhibition and enhanced host immune surveillance [231].

### 5.2 | Mucoprotective and Immunomodulatory Roles of Polysaccharides

A critical finding of this synthesis is the role of polysaccharides in mucilage-rich plants, like *Malva* and *Tilia*, as well as *Cydonia* seeds. They play important roles in various biological processes owing to their structural diversity and bioactivity. Unlike volatile-rich plants, these taxa provide mechanical mucosal protection by forming adhesive hydrocolloid layers, which physically shield the respiratory tract and reduce cough reflex [14, 231–233]. Polysaccharides also influence the immune system by activating macrophages, T/B lymphocytes, and natural killer cells [234]. By encouraging NO synthesis and balancing inflammatory/anti-inflammatory cytokines (e.g., IL-10), they stabilize the respiratory microenvironment [235]. The literature indicates that flavonoids are principal constituents of numerous folk remedies for respiratory ailments [236]. Flavonoids target prostaglandins involved in fever, and earlier studies suggest that flavonoids, tannins, and other phenolic compounds significantly contribute to the antipyretic effects of herbal medicines [237]. Comparison of citation frequencies (Figure 4) suggests that the high consensus on these taxa in folk medicine is due to this dual symptomatic-mechanistic action.

### 5.3 | Chronic Inflammatory and Allergic Airway Pathways

Chronic and allergic airway diseases are primarily driven by persistent inflammation, oxidative stress, and immune dysregulation, in contrast to acute respiratory conditions where infection is the dominant trigger. Therefore, therapeutic strategies in chronic conditions should mainly target inflammatory and immunological pathways rather than antimicrobial activity (Figure 5).

Within this framework, plants such as *U. dioica*, *Plantago* spp., *Tilia* spp., *Hypericum perforatum*, and members of Pinaceae (e.g., *Pinus* spp.) exert their effects through deep-tissue immunomodulation. Their bioactivity is largely attributed to diverse phytochemicals, including flavonoids (rhoifolin, quercetin glycosides), phenolic acids, polysaccharides, and essential oil terpenoids ( $\alpha$ -pinene, limonene, and  $\delta$ -3-carene). These compounds modulate Th2/Th17 cytokine signaling, stabilize reactive oxygen species and nitric oxide levels, inhibit COX and NF- $\kappa$ B pathways, and support mucosal protection [124, 125, 149, 150, 207]. As illustrated in Figure 3, *Plantago* spp. emerges as a high-priority candidate for chronic management due to its multi-target activity, including bronchodilatory, anti-inflammatory, and cough-suppressive effects, with additional supportive antiviral activity [142].

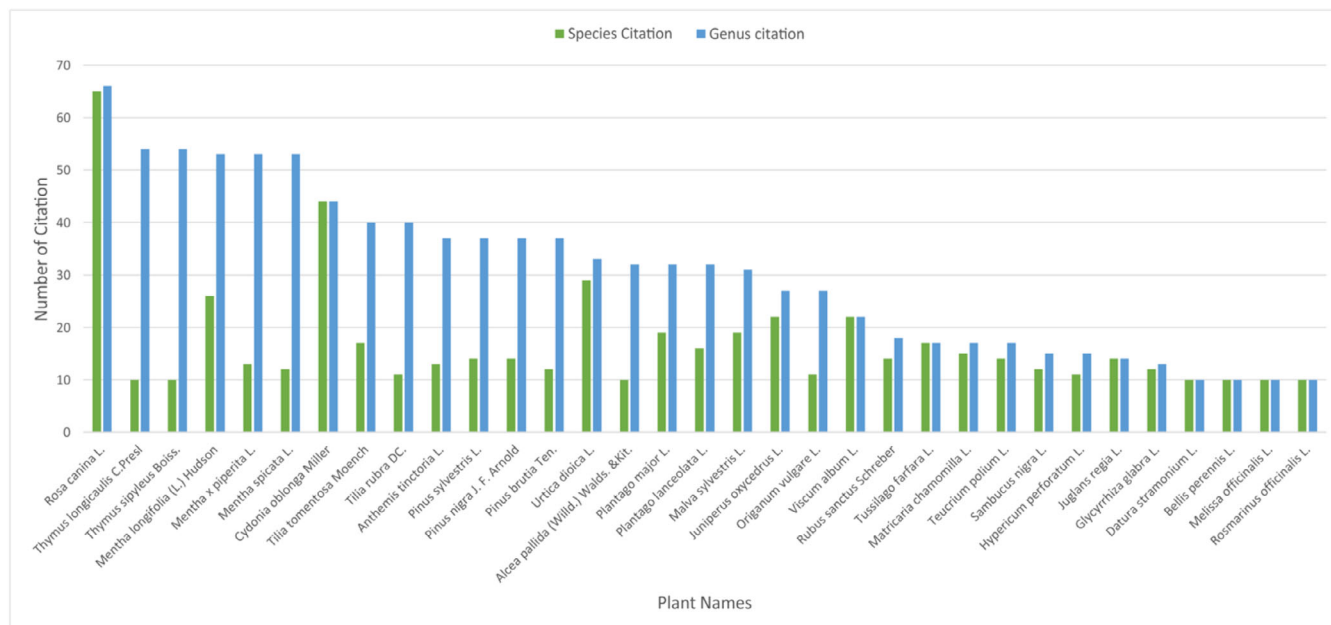
### 5.4 | Multifunctional Families and Literature Gaps

Multifunctional plant families such as Lamiaceae (*Mentha*, *Origanum*, *Thymus*, *Salvia*, *Teucrium*) and Asteraceae (*Artemisia*, *Anthemis*, *Bellis*, *Matricaria*) demonstrate both anti-inflammatory and antimicrobial activities, addressing infectious, inflammatory, and febrile respiratory conditions. Essential oils rich in thymol, carvacrol, menthol, pulegone,  $\alpha$ -humulene, and  $\beta$ -caryophyllene, along with flavonoids and phenolic acids, contribute to antioxidant, antiviral, antitussive, and immunomodulatory effects, supporting upper and lower respiratory tract health while also mitigating pathogen-induced and inflammatory damage [27, 74, 84, 103].

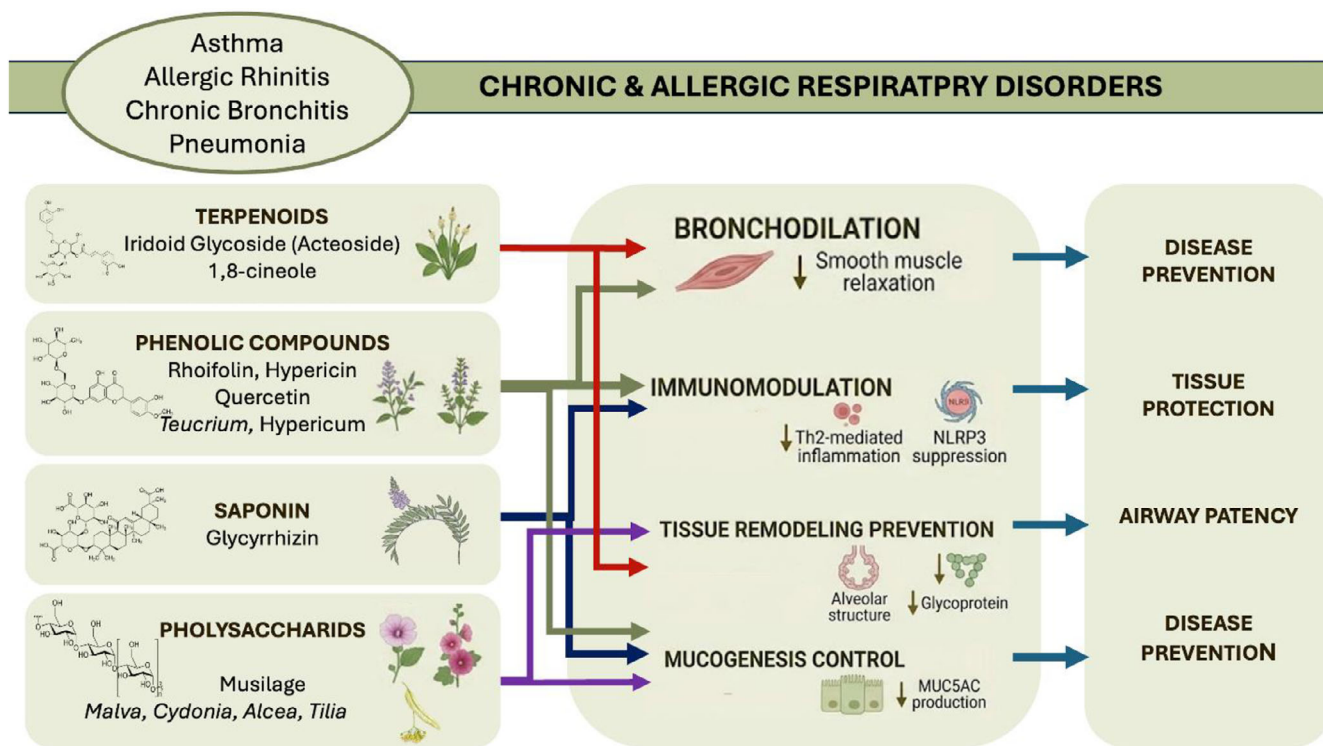
Several traditionally used plants, such as *Rubus* spp., *Cydonia oblonga*, and less studied *Plantago* species, demonstrate promising respiratory benefits but remain poorly characterized pharmacologically. While ethnomedicinal use suggests anti-inflammatory, antiviral, or mucoprotective potential, mechanistic studies and clinical trials are scarce, underscoring the need for targeted investigations to validate efficacy, optimize dosing, and clarify active constituents [164, 191, 151].

### 5.5 | Toxicological Imperatives and Safety

Lamiaceae chemotypes rich in pulegone or thujone may exert hepatotoxic or neurotoxic effects, particularly in children or during prolonged use [23, 85, 78]. *Sambucus nigra* leaves contain cyanogenic glycosides, necessitating caution in preparation and dosage [217, 218]. These findings highlight the importance of standardized extracts, chemotype identification, and safety evaluation in phytotherapeutic applications.



**FIGURE 4** | Comparison of the citation frequency per genus with the citation frequency per most used species (the medicinal plants) in the treatment of respiratory diseases.



**FIGURE 5** | Mechanistic pathways of prioritized Anatolian medicinal plants in the management of chronic and allergic respiratory disorders.

