Hormozgan Medical Journal

doi 10.34172/hmj.8394

Hormozgan Med J. 2025;29(2):91-98

Review Article

A Comprehensive Review of Medicinal Plants Effective in the Treatment of Respiratory Diseases

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Abstract

Background: The prevalence of antibiotic-resistant respiratory pathogens has increased despite significant advancements in conventional medicine. Given the growing interest in natural remedies, this review examined medicinal herbs as potential alternatives or complements to conventional treatments for respiratory infections, focusing on their antiviral properties.

Methods: A comprehensive literature search was conducted using PubMed, ScienceDirect, and Google Scholar databases, as well as other relevant online platforms to identify published research articles. Different key terms, including medicinal plants, antiviral, immune system modulator, anti-inflammatory, antimicrobial, antioxidant, shortness of breath, expectorant, and antitussive, were employed to retrieve studies published up to 2024.

Results: Traditional medicine employs a plethora of medicinal plants to address respiratory diseases and their associated symptoms. These plants are particularly prevalent for their expectorant, respiratory relief, antitussive, antiviral, and immune-modulating properties, including *Drimia maritima*, *Adiantum capillus-veneris*, *Glycyrrhiza glabra*, *Malva sylvestris*, *Cordia myxa*, *Origanum vulgare*, *Artemisia absinthium*, and *Hyssopus officinalis*. The other plants are *Stachys schtschegleevii*, *Withania somnifera*, *Syzygium aromaticum*, *Artemisia annua*, *Alpinia officinarum*, *Echinacea angustifolia*, and *Thymus vulgaris*. Notably, *E. angustifolia* and *G. glabra* have been extensively studied for their immune-modulating and antiviral effects, respectively. In Iran's pharmaceutical market, products derived from *E. angustifolia* and *T. vulgaris* are most commonly licensed for treating respiratory infections."

Conclusion: This review highlights the substantial potential of medicinal plants in addressing severe respiratory ailments. The compilation of this review serves as a valuable resource for future pharmacological and phytochemical research, facilitating the development of novel respiratory therapeutics and promoting the conservation of these significant botanical resources.

Keywords: Antimicrobial, Anti-virus, Medicinal plants, Shortness of breath

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Received: September 25, 2024, **Revised:** October 19, 2024, **Accepted:** November 4, 2024, **ePublished:** April 15, 2025

Background

The respiratory system, a network of organs facilitating respiration, enables the body to absorb oxygen from the atmosphere for vital organ function. Respiratory infections, among the most prevalent human infections, pose a significant threat to health, especially in individuals with severe conditions (1, 2). Common respiratory ailments include asthma, bronchitis, colds, pneumonia, and fungal pneumonia (3). The World Health Organization underscores the global burden of respiratory infections, identifying them as a leading cause of mortality among infectious diseases (4). Respiratory syncytial virus, influenza virus, metapneumovirus, parainfluenza viruses, adenoviruses, bocaviruses, rhinoviruses, and coronaviruses are respiratory viruses associated with epidemic or endemic infections worldwide (5).

The current century witnessed the emergence of the third global pandemic, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), or coronavirus disease 19 (COVID-19) (6, 7). This novel coronavirus disease posed a significant challenge to the international community (8). The analyses of the 2002 SARS outbreak suggested that the integration of traditional Chinese medicine (TCM) with conventional medicine could potentially mitigate morbidity and mortality rates compared to conventional therapy alone (9). Moreover, diverse traditional medical systems have historically addressed respiratory infections and their associated treatments (10-12).

Traditional medicine remains a widely recognized and effective approach to treating various ailments (13). Herbal remedies are commonly used for respiratory disorders globally (14, 15). Traditional medicine has served as a valuable source of treatments for common infections in developing countries (16). Medicinal plants offer not only therapeutic benefits but also ecological,

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economic, and cultural values. Historically, medicinal plants have been a cornerstone of disease treatment and infection prevention (17). A significant portion of the world's population relies on medicinal plants for healthcare (18).

This study aims to investigate the effect of medicinal plants employed in traditional medicine for the treatment of respiratory infections, focusing on their efficacy, mechanisms of action, and reported side effects as documented in laboratory and clinical research.

Methods

Several databases, such as PubMed, Scopus, ScienceDirect, Google Scholar, Web of Science, and Magiran, were utilized to conduct a comprehensive literature search. A variety of key terms, including medicinal plants, antiviral, immune system modulator, anti-inflammatory, antimicrobial, antioxidant, shortness of breath, expectorant, and antitussive, were applied to retrieve ethnobotanical/ethnomedicinal studies published up to 2024, focusing on medicinal plants traditionally used for respiratory disorders.