## 6 | Conclusion

This comprehensive review highlights the plants traditionally used for respiratory disease treatment in Anatolia and emphasizes their frequent incorporation into folk medicine practices. A total of 508 taxa were identified in ethnobotanical studies, with a particular emphasis on 33 commonly utilized plants and their

key phytochemicals responsible for biological activities related to respiratory health. Frequently employed taxa such as *Cydonia oblonga*, *Rosa canina*, and *Tilia tomentosa* remain foundational for acute symptomatic relief, while the Lamiaceae family (*Mentha longifolia*, *Mentha x piperita*, *Origanum vulgare*, *Salvia* spp., *Thymus* spp., and *Sideritis* spp.) provides a versatile chemical library of terpenoids essential for antimicrobial and mucolytic

action. Moreover, *Plantago major*, *P. lanceolata*, and several members of the Asteraceae family, such as *Anthemis*, *Matricaria*, and *Tussilago farfara*, play significant roles in treating cough, the most prevalent respiratory disease symptom, and act as expectorants.

For chronic conditions characterized by inflammation, such as asthma and shortness of breath, *Juniperus oxycedrus*, *Rosa canina*, *Viscum album*, and *Urtica dioica* represent some of the most frequently used taxa. These plants transition from traditional decoctions to promising pharmacological leads through their ability to modulate Th2/Th17 cytokines and inhibit the NF- $\kappa$ B/COX-2 cascades. Furthermore, the frequent application of *Anthemis tinctoria*, *Artemisia absinthium*, *Teucrium polium*, and *Salix* spp. in fever management suggests a potent antipyretic potential that warrants rigorous clinical validation.

However, the transition from folk medicine to standardized phytotherapy must be guided by toxicological vigilance. The presence of neurotoxic thujone in certain Asteraceae or the paradoxical bronchoconstrictive risk of *Urtica* amines necessitates strict chemotype standardization. As the global burden of viral and antibiotic-resistant respiratory diseases escalates, the Anatolian botanical heritage offers a high-priority reservoir for drug discovery. Future research must prioritize the synergistic potential of these multi-component systems and their interactions with conventional antivirals and immunosuppressants. By bridging the gap between traditional citation frequency and mechanistic clarity, this review provides a roadmap for integrating Anatolian biodiversity into evidence-based respiratory clinical guidelines.

#### Author Contributions

**Golshan Zare:** conceptualization, data curation, methodology, investigation, validation, and writing – original draft preparation, review, and final editing. **Yağmur Diker:** investigation, formal analysis, writing – original draft preparation. **Irem Tatlı Çankaya:** investigation, formal analysis, software, writing – original draft preparation. **Emran Habibi:** investigation, review, and final editing. **Satyajit D. Sarker:** investigation, review, and final editing; **Lutfun Nahar:** conceptualization, investigation, and writing – original draft preparation, review, and final editing. All authors reviewed the final version.

#### Funding

No funding was received.

#### Ethics Statement

Not applicable.

#### Consent

Not applicable.

#### Availability of Data and Material

Not applicable.

#### Conflicts of Interest

The authors declare no conflicts of interest.

#### Data Availability Statement

Research data are not shared.

#### References

1. L. Gandhi, D. Maisnam, D. Rathore, P. Chauhan, A. Bonagiri, and M. Venkataramana, "Respiratory Illness Virus Infections With Special Emphasis on COVID-19," *European Journal of Medical Research* 27 (2022): 236, <https://doi.org/10.1186/s40001-022-00874-x>.
2. H. A.-L. Mousa, "Prevention and Treatment of Influenza, Influenza-Like Illness, and Common Cold by Herbal, Complementary, and Natural Therapies," *Journal of evidence-based complementary & alternative medicine* 22 (2017): 166–174, <https://doi.org/10.1177/2156587216641831>.
3. P. Davis, R. Miller, and K. Tan, "*The Flora of Türkiye and the East Aegean Islands: v. 10: and the East Aegean Islands*," (Edinburgh University Press, 1988).
4. E. Sezik, E. Yeşilada, G. Honda, Y. Takaishi, Y. Takeda, and T. Tanaka, "Traditional Medicine in Türkiye X. Folk Medicine in Central Anatolia," *Journal of Ethnopharmacology* 75 (2001): 95–115, [https://doi.org/10.1016/S0378-8741\(00\)00399-8](https://doi.org/10.1016/S0378-8741(00)00399-8).
5. A. Güner and S. Aslan, "Türkiye bitkileri listesi:(damarlı bitkiler)," (2012), *Nezahat Gökyiğit Botanik Bahçesi Yayınları*.
6. M. Coşkun and A. M. G. Özkan, "Global Phytochemistry: the Turkish Frame," (2005), <https://doi.org/10.1016/j.phytochem.2005.03.012>.
7. I. Uysal, S. Guecel, T. Tütenocakli, and M. Öztürk, "Studies on the Medicinal Plants of Ayvacik-Çanakkale in Türkiye," *Pakistan Journal of Botany* 44 (2012): 239–244.
8. J. Noroozi, G. Zare, M. Sherafati, et al., "Patterns of Endemism in Türkiye, the Meeting Point of Three Global Biodiversity Hotspots, Based on Three Diverse Families of Vascular Plants," *Frontiers in Ecology and Evolution* 7 (2019): 159, <https://doi.org/10.3389/fevo.2019.00159>.
9. J. Gerard, "The Herball or General History of Plantes. Imprinted by John Norton, London, 1597. Cited as: Saddiq Z, Naeem I, Maimoona A. A Review of the Antibacterial Activity of Hypericum Perforatum L.," *Journal of Ethnopharmacology* 131 (2010): 511–521.
10. T. Baytop, "Therapy with Medicinal Plants in Türkiye (Past and Present)," *Publication of the Istanbul University* 312 (1999): 2.
11. N. Mamedov and L. E. Craker, "Medicinal Plants Used for the Treatment of Bronchial Asthma in Russia and Central Asia," *Journal of Herbs, Spices & Medicinal Plants* 8 (2001): 91–117, [https://doi.org/10.1300/J044v08n02\\_03](https://doi.org/10.1300/J044v08n02_03).
12. B. Mustafa, A. Hajdari, F. Krasniqi, et al., "Medical Ethnobotany of the Albanian Alps in Kosovo," *Journal of Ethnobiology and Ethnomedicine* 8, no. 1 (2012): 6, <https://doi.org/10.1186/1746-4269-8-6>.
13. N. Farzaneh, M. Mahmoud, M. Saeed Mohammadi, and G. Abdolbaset, "Labiatae family in Folk Medicine in Iran: From Ethnobotany to Pharmacology," *Iranian Journal of Pharmaceutical Research* 2 (2005): 63–79.
14. L. Talarico, C. Pujol, R. Zibetti, et al., "The Antiviral Activity of Sulfated Polysaccharides Against Dengue Virus is Dependent on Virus Serotype and Host Cell," *Antiviral Research* 66 (2005): 103–110, <https://doi.org/10.1016/j.antiviral.2005.02.001>.
15. I. E. Cock and S. F. Van Vuuren, "The Traditional Use of Southern African Medicinal Plants in the Treatment of Viral respiratory Diseases: A Review of the Ethnobotany and Scientific Evaluations," *Journal of Ethnopharmacology* 262 (2020): 113194, <https://doi.org/10.1016/j.jep.2020.113194>.
16. T. Ferkol and D. Schraufnagel, "The Global Burden of Respiratory Disease," *Annals of the American Thoracic Society* 11 (2014): 404–406, <https://doi.org/10.1513/AnnalsATS.201311-405PS>.
17. WFO (2026): World Flora Online Published on the Internet; <http://www.worldfloraonline.org>. Accessed on: 09 Mar 2026.

18. Ö. Ertürk and Z. Demirbag, "Scorzonare mollis Bieb (Compositae) Bitkisinin Antimikrobiyal Aktivitesi," *Ekoloji çevre dergisi* 12 (2003): 27–31.
19. D. Hristozov, F. B. Da Costa, and J. Gasteiger, "Sesquiterpene Lactones-Based Classification of the Family Asteraceae Using Neural Networks and k-Nearest Neighbors," *Journal of Chemical Information and Modeling* 47 (2007): 9–19, <https://doi.org/10.1021/ci060046x>.
20. European Medicines Agency (EMA/HMPC), "Community Herbal Monograph on *Artemisia absinthium* L., herba" <EMA/HMPC/234463/2008>.
21. J. D. Staneva, M. N. Todorova, and L. N. Evstatieva, "Sesquiterpene Lactones as Chemotaxonomic Markers in Genus *Anthemis*," *Phytochemistry* 69 (2008): 607–618, <https://doi.org/10.1016/j.phytochem.2007.07.021>.
22. T. M. Gönenç, E. K. Akkol, I. Süntar, T. F. Erdoğan, and B. Kıvçak, "Fatty Acid Composition and Preclinical Researches on *Anthemis wiedemanniana* Fisch. & Mey.: Discovery of a New Anti-Inflammatory Agent," *Pharmacognosy Magazine* 10 (2014): 53–60, <https://doi.org/10.4103/0973-1296.126660>.
23. M. Chadwick, H. Trewin, F. Gawthrop, and C. Wagstaff, "Sesquiterpenoids Lactones: Benefits to Plants and People," *International Journal of Molecular Sciences* 14 (2013): 12780, <https://doi.org/10.3390/ijms140612780>.
24. European Medicines Agency, "Assessment report on *Chamaemelum nobile* (L.) All., flos" Committee on Herbal Medicinal Products (HMPC), <EMA/HMPC/560906/2010> (2011).
25. M. M. Bhat, A. P. Ansari, A. Ahmad, I. Qayoom, and B. M. Reshi, "Antipyretic Activity of the Hydro-Alcoholic Extract of *Artemisia absinthium* L. as a Standalone and as an Adjuvant With Barley Water Against Yeast-Induced Pyrexia in Albino Wistar Rats," *Journal of Complementary and Integrative Medicine* 21 (2023): 46–52.
26. M. Ivanov, U. Gašić, D. Stojković, M. Kostić, D. Mišić, and M. Soković, "New Evidence for *Artemisia absinthium* L. Application in Gastrointestinal Ailments: Ethnopharmacology, Antimicrobial Capacity, Cytotoxicity, and Phenolic Profile," *Evidence-Based Complementary and Alternative Medicine* 2021 (2021): 9961089.
27. A. Ukwubile, N. D. Menkiti, and S. Yakubu, "Phytochemical Contents, Evaluation of Antiulcer, Antipyretic, Antinociceptive, and Anti-Inflammatory Activities of *Artemisia absinthium* L. (Asteraceae) Leaf Extract in Wistar Rats," *International Journal of Pharmacognosy & Chinese Medicine* 8 (2024): 000270.
28. M. Țiclea, R. M. Pop, M. Pârvu, et al., "Flowers and Leaves of *Artemisia absinthium* and *Artemisia annua*: Phytochemical Characterization, Anti-Inflammatory, Antioxidant, and Anti-Proliferative Activities Evaluation," *Plants* 14 (2025): 1029.
29. V. Kaul, S. Nigam, and K. Dhar, "Antimicrobial Activities of the Essential Oils of *Artemisia absinthium* Linn., *Artemisia vestita* Wall, and *Artemisia vulgaris* Linn.," *Indian Journal of Pharmacy* 38 (1976): 21–22.
30. A. Hadi, N. Hossein, P. Shirin, N. Najmeh, and M. Abolfazl, "Anti-Inflammatory and Analgesic Activities of *Artemisia absinthium* and Chemical Composition of Its Essential Oil," *International Journal of Pharmaceutica Science Review and Research* 38 (2014): 237–244.
31. T. Siatka and M. Kašparová, "Seasonal Variation in Total Phenolic and Flavonoid Contents and DPPH Scavenging Activity of *Bellis perennis* L. flowers," *Molecules* 15 (2010): 9450–9461, <https://doi.org/10.3390/molecules15129450>.
32. P. Avato, C. Vitali, P. Mongelli, and A. Tava, "Antimicrobial Activity of Polyacetylenes from *Bellis perennis* and Their Synthetic Derivatives," *Planta Medica* 63 (1997): 503–507, <https://doi.org/10.1055/s-2006-957751>.
33. T. H. Costa Marques, A. A. Cardoso de Almeida, P. S. dos Santos, C. H. S. Melo, and R. Mendes de Freitas, "Estudios Agronómicos, Genéticos, Morfoanatómicos, Fitoquímicos, Toxicológicos y Farmacológicos de *Bellis perennis* L. (margarita)," *Revista Cubana de Plantas Medicinales* 19 (2014): 85–100.
34. A. E. Al-Snafi, "The Pharmacological Importance of *Bellis perennis*-A Review," *International Journal of Phytotherapy* 5 (2015): 63–69.
35. F. P. Karakaş, A. U. Türker, A. Karakaş, V. Mshvildadze, A. Pichette, and J. Legault, "In Vitro Cytotoxic, Antibacterial, Anti-Inflammatory and Antioxident Activities and Phenolic Content in Wild-Grown Flowers of Common Daisy—A Medicinal Plant," *Journal of Herbal Medicine* 8 (2017): 31–39.
36. J. Pino, R. Marbot, J. Agiero, and V. Fuentes, "Essential Oil of Chamomile *Chamomilla recutita* (L.) Rausch. From Cuba," *Journal of Essential Oil-Bearing Plants* 3 (2000): 1–3.
37. M. V. Catani, F. Rinaldi, V. Tullio, V. Gasperi, and I. Savini, "Comparative Analysis of Phenolic Composition of Six Commercially Available Chamomile (*Matricaria chamomilla* L.) Extracts: Potential Biological Implications," *International Journal of Molecular Sciences* 22 (2021): 10601, <https://doi.org/10.3390/ijms221910601>.
38. J. C. R. Nogueira, M. D. F. M. Diniz, and E. O. Lima, "In Vitro Antimicrobial Activity of Plants in Acute Otitis Externa," *Brazilian Journal of Otorhinolaryngology* 74 (2008): 118–124, [https://doi.org/10.1016/s1808-8694\(15\)30761-8](https://doi.org/10.1016/s1808-8694(15)30761-8).
39. P. De Cicco, G. Ercolano, C. Sirignano, et al., "Chamomile Essential Oils Exert Anti-Inflammatory Effects Involving Human and Murine Macrophages: Evidence to Support a Therapeutic Action," *Journal of Ethnopharmacology* 311 (2023): 116391, <https://doi.org/10.1016/j.jep.2023.116391>.
40. B. Uteshev, I. Laskova, and V. Afanas' ev, "The Immunomodulating Activity of the Heteropolysaccharides From German Chamomile (*Matricaria chamomilla*) During Air and Immersion Cooling," *Experimental'naia i Klinicheskaia Farmakologiya* 62 (1999): 52.
41. C. Schulz, P. Knopf, and T. Stützel, "Identification Key to the Cypress Family (Cupressaceae)," *Feddes Repertorium: Zeitschrift für botanische Taxonomie und Geobotanik* 116 (2005): 96–146, <https://doi.org/10.1002/fedr.200411062>.
42. J. M. Celedon and J. Bohlmann, "Oleoresin Defenses in Conifers: Chemical Diversity, Terpene Synthases and Limitations of Oleoresin Defense Under Climate Change," *New Phytologist* 224 (2019): 1444–1463, <https://doi.org/10.1111/nph.15984>.
43. F. Bakkali, S. Averbeck, D. Averbeck, and M. Idaomar, "Biological Effects of Essential Oils—A Review," *Food and Chemical Toxicology* 46 (2008): 446–475, <https://doi.org/10.1016/j.fct.2007.09.106>.
44. B. Adorjan and G. Buchbauer, "Biological Properties of Essential Oils: An Updated Review," *Flavour and fragrance journal* 25 (2010): 407, <https://doi.org/10.1002/ffj.2024>.
45. B. Bayala, I. H. Bassole, R. Scifo, et al., "Anticancer Activity of Essential Oils and Their Chemical Components—A Review," *American Journal of Cancer Research* 4 (2014): 591.
46. G. Honda, E. Yeşilada, M. Tabata, et al., "Traditional Medicine in Türkiye VI. Folk Medicine in West Anatolia: Afyon, Kütahya, Denizli, Muğla, Aydın Provinces," *Journal of Ethnopharmacology* 53 (1996): 75–78, [https://doi.org/10.1016/S0378-8741\(96\)01426-2](https://doi.org/10.1016/S0378-8741(96)01426-2).
47. N. Orhan, E. Akkol, and F. Ergun, "Evaluation of Antiinflammatory and Antinociceptive Effects of Some *Juniperus* Species Growing in Türkiye," *Turkish Journal of Biology* 36 (2012): 719–726, <https://doi.org/10.3906/biy-1203-32>.
48. S. Bais, N. S. Gill, N. Rana, and S. Shandil, "A Phytopharmacological Review on a Medicinal Plant: *Juniperus communis*," *International Scholarly Research Notices* 2014 (2014): 634723, <https://doi.org/10.1155/2014/634723>.
49. R. S. Darwish, H. M. Hammada, D. A. Ghareeb, et al., "Efficacy-Directed Discrimination of the Essential Oils of Three *Juniperus* Species Based on Their In-Vitro Antimicrobial and Anti-Inflammatory Activities," *Journal of Ethnopharmacology* 259 (2020): 112971, <https://doi.org/10.1016/j.jep.2020.112971>.