Two researchers independently screened the literature, reviewing abstracts and titles to identify potentially relevant studies. Full-text articles were subsequently obtained and evaluated for inclusion. Additionally, reference lists of retrieved articles were manually searched to identify further potentially eligible studies. Studies published in languages other than English or Persian, as well as review articles, conference papers, and research on nonrespiratory or non-human pathogenic viruses, were excluded from the review. The extracted data encompassed the plant's scientific name, Persian name, English common name, used plant part, reported antiviral effect, and study type (in-vitro, animal, or clinical).

A total of 960 articles were retrieved from various online sources (Figure 1). However, only 51 articles that provided comprehensive information on the utilization of medicinal plant species for treating respiratory disorders were ultimately selected for inclusion in this review (Figure 1).

Results

Traditional medicine has a rich history of utilizing various plants for controlling respiratory diseases. A review of 51 articles identified 16 medicinal plants with comprehensive information on their application in treating respiratory disorders (Table 1).

Discussion

The outbreaks of viral respiratory infections have spurred research into novel therapeutic options, particularly those derived from natural sources, leading to the identification of potential drug candidates. The efficacy of various herbs has been documented through case series, clinical trials, and systematic reviews (1).

The historical records of the 2002 SARS outbreak suggest that the integration of TCM with conventional therapy can enhance outcomes compared to conventional treatment alone (9). TCM practitioners prescribe herbal remedies known for their anti-inflammatory, antiviral, and immunomodulatory properties to optimize patient management (9). A meta-analysis of 24 trials