50. M. Unlu, G. Vardar-Unlu, N. Vural, E. Donmez, and O. Cakmak, "Composition and Antimicrobial Activity of *Juniperus excelsa* Essential Oil," *Chemistry of Natural Compounds* 44 (2008): 129–131, <https://doi.org/10.1007/s10600-008-0040-x>.
51. F. Sela, M. Karapandzova, G. Stefkov, I. Cvetković, and S. Kulevanova, "Chemical Composition and Antimicrobial Activity of Essential Oils of *Juniperus excelsa* Bieb. (Cupressaceae) Grown in R. Macedonia," *Pharmacognosy Research* 7 (2015): 74, <https://doi.org/10.4103/0974-8490.147212>.
52. G. Topçu, A. C. Gören, G. Bilsel, et al., "Cytotoxic Activity and Essential Oil Composition of Leaves and Berries of *Juniperus excelsa*," *Pharmaceutical Biology* 43 (2005): 125–128, <https://doi.org/10.1080/1388200590919429>.
53. G. Topçu, R. Erenler, O. Çakmak, et al., "Diterpenes From the Berries of *Juniperus excelsa*," *Phytochemistry* 50 (1999): 1195–1199, [https://doi.org/10.1016/S0031-9422\(98\)00675-X](https://doi.org/10.1016/S0031-9422(98)00675-X).
54. G. Pastorino, L. Cornara, S. Soares, F. Rodrigues, and M. B. P. Oliveira, "Licorice (*Glycyrrhiza glabra*): A Phytochemical and Pharmacological Review," *Phytotherapy Research* 32 (2018): 2323, <https://doi.org/10.1002/ptr.6178>.
55. H. Hayashi and H. Sudo, "Economic Importance of Licorice," *Plant Biotechnology* 26 (2009): 101–104, <https://doi.org/10.5511/plantbiotechnology.26.101>.
56. V. Singh, A. Pal, and M. P. Darokar, "A Polyphenolic Flavonoid Glabridin: Oxidative Stress Response in Multidrug-Resistant *Staphylococcus aureus*," *Free Radical Biology and Medicine* 87 (2015): 48–57, <https://doi.org/10.1016/j.freeradbiomed.2015.06.016>.
57. L. Wang, R. Yang, B. Yuan, Y. Liu, and C. Liu, "The Antiviral and Antimicrobial Activities of Licorice, a Widely Used Chinese Herb," *Acta Pharmaceutica Sinica B* 5 (2015): 310–315, <https://doi.org/10.1016/j.apsb.2015.05.005>.
58. S. L. Ajagannanavar, H. Battur, S. Shamarao, V. Sivakumar, P. U. Patil, and P. Shanavas, "Effect of Aqueous and Alcoholic Licorice (*Glycyrrhiza glabra*) Root Extract Against *Streptococcus mutans* and *Lactobacillus acidophilus* in Comparison to Chlorhexidine: an *In Vitro* Study," *Journal of International Oral Health: JIOH* 6 (2014): 29.
59. X. Yin, X. Gong, L. Zhang, et al., "Glycyrrhetic Acid Attenuates Lipopolysaccharide-Induced Fulminant Hepatic Failure in D-Galactosamine-Sensitized Mice by Up-regulating Expression of Interleukin-1 Receptor-associated Kinase-M," *Toxicology and Applied Pharmacology* 320 (2017): 8–16, <https://doi.org/10.1016/j.taap.2017.02.011>.
60. V. Sharma, A. Katiyar, and R. Agrawal, in *Glycyrrhiza glabra: Chemistry and Pharmacological Activity* (Springer, 2016).
61. R. B. Wills, K. Bone, and M. Morgan, "Herbal Products: Active Constituents, Modes of Action and Quality Control," *Nutrition Research Reviews* 13 (2000): 47–77, <https://doi.org/10.1079/095442200108729007>.
62. V. Butterweck, "Mechanism of Action of St John's Wort in Depression: What Is Known?," *CNS Drugs* 17 (2003): 539–562, <https://doi.org/10.2165/00023210-200317080-00001>.
63. A. Nahrstedt and V. Butterweck, "Biologically Active and Other Chemical Constituents of the Herb of *Hypericum perforatum* L.," *Pharmacopsychiatry* 30 (1997): 129–134, <https://doi.org/10.1055/s-2007-979533>.
64. L. Cervo, M. Rozio, C. Ekalle-Soppo, G. Guiso, P. Morazzoni, and S. Caccia, "Role of Hyperforin in the Antidepressant-Like Activity of *Hypericum perforatum* Extracts," *Psychopharmacology* 164 (2002): 423–428, <https://doi.org/10.1007/s00213-002-1229-5>.
65. T. Milosevic, S. Solujic-Sukdolac, and S. Sukdolac, "*In Vitro* Study of Ethanolic Extract of *Hypericum perforatum* L. on Growth and Sporulation of Some Bacteria and Fungi," *Turkish Journal of Biology* 31, no. 4 (2007): 237–241.
66. J. Reichling, A. Weseler, and R. Saller, "A Current Review of the Antimicrobial Activity of *Hypericum perforatum* L.," *Pharmacopsychiatry* 34 (2001): 116–118, <https://doi.org/10.1055/s-2001-15514>.
67. Z. Sadiq, I. Naeem, and A. Maimoona, "A Review of the Antibacterial Activity of *Hypericum perforatum* L.," *Journal of Ethnopharmacology* 131 (2010): 511–521, <https://doi.org/10.1016/j.jep.2010.07.034>.
68. A. P. Singh, "Hypericin-a Naphodianthrone From *Hypericum perforatum*," *Ethnobotanical Leaflets* 2003, no. 1 (2005): 11.
69. F. Celep and T. Dirmenci, "Systematic and Biogeographic Overview of Lamiaceae in Türkiye," *Natural Volatiles and Essential Oils* 4 (2017): 14.
70. G. Zare, N. Y. Diker, and I. I. T. Çankaga, in "*Traditional Use of Medicinal Plants and Essential Oils*," (CRC Press, 2023): 134–181.
71. C. M. Uritu, C. T. Mihai, G.-D. Stanciu, et al., "Medicinal Plants of the Family Lamiaceae in Pain Therapy: A Review," *Pain Research and Management* 2018 (2018): 7801543.
72. H. Masuda, S. Hironaka, Y. Matsui, et al., "Comparative Study of the Antioxidative Activity of Culinary Herbs and Spices, and Hepatoprotective Effects of Three Selected Lamiaceae Plants on Carbon Tetrachloride-Induced Oxidative Stress in Rats," *Food Science and Technology Research* 21 (2015): 407–418.
73. H. H. Bendif, "Phytochemical Constituents of Lamiaceae Family," *RHAZES: Green and Applied Chemistry* 11 (2021): 71, <https://doi.org/10.48419/IMIST.PRSM/rhazes-v11.25070>.
74. R. Nurzyńska-Wierdak and M. Walasek-Janusz, "Chemical Composition, Biological Activity, and Potential Uses of Oregano (*Origanum vulgare* L.) and Oregano Essential Oil," *Pharmaceuticals* 18 (2025): 267.
75. D. H. Gilling, M. Kitajima, J. Torrey, and K. Bright, "Antiviral Efficacy and Mechanisms of Action of Oregano Essential Oil and Its Primary Component Carvacrol Against Murine Norovirus," *Journal of Applied Microbiology* 116 (2014): 1149–1163, <https://doi.org/10.1111/jam.12453>.
76. M. Bekut, S. Brkić, N. Kladar, G. Dragović, N. Gavarić, and B. Božin, "Potential of Selected Lamiaceae Plants in Anti (retro) Viral Therapy," *Pharmacological Research* 133 (2018): 301–314, <https://doi.org/10.1016/j.phrs.2017.12.016>.
77. D. W. Lachenmeier, J. Emmert, T. Kuballa, and G. Sartor, "Thujone—Cause of Absinthism?," *Forensic Science International* 158 (2006): 1–8.
78. European Medicines Agency (EMA/HMPC), "Public statement on *Salvia officinalis* L., aetheroleum" EMA/HMPC/41843/2009 (2009).
79. European Medicines Agency (EMA/HMPC), "Public Statement on the Use of Herbal Medicinal Products Containing Thujone" EMA/HMPC/732886/2010 (2010).
80. European Medicines Agency, "European Union Herbal Monograph on *Mentha × piperita* L, folium" EMA/HMPC/572705/2014 (2020).
81. A. Kumar, U. Baitha, P. Aggarwal, and N. Jamshed, "A Fatal Case of Menthol Poisoning," *International Journal of Applied and Basic Medical Research* 6 (2016): 137–139.
82. P. Mikaili, S. Mojaverrostami, M. Moloudizargari, and S. Aghajanshakeri, "Pharmacological and Therapeutic Effects of *Mentha longifolia* L. and Its Main Constituent, Menthol," *Ancient Science of Life* 33 (2013): 131–138.
83. N. Hudz, L. Kobylinska, K. Pokajewicz, et al., "*Mentha piperita*: Essential Oil and Extracts, Their Biological Activities, and Perspectives on the Development of New Medicinal and Cosmetic Products," *Molecules* 28 (2023): 7444.
84. S. Saqib, F. Ullah, M. Naeem, et al., "*Mentha*: Nutritional and Health Attributes to Treat Various Ailments Including Cardiovascular Diseases," *Molecules* 27 (2022): 6728.
85. Z. Wu, B. Tan, Y. Liu, et al., "Chemical Composition and Antioxidant Properties of Essential Oils From Peppermint, Native Spearmint and Scotch Spearmint," *Molecules* 24 (2019): 2825.
86. M. Messaoudi, A. Rebiai, B. Sawicka, et al., "Effect of Extraction Methods on Polyphenols, Flavonoids, Mineral Elements, and Biological Activities of Essential Oil and Extracts of *Mentha pulegium* L.," *Molecules* 27 (2021): 11.