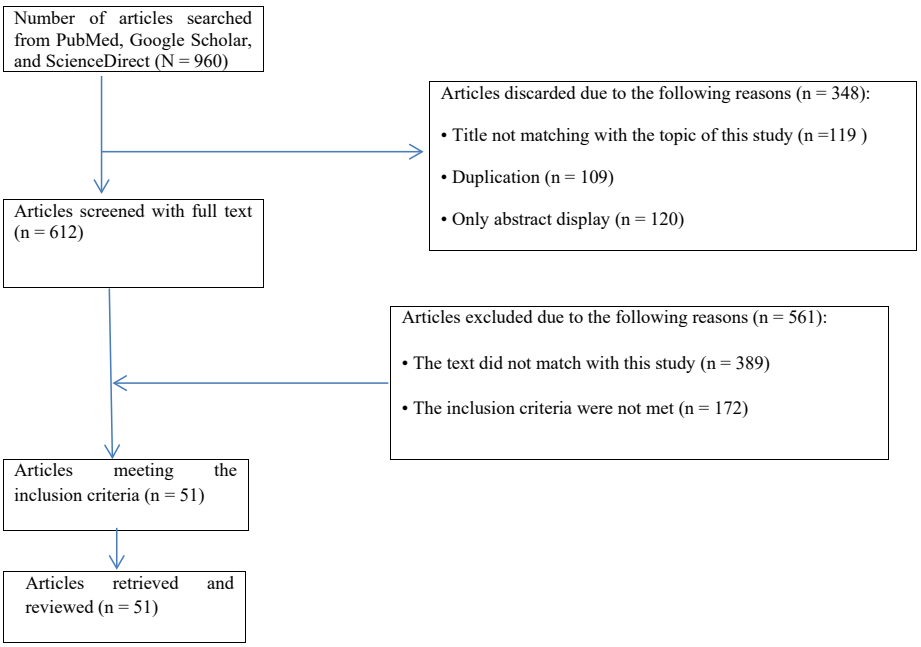

Figure 1. A Diagram Showing the Selection Procedures of Articles for This Review

Table 1. Medicinal Plants Effective in Respiratory Diseases

Plant Family	Scientific Name	Uses in Traditional Medicine in Respiratory Diseases	Parts Used	Side Effects	Pharmacological Compounds and Effects	Sources
Polypodiopsida	*Adiantum capillus-veneris*	Chronic lung diseases, bronchitis, cough, and whooping cough	All parts	Vomiting in certain individuals	Flavonoids, triterpenoids, oleanes, phenylpropanoids, carbohydrates, carotenoids and alicyclics in the extract. The plant has antioxidant, anti-inflammatory, antibacterial, anti-viral, expectorant effects, and many compounds (e.g., caravan, carvacrol, and thymol) with antioxidant and anti-inflammatory effects on the essential oils of the plant.	Haider et al (19) Rajurkar and Gaikwad (20) Al-Snafi (21) Ebadi et al (22)
Malvaceae	*Malva*	Lung infections, expectorant, lung cleaner, anti-inflammatory, and antitussive effects	Leaves and flowers	Confusion, disorientation, insomnia, depression, and dizziness	Polysaccharides, coumarins, flavonoids, polyphenols, vitamins, terpenes, tannins, and mucilages have immune-modulating, anti-inflammatory, antimicrobial, antiviral effects.	Gasparetto et al (23) Martins et al (24) Ameri et al (25) Jaradat et al (26)
Boraginaceae	*Cordia myxa*	Lung infections, respiratory disorders, and cough	Fruit	Muscle weakness, irregular menstrual cycles, high blood pressure, fluid retention, sodium retention, and potentially heart failure	Phenolic acids, coumarins, tannins, resins, gums, and mucilage have anti-inflammatory, antioxidant, analgesic, antimicrobial, emollient and expectorant effects.	Al-Snafi (27) Abdel-Aleem et al (28)
Asteraceae	*Artemisia absinthium*	Viral infections and modulation of the immune system	Flower	Nausea, vomiting, muscle aches, seizures, kidney failure, insomnia, hallucinations, and tremors	Lacto-neha, terpenoids, essential oils, organic acids, resins, tannins, and phenols have antiviral effects, and immune system modulation	Mehrabani et al (29) Ruwali et al (30) Wang et al (31)
Liquorice	*Glycyrrhiza glabra*	Bronchodilator, antitussive effects hoarseness, treatment of asthma, shortness of breath, and relief of congestion in the upper respiratory tract	Root	Headaches, fatigue, high blood pressure, and even heart attacks	Glycerin zinc has antiviral, anti-inflammatory, antioxidant, and expectorant effects	Badr et al (32) Fu et al (33) Feng Yeh et al (34) Wang et al (35) Luo et al (36)
Lamiaceae	*Lavandula angustifolia* Mill.	Effects on non-preincubated tracheal smooth muscle, treat digestive problems, inflammation, and coughing	Aerial part	Constipation, diarrhea, and headache	Anticonvulsant, anxiolytic, antioxidant, anticholinesterase, antimicrobial, and antifungal activities	Arzi et al (37) Woelk and Schläfke (38) Messaoud et al (39) Varona et al (40)
Lamiaceae	*Origanum majorana*	Spices, viral infections, chronic rhinosinusitis, and prevention of inflammation	Aerial parts	Slow heart rate (bradycardia). Additionally, high doses can lead to stomach irritation, burning sensations, and constipation.	Rosmarinic and chlorogenic acids are the main components, and essential oils of carvacrol, beta-phenicol alcohol, thymol, and -γ-terpinene have antioxidant, antibacterial, and antiviral effects.	Zhang et al (41) Gutiérrez-Grijalva et al (42) Pezzani et al (43) Oniga et al (44)
Squill	*Drimia*	Pneumonia, chronic bronchitis, asthma, and cough	Onions and leaves	Gastrointestinal issues (e.g., abdominal pain, diarrhea, and vomiting), central nervous system symptoms (e.g., confusion, hallucinations, and depression), and cardiovascular irregularities (irregular heartbeat and potential convulsions).	Prosylaridin A, the main active ingredient, has strong T-cell suppressive activity and antiviral, antibacterial, anti-inflammatory, antioxidant, anticholinergic, and expectorant effects.	Bashir et al (45) Bozorgi et al (46) Nejatbakhsh et al (47) Zhang et al (48)
Lamiaceae	*Hyssopus officinalis*	Respiratory disorders, bronchial inflammation, nasal congestion, antiseptic, and cough	Flowering branches	Gastrointestinal upset, anxiety, and tremors	Tannins, phenols, terpenoids, one acid, and several triterpenoid acids have antiviral, antioxidant, expectorant, and antimicrobial effects.	Ha et al (49) Tahir et al (50)
Lamiaceae	*Stachys inflata*	Sinusitis, asthma, fever, respiratory and inflammatory infections, influenza, and cold	Leaves	No reports on the possible toxic effects	Phenolic compounds and flavonoids have antimicrobial effects	Rezazadeh et al (51) Chitsaz et al (52)

Table 1. Continued.