87. Y. Yu, Y. Ma, Z. Ouyang, and L. Huang, "Mentha Essential Oils: Unraveling Chemotype-Dependent Biosynthesis and Assessing Evidence for Health-Promoting Activities," *Nutrients* 17 (2025): 3258.
88. X. Chen, S. Shang, F. Yan, et al., "Antioxidant Activities of Essential Oils and Their Major Components in Scavenging Free Radicals, Inhibiting Lipid Oxidation and Reducing Cellular Oxidative Stress," *Molecules* 28 (2023): 4559.
89. S. Amat, G. Magossi, A. Rakibuzzaman, et al., "Screening and Selection of Essential Oils for an Intranasal Spray Against Bovine Respiratory Pathogens Based on Antimicrobial, Antiviral, Immunomodulatory, and Antibiofilm Activities," *Frontiers in Veterinary Science* 11 (2024): 1360398.
90. S. Kozlovich, G. Chen, C. J. Watson, W. J. Blot, and P. Lazarus, "Role of L- and D-menthol in the Glucuronidation and Detoxification of the Major Lung Carcinogen, NNAL," *Drug Metabolism and Disposition* 47 (2019): 1388–1396.
91. S. Sharma, V. P. Rasal, P. A. Patil, and R. K. Joshi, "Mentha arvensis Essential Oil Suppressed Airway Changes Induced by Histamine and Ovalbumin in Experimental Animals," *Natural Product Research* 32 (2018): 468–472.
92. N. Jaradat, H. Al Zabadi, B. Rahhal, et al., "The Effect of Inhalation of Citrus sinensis Flowers and Mentha spicata Leaf Essential Oils on Lung Function and Exercise Performance: A Quasi-Experimental Uncontrolled Before-and-After Study," *Journal of the International Society of Sports Nutrition* 13 (2016): 36.
93. H. Whiley, S. Gaskin, T. Schroder, and K. E. Ross, "Antifungal Properties of Essential Oils for Improvement of Indoor Air Quality: A Review," *Reviews on Environmental Health* 33 (2018): 63–76.
94. K. Başer, "Her Derde Deva Bir Bitki kekik," *Bilim ve Teknik Dergisi* 402 (2001): 74.
95. A. Altintas, N. Tabanca, E. Tyihák, et al., "Characterization of Volatile Constituents from Origanum onites and Their Antifungal and Antibacterial Activity," *Journal of AOAC International* 96 (2013): 1200, <https://doi.org/10.5740/jaoacint.sgealtintas>.
96. B. Tepe, A. Cakir, and A. Sihoglu Tepe, "Medicinal Uses, Phytochemistry, and Pharmacology of Origanum onites (L.): A Review," *Chemistry and Biodiversity* 13 (2016): 504–520, <https://doi.org/10.1002/cbdv.201500069>.
97. M. Sharifi-Rad, Y. B. Yilmaz, G. Antika, et al., "Phytochemical Constituents, Biological Activities, and Health-Promoting Effects of the Genus Origanum," *Phytotherapy Research* 35 (2021): 95–121.
98. N. Yazıcı, R. Reis, E. M. Kara, et al., "Phytochemical Profiling and Biological Activities of Origanum onites L. Growing in Balıkesir, Türkiye," *İstanbul Journal of Pharmacy* 55 (2025): 427–434, <https://doi.org/10.26650/IstanbulJPharm.2025.1619681>.
99. B. Piasecki, V. L. Balázs, A. Kiełtyka-Dadasiewicz, et al., "Microbiological Studies on the Influence of Essential Oils From Several Origanum Species on Respiratory Pathogens," *Molecules* 28 (2023): 3044, <https://doi.org/10.3390/molecules28073044>.
100. K. Kachur and Z. Suntres, "The Antibacterial Properties of Phenolic Isomers, Carvacrol and Thymol," *Critical Reviews in Food Science and Nutrition* 60 (2020): 3042–3053.
101. S. T. Khan, M. Khan, J. Ahmad, et al., "Thymol and Carvacrol Induce Autolysis, Stress, Growth Inhibition and Reduce Biofilm Formation by Streptococcus mutans," *AMB Express* 7 (2017): 49.
102. A. Sihoglu Tepe, M. Ozaslan, I. H. Kilic, and S. B. Oguzkan, "Traditional Uses, Phytochemistry, and Toxic Potential of Teucrium polium L.: A Comprehensive Review," *International journal of plant based pharmaceuticals* 1 (2021): 1–41.
103. S. Daneshvar-Ghahfarokhi, V. Mohammadi-Shahrokhi, A. Rahnama, and R. Nosratabadi, "Teucrium polium Extract Alleviates Pathological Features of Asthma via IL-12 and IFN- $\gamma$  Modulation in Murine OVA-Induced Allergic Asthma," *Iranian Journal of Allergy, Asthma and Immunology* 22 (2023): 327–336, <https://doi.org/10.18502/ijaai.v22i4.13605>.
104. S. Daneshvar-Ghahfarokhi, A. Rahnama, and V. Mohammadi-Shahrokhi, "Teucrium polium Extract Attenuates Inflammation in Asthma by Reducing ROR $\gamma$ t Transcription and Increasing IL-10 Secretion in an Ovalbumin-Induced Murine Asthma Model," *Iranian Journal of Immunology* 20 (2023): 159–166, <https://doi.org/10.22034/iji.2023.97422.2509>.
105. E. Al-Shalabi, S. Sunoqrot, T. Al-Zuhd, R. S. Alshehada, A. I. M. Ibrahim, and A. M. Hammad, "Exploring the Antioxidant and Anti-inflammatory Effects of Rhoifolin Isolated From Teucrium polium on Rats' Lungs Exposed to Tobacco Smoke," *Chemistry & Biodiversity* 21 (2024): e202400958.
106. M. Derakhshan, S. Niazmand, A. Sadeghian, et al., "The Evaluation of the Effect of Teucrium polium L. on Infectivity of Human Influenza Virus In Vitro," *Clinical Biochemistry* 44 (2011): S351.
107. J. M. Jellin, F. Batz, and K. Hitchens, "Natural Medicines Comprehensive Database," *Therapeutic Research Faculty* (2004): 1254.
108. F. Demirci, N. Karaca, M. Tekin, and B. Demirci, "Anti-inflammatory and Antibacterial Evaluation of Thymus sipyleus Boiss. subsp. Sipyleus Var. Sipyleus Essential Oil against Rhinosinusitis Pathogens," *Microbial Pathogenesis* 122 (2018): 117–121, <https://doi.org/10.1016/j.micpath.2018.08.001>.
109. H. G. Ağalar, M. Kürkçüoğlu, K. H. C. Başer, and K. Turgut, "Volatile Constituents of Three Thymus sipyleus Boiss. Subspecies From Different Sites in Türkiye," *Turkish Journal of Chemistry* 45 (2021): 1959–1967, <https://doi.org/10.3906/kim-2103-6>.
110. A. Ghahremani-Chabok, M. Bagheri-Nesami, S. A. Shorofi, S. N. Mousavinasab, A. Gholipour-Baradari, and M. Saeedi, "The Effects of Thymus vulgaris Inhalation Therapy on Airway Status and Oxygen Saturation of Patients Under Mechanical Ventilation: A Randomized Clinical Trial," *Advances in Integrative Medicine* 8 (2021): 92–100.
111. E. Pandur, G. Micalizzi, L. Mondello, A. Horváth, K. Sipos, and G. Horváth, "Antioxidant and Anti-inflammatory Effects of Thyme (Thymus vulgaris L.) Essential Oils Prepared at Different Plant Phenophases on Pseudomonas aeruginosa LPS-Activated THP-1 Macrophages," *Antioxidants* 11 (2022): 1330, <https://doi.org/10.3390/antiox11071330>.
112. A. Beceren, A. N. Hazar-Yavuz, O. Bingol Ozakpinar, et al., "Evaluation of the Cytotoxicity, Genotoxicity and Acute Oral Toxicity of Thymus longicaulis subsp. chaubardii (Rchb.f.) Jalas," *Pharmaceuticals* 18 (2025): 1037, <https://doi.org/10.3390/ph18071037>.
113. C. Classen and H. Blaschek, "High Molecular Weight Acidic Polysaccharides From Malva sylvestris and Alcea rosea," *Planta Medica* 64 (1998): 640–644.
114. E. Sezik, E. Yeşilada, M. Tabata, et al., "Traditional Medicine in Türkiye VIII. Folk Medicine in East Anatolia; Erzurum, Erzincan, Ağrı, Kars, Iğdır Provinces," *Economic Botany* 51 (1997): 195–211.
115. Z. Zare and Ç. Çankaya, "Focusing on Malva sylvestris L.," in *Medicinal Plants of Türkiye*, ed. U. Koca-Çalışkan, (CRC Press, 2024).
116. A. Gasparetto, et al., "Ethnobotanical and Scientific Aspects of Malva sylvestris L.: A Millennial Herbal Medicine," *Journal of Pharmacy and Pharmacology* 64 (2012): 172–189.
117. W. B. J. El Ghaoui, et al., "The Effects of Alcea rosea L., Malva sylvestris L. and Salvia Libanotica L. Water Extracts on the Production of Anti-Egg Albumin Antibodies, Interleukin-4, Gamma Interferon and Interleukin-12 in BALB/c Mice," *Phytotherapy Research* 22 (2008): 1599–1604.
118. H. Azaizeh, B. Saad, K. Khalil, and O. Said, "The state of the Art of Traditional Arab Herbal Medicine in the Eastern Region of the Mediterranean: A Review," *Evidence-based Complementary and Alternative Medicine* 3 (2006): 229–235, <https://doi.org/10.1093/ecam/nel034>.
119. H. Rouhi and F. Ganji, "Effect of Althaea officinalis on Cough Associated With ACE Inhibitors," *Pakistan Journal of Nutrition* 6 (2007): 256, <https://doi.org/10.3923/pjn.2007.256.258>.

120. I. Chinou, "Assessment Report on *Tilia cordata* Miller, *Tilia Platyphyllos* Scop., *Tilia X vulgaris* Heyne or Their Mixtures, Flos," (2012).
121. P. Bradley, "British Herbal Compendium; A Handbook of Scientific Information on Widely Used Plant Drugs," *British Herbal Medicine Association 1* (1992).
122. Z. Sroka and J. Belz, "Antioxidant Activity of Hydrolyzed and Non-Hydrolyzed Extracts of the Inflorescence of Linden (*Tiliae inflorescentia*)," *Advances in Clinical and Experimental Medicine* 18 (2009): 329–335.
123. F. Ieri, M. Innocenti, L. Possieri, S. Gallori, and N. Mulinacci, "Phenolic Composition of "Bud Extracts" of *Ribes nigrum* L., *Rosa canina* L. and *Tilia tomentosa* M.," *Journal of Pharmaceutical and Biomedical analysis* 115 (2015): 1, <https://doi.org/10.1016/j.jpba.2015.06.004>.
124. M. E. Czerwinska, M. K. Dudek, K. A. Pawlowska, et al., "The Influence of Procyanidins Isolated From Small-Leaved Lime Flowers (*Tilia cordata* Mill.) on Human Neutrophils," *Fitoterapia* 127 (2018): 115–122, <https://doi.org/10.1016/j.fitote.2018.02.018>.
125. Y. N. Georgiev, B. S. Paulsen, H. Kiyohara, et al., "*Tilia tomentosa* Pectins Exhibit Dual Mode of Action on Phagocytes as Beta-Glucuronic Acid Monomers Are Abundant in Their Rhamnogalacturonans I," *Carbohydrate Polymers* 175 (2017): 178–191, <https://doi.org/10.1016/j.carbpol.2017.07.073>.
126. M. Wichtl, "Tiliae Flos—lime Tree Flower," in *Herbal Drugs and Phytopharmaceuticals, a Handbook of Practice on a Scientific Basis*, 3rd ed., (CRC Press, 2004).
127. O. K. Kosakowska, K. Bączek, J. L. Przybyła, et al., "Intraspecific Variability in the Content of Phenolic Compounds, Essential Oil and Mucilage of Small-Leaved Lime (*Tilia Cordata* Mill.) From Poland," *Industrial Crops and Products* 78 (2015): 58–65.
128. J. Grassmann, S. Hippeli, R. Vollmann, and E. F. Elstner, "Antioxidative Properties of the Essential Oil From *Pinus mugo*," *Journal of Agricultural and Food Chemistry* 51 (2003): 7576–7582, <https://doi.org/10.1021/jf030496e>.
129. B. Mustafa, A. Hajdari, F. Krasniqi, et al., "Medical Ethnobotany of the Albanian Alps in Kosovo," *Journal of Ethnobiology and Ethnomedicine* 8 (2012): 6, <https://doi.org/10.1186/1746-4269-8-6>.
130. I. Süntar, I. Tumen, O. Ustün, H. Keleş, and E. K. Akkol, "Appraisal on the Wound Healing and Anti-Inflammatory Activities of the Essential Oils Obtained From the Cones and Needles of *Pinus* Species by *In Vivo* and *In Vitro* Experimental Models," *Journal of Ethnopharmacology* 139 (2012): 533, <https://doi.org/10.1016/j.jep.2011.11.045>.
131. M. Shuaib, M. Ali, J. Ahamad, K. J. Naquvi, and M. I. Ahmad, "Pharmacognosy of *Pinus roxburghii*: A Review," *Journal of Pharmacognosy and Phytochemistry* 2 (2013): 262–268.
132. F. Kurti, A. Giorgi, G. Beretta, et al., "Chemical Composition, Antioxidant and Antimicrobial Activities of Essential Oils of Different *Pinus* Species From Kosovo," *Journal of Essential Oil Research* 31 (2019): 263, <https://doi.org/10.1080/10412905.2019.1584591>.
133. M. Basholli-Salih, R. Schuster, A. Hajdari, et al., "Phytochemical Composition, Anti-Inflammatory Activity and Cytotoxic Effects of Essential Oils From Three *Pinus* spp.," *Pharmaceutical Biology* 55 (2017): 1553–1560, <https://doi.org/10.1080/13880209.2017.1309555>.
134. W. J. Yoon, S. S. Kim, T. H. Oh, N. H. Lee, and C. G. Hyun, "*Abies koreana* Essential Oil Inhibits Drug-Resistant Skin Pathogen Growth and LPS-induced Inflammatory Effects of Murine Macrophage," *Lipids* 44 (2009): 471–476, <https://doi.org/10.1007/s11745-009-3297-3>.
135. I.-S. Shin, N.-R. Shin, C.-M. Jeon, et al., "Inhibitory Effects of Pycnogenol® (French maritime pine bark extract) on Airway Inflammation in Ovalbumin-Induced Allergic Asthma," *Food and Chemical Toxicology* 62 (2013): 681, <https://doi.org/10.1016/j.fct.2013.09.032>.
136. S. Iravani and B. Zolfaghari, "Pharmaceutical and Nutraceutical Effects of *Pinus pinaster* Bark Extract," *Research in Pharmaceutical Sciences* 6 (2011): 1.
137. G. Belcaro, R. Luzzi, P. Cesinaro Di Rocco, et al., "Pycnogenol® Improvements in Asthma Management," *Panminerva Medica* 53 (2011): 57–64.
138. S. Hosseini, S. Pishnamazi, S. Sadrzadeh, F. Farid, R. Farid, and R. R. Watson, "Pycnogenol® in the Management of Asthma," *Journal of Medicinal Food* 4 (2001): 201, <https://doi.org/10.1089/10966200152744472>.
139. A. Matsumori, H. Higuchi, and M. Shimada, "French Maritime Pine Bark Extract Inhibits Viral Replication and Prevents Development of Viral Myocarditis," *Journal of Cardiac Failure* 13 (2007): 785, <https://doi.org/10.1016/j.cardfail.2007.06.721>.
140. Y. Najafian, S. S. Hamed, M. K. Farshchi, and Z. Feyzabadi, "Plantago Major in Traditional Persian Medicine and Modern Phytotherapy: A Narrative Review," *Electronic Physician* 10 (2018): 6390, <https://doi.org/10.19082/6390>.
141. E. Weryszko-Chmielewska, A. Matysik-Wozniak, A. Sulborska, and R. Rejda, "Commercially Important Properties of Plants of the Genus *Plantago*," *Acta Agrobotanica* 65 (2012): 11–20.
142. S. J. Boskabadi, F. Farzameh, K. Mohammadnejad, and M. H. Boskabadi, "The Therapeutic Effects of *Plantago Major* and Its Main Constituents on respiratory Diseases: A Narrative Review," *Naunyn-Schmiedeberg's Archives of Pharmacology* (2025): 1, <https://doi.org/10.1007/s00210-025-04276-8>.
143. J. L. Guil-Guerrero and I. Rodríguez-García, "Lipids Classes, Fatty Acids and Carotenes of the Leaves of Six Edible Wild Plants," *European Food Research and Technology* 209 (1999): 313–316, <https://doi.org/10.1007/s002170050501>.
144. J. Jamilah, A. Sharifa, and N. Sharifah, "GC-MS Analysis of Various Extracts from Leaf of *Plantago major* Used as Traditional Medicine," (2012).
145. O. A. Isabel, M. Getino Antonio, L. O. Larrechea, et al., "A Pilot Study of Efficacy and Safety of *Plantago lanceolata* and *Primula veris* in the Treatment of the Common Cold," *Archives of Pharmacy Practice* 11, no. 3 (2020): 1–7.
146. A. Naderi, S. A. Mozaffarpur, H. Shirafkan, M. Bayani, and Z. Memariani, "Effect of *Plantago major* on Cough Severity in Acute Bronchitis: A Double-Blind Randomized Clinical Trial," *Caspian Journal of Internal Medicine* 15, no. 4 (2024): 651–658.
147. M. Zarei, M. Zarei, A. Moini, N. Norouzi, R. Biranvand, and R. Ghafarzadegan, "Herbal Medicine Formula for Asthma: A Triple-Blind Placebo-Controlled Randomized Clinical Trial," *Advances in Integrative Medicine* 13 (2026): 100609, <https://doi.org/10.1016/j.aimed.2026.100609>.
148. M. Anushiravania, F. J. Azad, A. Taghipour, et al., "The Effect of *Plantago major* Seed and Almond Gum on Refractory Asthma: A Proof-of-Concept Study," *Journal of Herbal Medicine* 19 (2020): 100297, <https://doi.org/10.1016/j.hermed.2019.100297>.
149. F. Farokhi and F. Khaneshi, "Histopathologic Changes of Lung in Asthmatic Male Rats Treated With Hydroalcoholic Extract of *Plantago major* and Theophylline," *Avicenna Journal of Phytomedicine* 3, no. 2 (2013): 143–151.
150. C. Ma and W. Ma, "Plantamajoside Inhibits Lipopolysaccharide-Induced MUC5AC Expression and Inflammation Through Suppressing the PI3K/Akt and NF- $\kappa$ B Signaling Pathways in Human Airway Epithelial Cells," *Inflammation* 41, no. 3 (2018): 795–802, <https://doi.org/10.1007/s10753-018-0733-7>.
151. K. Chathuranga, M. S. Kim, H.-C. Lee, et al., "Anti-Respiratory Syncytial Virus Activity of *Plantago asiatica* and *Clerodendrum trichotomum* Extracts *In Vitro* and *In Vivo*," *Viruses* 11, no. 7 (2019): 604, <https://doi.org/10.3390/v11070604>.
152. G. Hetland, A. Samuelsen, V. Loslash, et al., "Protective Effect of *Plantago major* L. Pectin Polysaccharide Against Systemic *Streptococcus pneumoniae* Infection in Mice," *Scandinavian Journal of Immunology* 52 (2000): 348–355, <https://doi.org/10.1046/j.1365-3083.2000.00793.x>.

153. M. Jafari, A. Zarban, S. Pham, and T. Wang, "Rosa damascena Decreased Mortality in Adult Drosophila," *Journal of Medicinal Food* 11 (2008): 9–13, <https://doi.org/10.1089/jmf.2007.546>.
154. M. Crespo, J. Galvez, T. Cruz, M. Ocete, and A. Zarzuelo, "Anti-inflammatory Activity of Diosmin and Hesperidin in Rat Colitis Induced by TNBS," *Planta Medica* 65 (1999): 651–653, <https://doi.org/10.1055/s-2006-960838>.
155. A. Dogan, G. Bulut, I. Senkardes, and E. Tuzlacı, "An Ethnopharmacological Analysis of Rosaceae Taxa in Türkiye," (2016), *WEI International Academic Conference Proceedings Boston*.
156. A. Nadkarni, "Dr. KM Nadkarni's Indian Materia Medica: With Ayurvedic, Unani-tibbi, Siddha, Allopathic, Homeopathic, Naturopathic & Home Remedies, Appendices & Indexes," Popular Prakashan (2007).
157. M. A. Tuba, G. Muhammed, M. A. Raza, et al., "A Comprehensive Review on Phytochemistry, Pharmacology, Preclinical, and Clinical Trials of *Cydonia oblonga*," *Phytochemistry Reviews* 24 (2025): 85–118, <https://doi.org/10.1007/s11101-024-09946-8>.
158. R. Ghadermazi, F. Tamjidi, and A. Mirzaei-Mohkam, "A Review on Characteristics, Functional Properties and Potential Applications of Quince (*Cydonia oblonga*) Seed Mucilage," *Food Review International* (2025): 2885–2922, <https://doi.org/10.1080/87559129.2025.2572782>.
159. A. Karimi, M. Movahhad, H. HajiMehdipoor, and F. Allahyari, "A Review on *Cydonia oblonga* Miller as an Herbal Medicine," *Indo American Journal of Pharmaceutical Sciences* 4, no. 12 (2017): 4370–4386.
160. A. P. Oliveira, R. M. Costa, A. S. Magalhaes, et al., "Targeted Metabolites and Biological Activities of *Cydonia oblonga* Miller Leaves," *Food Research International* 46 (2012): 496–504, <https://doi.org/10.1016/j.foodres.2010.10.021>.
161. F. Sonmez and Z. Sahin, "Comparative Study of Total Phenolic Content, Antioxidant Activities, and Polyphenol Oxidase Enzyme Inhibition of Quince Leaf, Peel, and Seed Extracts," *Erwerbs-Obstbau* 65 (2023): 745–750, <https://doi.org/10.1007/s10341-022-00696-5>.
162. S. Benzarti, K. Belkadhi, and H. Hamdi, "Biological Activities of Phenolics From Leaves of Tunisian *Cydonia oblonga* Miller," *Allelopathy Journal* 45, no. 2 (2018): 229–242, <https://doi.org/10.26651/allelo.j/2018-45-2-1189>.
163. E. Dikici, S. Altin, C. Alp, M. Isik, E. Köksal, and I. Gülçin, "Determination of Secondary Metabolites of *Cydonia oblonga* (Quince) by LC-MS/MS Method Together With Evaluation of Its Antioxidant and Cholinergic Potentials," *Journal of Chemical Metrology* 18, no. 2 (2025): 146–164, <https://doi.org/10.25135/jcm.120.2411.3380>.
164. K. Essafi-Benkhadir, A. Refai, I. Riahi, S. Fattouch, H. Karoui, and M. Essafi, "Quince (*Cydonia oblonga* Miller) Peel Polyphenols Modulate LPS-induced Inflammation in Human THP-1-Derived Macrophages Through NF- $\kappa$ B, p38MAPK and Akt Inhibition," *Biochemical and Biophysical Research Communications* 418 (2012): 180–185, <https://doi.org/10.1016/j.bbrc.2012.01.003>.
165. N. Tomljenovic and I. Pejić, "Taxonomic Review of the Genus *Rosa*," *Agriculturae Conspectus Scientificus* 83 (2018): 139–147.
166. M. Blumenthal, A. Goldberg, and J. Brinckmann, "Herbal Medicine," (2000), Expanded Commission E monographs.
167. M. E. H. Kayesh, M. Kohara, and K. Tsukiyama-Kohara, "Effects of Oxidative Stress on Viral Infections: An Overview," *npj Viruses* 3 (2025): 27, <https://doi.org/10.1038/s44298-025-00110-3>.
168. I. Egea, P. Sánchez-Bel, F. Romojaro, and M. T. Pretel, "Six Edible Wild Fruits as Potential Antioxidant Additives or Nutritional Supplements," *Plant Foods for Human Nutrition* 65 (2010): 121–129, <https://doi.org/10.1007/s11130-010-0159-3>.
169. H. Kılıçgün and D. Altner, "Correlation Between Antioxidant Effect Mechanisms and Polyphenol Content of *Rosa canina*," *Pharmacognosy Magazine* 6 (2010): 238, <https://doi.org/10.4103/0973-1296.66943>.
170. I. Fecka, "Qualitative and Quantitative Determination of Hydrolysable Tannins and Other Polyphenols in Herbal Products From Meadowsweet and Dog Rose," *Phytochemistry Analysis* 20 (2009): 177–190, <https://doi.org/10.1002/pca.1113>.
171. M. Khazaei, M. R. Khazaei, and M. Pazhouhi, "An Overview of Therapeutic Potentials of *Rosa canina*: A Traditionally Valuable Herb," *World Cancer Research Journal* 7 (2020): e1580.
172. O. R. Negrean, A. C. Farcas, S. A. Nemes, D. E. Cic, and S. A. Socaci, "Recent Advances and Insights into the Bioactive Properties and Applications of *Rosa canina* L. and Its By-Products," *Heliyon* 10 (2024): e30816, <https://doi.org/10.1016/j.heliyon.2024.e30816>.
173. D. Deliorman Orhan, A. Hartevioğlu, E. Küpeli, and E. Yesilada, "In Vivo Anti-Inflammatory and Antinociceptive Activity of the Crude Extract and Fractions From *Rosa Canina* L. Fruits," *Journal of Ethnopharmacology* 112 (2007): 394–400.
174. F. Lattanzio, E. Greco, D. Carretta, R. Cervellati, P. Govoni, and E. Speroni, "In Vivo Anti-inflammatory Effect of *Rosa canina* L. extract," *Journal of Ethnopharmacology* 137 (2011): 880–885.
175. A. K. Jäger, K. N. Petersen, G. Thomasen, and S. B. Christensen, "Isolation of Linoleic and Alpha-Linolenic Acids as COX-1 and -2 Inhibitors in Rose Hip," *Phytotherapy Research* 22 (2008): 982–984.
176. E. Larsen, A. Kharazmi, L. P. Christensen, and S. B. Christensen, "An Anti-Inflammatory Galactolipid From Rose Hip Fruit (*Rosa canina*) That Inhibits Chemotaxis of human Peripheral Blood Neutrophils In Vitro," *Journal of Natural Products* 66 (2003): 994–995.
177. L. Saaby, A. K. Jäger, L. Moesby, E. W. Hansen, and S. B. Christensen, "Isolation of Immunomodulatory Triterpene Acids From a Standardized *Rosa canina* Fruit Powder (*Rosa canina* L.)," *Phytotherapy Research* 25 (2011): 195–201.
178. D. D. Orhan, A. Hartevioğlu, E. Küpeli, and E. Yesilada, "In Vivo Anti-Inflammatory and Antinociceptive Activity of the Crude Extract and Fractions From *Rosa canina* L. Fruits," *Journal of Ethnopharmacology* 112 (2007): 394–400, <https://doi.org/10.1016/j.jep.2007.03.029>.
179. C. Chrubasik, R. Duke, and S. Chrubasik, "The Evidence for Clinical Efficacy of Rose Hip and Seed: A Systematic Review," *Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives* 20 (2006): 1–3, <https://doi.org/10.1002/ptr.1729>.
180. M. P. Nantz, C. A. Rowe, C. Muller, et al., "Consumption of Cranberry Polyphenols Enhances Human  $\Gamma\delta$ T Cell Proliferation and Reduces the Number of Symptoms Associated With Colds and Influenza: A Randomized, Placebo-Controlled Intervention Study," *Nutrition Journal* 12 (2013): 161, <https://doi.org/10.1186/1475-2891-12-161>.
181. X. Gao, Z. Zhang, X. Wang, et al., "Studies of Value in Use, Chemical Compositions, Biological and Pharmacological Activities, and Quality Control of Rubus Berries: A Comprehensive Review," *Journal of Food Composition and Analysis* 124 (2023): 105707, <https://doi.org/10.1016/j.jfca.2023.105707>.
182. B.-G. Wang, W.-M. Zhu, X.-M. Li, Z.-J. Jia, and X.-J. Hao, "Rubupungenosides A and B, Two Novel Triterpenoid Saponin Dimers From the Aerial Parts of *Rubus pungens*," *Journal of Natural Products* 63 (2000): 851–854, <https://doi.org/10.1021/np990473n>.
183. N. Weihua, X. Zhang, B. Hongtao, et al., "Preparation of a Glucan From the Roots of *Rubus crataegifolius* Bge. And Its Immunological Activity," *Carbohydrate Research* (2009): 2512–2518, <https://doi.org/10.1016/j.carres.2009.08.042>.
184. Y. Guo, W. Qin, Y. Hou, et al., "Extraction, Purification, Structural Characteristics and Biological Properties of the Polysaccharides From *Rubus* L.: A Review," *Food Chemistry* 478 (2025): 143711, <https://doi.org/10.1016/j.foodchem.2025.143711>.
185. A. Patel, J. Rojas-Vera, and C. Dacke, "Therapeutic Constituents and Actions of *Rubus* Species," *Current Medicinal Chemistry* 11 (2004): 1501–1512, <https://doi.org/10.2174/0929867043365143>.
186. R. Gevrenova, D. Zheleva-Dimitrova, and V. Balabanova, "The Genus *Rubus* L.: An Insight Into Phytochemicals and Pharmacological Studies

- of Leaves From the Most Promising Species,” *Pharmacia* 71 (2024): 1–12, <https://doi.org/10.3897/pharmacia.71.e124248>.
187. G. Sanna, P. Farci, B. Busonera, G. Murgia, P. La Colla, and G. Giliberti, “Antiviral Properties From Plants of the Mediterranean Flora,” *Natural Product Research* 29 (2015): 2065–2070, <https://doi.org/10.1080/14786419.2014.1003187>.
188. A. Niaz, M. Shaoib, S. W. A. Shah, I. Shah, and M. Shuaib, “Pharmacological Profile of the Aerial Parts of *Rubus ulmifolius* Schott,” *BMC Complementary Medicine and Therapies* 17 (2017): 59, <https://doi.org/10.1186/s12906-017-1564-z>.
189. European Medicines Agency, European Union Herbal Monograph on *Rubus fruticosus* L., Folium (EMA, 2012).
190. Y. Tao, J. Bao, F. Zhu, M. Pan, Q. Liu, and P. Wang, “Ethnopharmacology of *Rubus idaeus* Linnaeus: A Critical Review on Ethnobotany, Processing Methods, Phytochemicals, Pharmacology and Quality Control,” *Journal of Ethnopharmacology* 302 (2023): 115870, <https://doi.org/10.1016/j.jep.2022.115870>.
191. I. Yener, “The Phenolic Content and Bioactivity Assessment of *Rubus sanctus* Schreber Species with Potential for Food and Ethnopharmacological Uses,” *Chemistry & Biodiversity* 22, no. 9 (2025): e202500034, <https://doi.org/10.1002/cbdv.202500034>.
192. N. Erdemoglu, E. Küpeli, and E. Yesilada, “Anti-Inflammatory and Antinociceptive Activity Assessment of Plants Used as Remedy in Turkish Folk Medicine,” *Journal of Ethnopharmacology* 89, no. 1 (2003): 123–129.
193. D. Deliorman Orhan, B. Özçelik, S. Hosbas, and M. Vural, “Assessment of Antioxidant, Antibacterial, Antimycobacterial, and Antifungal Activities of Some Plants Used as Folk Remedies in Türkiye Against Dermatophytes and Yeast-Like Fungi,” *Turkish Journal of Biology* 36, no. 6 (2012): 672–686.
194. A. Buessing, W. Tröger, C. Stumpf, and M. Schietzel, “Local Reactions to Treatments with *Viscum album* L. Extracts and Their Association With T-lymphocyte Subsets and Quality of Life,” *Anticancer Research* 28 (2008): 1893.
195. K. Urech, G. Schaller, and C. Jäggy, “Viscotoxins, Mistletoe Lectins and Their Isoforms in Mistletoe (*Viscum album* L.) Extracts Iscador,” *Arzneimittelforschung* 56 (2006): 428–434, <https://doi.org/10.1055/s-0031-1296808>.
196. C.-H. Lee, J.-K. Kim, H.-Y. Kim, S.-M. Park, and S.-M. Lee, “Immunomodulating Effects of Korean Mistletoe Lectin *In Vitro* and *In Vivo*,” *International Immunopharmacology* 9 (2009): 1555.
197. D. Deliorman, İ. Çaliş, F. Ergun, B. S. U. Doğan, C. K. Buharaloğlu, and I. Kanzik, “Studies on the Vascular Effects of the Fractions and Phenolic Compounds Isolated From *Viscum album* ssp. *Album*,” *Journal of Ethnopharmacology* 72 (2000): 323–329, [https://doi.org/10.1016/S0378-8741\(00\)00251-8](https://doi.org/10.1016/S0378-8741(00)00251-8).
198. P. Hegde, M. S. Maddur, A. Friboulet, J. Bayry, and S. V. Kaveri, “*Viscum album* Exerts Anti-Inflammatory Effect by Selectively Inhibiting Cytokine-Induced Expression of Cyclooxygenase-2,” *PLoS ONE* 6, no. 10 (2011): e26312, <https://doi.org/10.1371/journal.pone.0026312>.
199. Y. Taheri, C. Quispe, J. Herrera-Bravo, et al., “*Urtica dioica*-Derived Phytochemicals for Pharmacological and Therapeutic Applications,” *Evidence-Based Complementary and Alternative Medicine* 2022, no. 1 (2022): 4024331, <https://doi.org/10.1155/2022/4024331>.
200. F. Martz and S. Kankaanpää, “Stinging Nettle (*Urtica dioica*) Roots: the Power Underground—A Review,” *Plants* 14 (2025): 279, <https://doi.org/10.3390/plants14020279>.
201. S. Đurovic, I. Kojic, D. Radic, et al., “Chemical Constituents of Stinging Nettle (*Urtica dioica* L.): A Comprehensive Review on Phenolic and Polyphenolic Compounds and Their Bioactivity,” *International Journal of Molecular Sciences* 25 (2024): 3430, <https://doi.org/10.3390/ijms25063430>.
202. R. Parente, A. C. Paiva-Santos, C. Cabral, and G. Costa, “Comprehensive Review of *Urtica dioica* L. (Urticaceae) phytochemistry and Anti-Inflammatory Properties,” *Phytochemistry Reviews* 24 (2025): 1591–1628, <https://doi.org/10.1007/s1101-024-09980-6>.
203. World Health Organization, “WHO Monographs on Selected Medicinal Plants”, Vol. 2, World Health Organization, 2002.
204. ESCOP, ‘ESCOP Monographs: The Scientific Foundation for Herbal Medicinal Products’, 2nd ed., Thieme, 2003.
205. H. Zemouri, O. Sekiou, S. Ammar, et al., “*Urtica dioica* Attenuates Ovalbumin-Induced Inflammation and Lipid Peroxidation of Lung Tissues in Rat Asthma Model,” *Pharmaceutical biology* 55 (2017): 1561–1568, <https://doi.org/10.1080/13880209.2017.1310905>.
206. N. Shahzad, A. R. Alzahrani, I. A. A. Ibrahim, et al., “*In Vivo* Pharmacological Testing of Herbal Drugs for Anti-Allergic and Anti-Asthmatic Properties,” *Journal of Pharmacy And Bioallied Sciences* 13 (2021): 380–386, [https://doi.org/10.4103/jpbs.jpbs\\_454\\_21](https://doi.org/10.4103/jpbs.jpbs_454_21).
207. M. Irani, R. Choopani, S. Esmaeili, T. Dargahi, S. M. Athari, and S. S. Athari, “Effect of Nettle Seed on Immune Response in a Murine Model of Allergic Asthma,” *Revue Française d’Allergologie* 60 (2020): 417–422, <https://doi.org/10.1016/j.reval.2020.03.007>.
208. B. Roschek, R. C. Fink, M. McMichael, and R. S. Alberte, “Nettle Extract (*Urtica dioica*) Affects Key Receptors and Enzymes Associated With Allergic Rhinitis,” *Phytotherapy Research* 23 (2009): 920–926, <https://doi.org/10.1002/ptr.2763>.
209. M. Bakhshae, A. H. Mohammadpour, M. Esmaeili, et al., “Efficacy of Supportive Therapy of Allergic Rhinitis by Stinging Nettle (*Urtica dioica*) Root Extract: A Randomized, Double-Blind, Placebo-Controlled, Clinical Trial,” *Iranian Journal of Pharmaceutical Research* 16 (2017): 112–118.
210. J. S. MD Alimoddin, B. Fatima, N. Hasan, et al., “Pharmacological Applications of *Urtica dioica*: A Comprehensive Review of Its Traditional Use and Modern Scientific Evidence,” *Journal of Herbal Medicine* 48 (2024): 100935, <https://doi.org/10.1016/j.hermed.2024.100935>.
211. Y. Kumaki, M. K. Wandersee, K. W. Bailey, et al., “Inhibition of Severe Acute Respiratory Syndrome Coronavirus Replication in a Lethal SARS-Cov Balb/C Mouse Model by Stinging Nettle Lectin, *Urtica dioica* Agglutinin (UDA),” *Antivirus Research* 86 (2010): A36.
212. S. Upreti, J. S. Prusty, S. C. Pandey, A. Kumar, and M. Samant, “Identification of Novel Inhibitors of Angiotensin-Converting Enzyme 2 (ACE-2) Receptor From *Urtica dioica* to Combat Coronavirus Disease 2019 (COVID-19),” *Molecular Diversity* 25 (2021): 1795–1809, <https://doi.org/10.1007/s11030-020-10159-2>.
213. S. Arefani, S. M. M. Mehran, H. Moladoust, M. R. Norasfard, A. Ghorbani, and M. Abedinzade, “Effects of Standardized Extracts of *Lamium album* and *Urtica dioica* on Rat Tracheal Smooth Muscle Contraction,” *Journal of Pharmacopuncture* 21, no. 2 (2018): 70–75, <https://doi.org/10.3831/KPI.2018.21.008>.
214. V. Schmitzer, R. Veberic, and F. Stampar, “European Elderberry (*Sambucus nigra* L.) and American Elderberry (*Sambucus canadensis* L.): Botanical, Chemical and Health Properties of Flowers, Berries and Their Products,” *Berries: Properties, Consumption and Nutrition* (2012): 127–148, COBISS-ID: 7099001.
215. J. Hughes and R. Eder, “The Relationship Between Sensory Quality and Volatile Compounds in Raw Juice Processed From Elderberries (*Sambucus nigra* L.),” *European Food Research and Technology* 221 (2005): 244–254.
216. A. L. Dawidowicz, D. Wianowska, and B. Baraniak, “The Antioxidant Properties of Alcoholic Extracts From *Sambucus nigra* L. (antioxidant properties of extracts),” *LWT-Food Science and Technology* 39 (2006): 308, <https://doi.org/10.1016/j.lwt.2005.01.005>.
217. M. Dellagrecia, A. Fiorentino, P. Monaco, L. Previtera, and A. M. Simonet, “Cyanogenic Glycosides From *Sambucus nigra*,” *Natural Product Letters* 14 (2000): 175–182, <https://doi.org/10.1080/10575630008041228>.
218. M. Senica, F. Stampar, R. Veberic, and M. Mikulic-Petkovsek, “The Higher the Better? Differences in Phenolics and Cyanogenic Glycosides

- in *Sambucus nigra* Leaves, Flowers and Berries from Different Altitudes,” *Journal of the Science of Food and Agriculture* 97 (2017): 2623, <https://doi.org/10.1002/jsfa.8085>.
219. O. Sahpira-Nahor, Z. Zakay-Rones, and M. Mumcuoglu, “The Effects of Sambucol® on HIV Infection *In Vitro*,” (1995), 6–7.
220. Z. Zakay-Rones, E. Thom, T. Wollan, and J. Wadstein, “Randomized Study of the Efficacy and Safety of Oral Elderberry Extract in the Treatment of Influenza A and B Virus Infections,” *Journal of International Medical Research* 32 (2004): 132, <https://doi.org/10.1177/147323000403200205>.
221. B. Roschek Jr, R. C. Fink, M. D. McMichael, D. Li, and R. S. Alberte, “Elderberry Flavonoids Bind to and Prevent H1N1 Infection *In Vitro*,” *Phytochemistry* 70 (2009): 1255, <https://doi.org/10.1016/j.phytochem.2009.06.003>.
222. B. Barrett, “19 Acute Respiratory Infection Cold and Flu,” *Integrative Medicine, eBook: Integrative Medicine, eBook* (2022): 162.
223. E. Kinoshita, K. Hayashi, H. Katayama, T. Hayashi, and A. Obata, “Anti-Influenza Virus Effects of Elderberry Juice and Its Fractions,” *Bioscience, Biotechnology, and Biochemistry* 76 (2012): 1633, <https://doi.org/10.1271/bbb.120112>.
224. J. Harnett, K. Oakes, J. Carè, et al., “The Effects of *Sambucus nigra* Berry on Acute respiratory Viral Infections: A Rapid Review of Clinical Studies,” *Advances in Integrative Medicine* 7 (2020): 240–246, <https://doi.org/10.1016/j.aimed.2020.08.001>.
225. A. Firdaus, M. H. Yunus, S. K. Izhar, and U. Afaq, “Medicinal Plants in the Treatment of respiratory Diseases and Their Future Aspects,” *Recent Patents on Biotechnology* 19 (2025): 2, <https://doi.org/10.2174/0118722083278561231212072408>.
226. J. H. Lee, Y. G. Kim, and J. Lee, “Carvacrol-rich Oregano Oil and Thymol-Rich Thyme Red Oil Inhibit Biofilm Formation and the Virulence of Uropathogenic *Escherichia coli*,” *Journal of Applied Microbiology* 123 (2017): 1420–1428, <https://doi.org/10.1111/jam.13602>.
227. R. S. Chaugule and R. S. Barve, in *Role of Herbal Medicines in the Treatment of Infectious Diseases* (Bentham Science Publishers, 2024).
228. J. Xu, F. Zhou, B. P. Ji, R. S. Pei, and N. Xu, “The Antibacterial Mechanism of Carvacrol and Thymol Against *Escherichia coli*,” *Letters in Applied Microbiology* 47 (2008): 174–179, <https://doi.org/10.1111/j.1472-765X.2008.02407.x>.
229. V. Litvinenko, T. Popova, A. Simonjan, I. Zoz, and V. Sokolov, “Tannins” and Derivatives of Hydroxycinnamic Acid in Labiatae,” (1975): 372–380.
230. S. Hemaiswarya, P. K. Prabhakar, and M. Doble, in *Synergistic Herb-Drug Interactions Against Viral Diseases* (Springer, 2022).
231. M. Hosoya, J. Balzarini, S. Shigeta, and E. De Clercq, “Differential Inhibitory Effects of Sulfated Polysaccharides and Polymers on the Replication of Various Myxoviruses and Retroviruses, Depending on the Composition of the Target Amino Acid Sequences of the Viral Envelope Glycoproteins,” *Antimicrobial Agents and Chemotherapy* 35 (1991): 2515, <https://doi.org/10.1128/aac.35.12.2515>.
232. S. Muto, K. Niimura, M. Oohara, et al., “Polysaccharides and Antiviral Drugs Containing the Same as Active Ingredient,” (Google Patents, 1992).
233. K. Queiroz, V. Medeiros, L. Queiroz, et al., “Inhibition of Reverse Transcriptase Activity of HIV by Polysaccharides of Brown Algae,” *Biomedicine & Pharmacotherapy* 62 (2008): 303–307, <https://doi.org/10.1016/j.biopha.2008.03.006>.
234. I. A. Schepetkin and M. T. Quinn, “Botanical Polysaccharides: Macrophage Immunomodulation and Therapeutic Potential,” *International Immunopharmacology* 6 (2006): 317–333, <https://doi.org/10.1016/j.intimp.2005.10.005>.
235. I. A. Schepetkin, C. L. Faulkner, L. K. Nelson-Overton, J. A. Wiley, and M. T. Quinn, “Macrophage Immunomodulatory Activity of Polysaccharides Isolated From *Juniperus scopolorum*,” *International Immunopharmacology* 5 (2005): 1783, <https://doi.org/10.1016/j.intimp.2005.05.009>.
236. K. R. Narayana, M. S. Reddy, M. Chaluvadi, and D. Krishna, “Bioflavonoids Classification, Pharmacological, Biochemical Effects and Therapeutic Potential,” *Indian Journal of Pharmacology* 33 (2001): 2–16.
237. S. Majumdar, S. Sasmal, A. Mukherjee, and M. Gupta, “Evaluation of Antipyretic Efficacy of a Traditional Herbal Medicine,” *Journal of Pharmacy Research* 4 (2011): 3985–3988.