Plant Family	Scientific Name	Uses in Traditional Medicine in Respiratory Diseases	Parts Used	Side Effects	Pharmacological Compounds and Effects	Sources
Apiaceae	*Pimpinella anisum* L.	The drug is used internally for bronchial catarrh, pertussis, spasmodic cough, and flatulent colic and externally for pediculosis and scabies	Fruit	Abnormal hormone levels—with potential effects on sperm count or fertility. Breathing problems from an allergic reaction or too much fluid in the lungs	Eugenol trans-anethole, methyl chavicol, anisaldehyde, estragole, coumarins, scopoletin, umbelliferone, estrols, terpene hydrocarbons, polyenes, and polyacetylenes are the major compounds of the essential oil of anise seed.	Lee et al (53) Denev et al (54) Picon et al (55)
Myrtaceae	*Syzygium aromaticum*	Painkillers, respiratory diseases, and cough	Flower buds	Irritation and sensitivity in the mouth and possible interference with blood clotting, which may increase the risk of bleeding.	Eugenol (as the main compound), eugenin, eugenol acetate, and heptacosane have anti-inflammatory, antiviral, antibacterial, and antioxidant effects.	Saleem et al (56) Kanyinda (57) Singh et al (58)
Asteraceae	*Artemisia annua*	Viral, bacterial and autoimmune diseases	All parts	A stomach pain, a slowed heart rate, diarrhea, nausea, vomiting, decreased appetite, and flu-like symptoms	Artemisinin and its derivatives and sterol compounds have antiviral, antioxidant, immune system modulation and anti-inflammatory activity	Chukwurah et al (59) Ekiert et al (60)
Zingiberaceae	*Alpinia officinarum*	Pulmonary viral infections, colds, pain, inflammation, and microbial infection	Root	Increased stomach acid	Betasitosterol and flavonols such as quercetin and galangina have antioxidant effects, and diarylheptanoid has antiviral effects.	Sawamura et al (61) Dixit et al (62)
Urticaceae	*Urtica dioica* L.	DiGerent SARS-CoV strains	Leaves	Mild stomach upset, fluid retention, sweating, diarrhea, and hives or rash	Histamine serotonin acetylcholine formic acid and N-acetylglucosamine-specific stinging nettle lectin	Jalali et al (63) Parente et al (64)
Asteraceae	*Echinacea angustifolia*	Upper and lower respiratory tract infections, such as sinusitis, bronchitis, tonsillitis, and pneumonia	All parts	Stomach pain, constipation, diarrhea, heartburn, vomiting, and rash	It has antiviral and antimicrobial effects. The compounds include alkamides, caffeic acid derivatives, polyalkenes, polyalkynes, and polysaccharides, and immune system-modulating agents	Percival (65) Radad et al (66)
Lamiaceae16	*Thymus*	Shortness of breath and cough caused by the microbial infection of the respiratory tract and viral infections	Aerial organs	No side effects or adverse effects have been reported.	Thymol (as an active ingredient), carvacrol other phenolic compounds, monoterpene hydrocarbons, and alcohols have antioxidant, anti-inflammatory, immune system modulatory, antiviral, and antimicrobial effects.	Ayenechi (67) Schönknecht et al (68)

Note. SARS-CoV: Severe acute respiratory syndrome coronavirus 2.

revealed no long-term adverse effects associated with high-dose corticosteroid use in integrative treatment, combining herbal drugs and conventional therapy (69). It is noteworthy that ancient medical systems, such as Persian medicine, TCM, and Unani medicine, often employ individualized, phenotype-based approaches to treatment. Traditional practitioners consider several factors, such as gender, age, season, comorbidities, and other patient characteristics, to diagnose and manage diseases effectively (9).

The COVID-19 pandemic underscored the importance of preventive measures and symptomatic therapies within human society (70). Consequently, numerous research studies have investigated the safety and efficacy of various traditional medical systems' recommended preventive, therapeutic, supportive, or rehabilitative interventions (71). The World Health Organization's emphasis on integrating traditional, complementary, and alternative medicine into conventional healthcare systems, coupled with the increasing interest in natural products for disease management, highlights the need for comprehensive research on diverse aspects of traditional medicines to bolster the scientific evidence supporting natural remedies (15).

Numerous previous studies examined the efficacy of medicinal herbs traditionally used for respiratory infections in diverse cultural contexts (10). A Guatemalan study evaluated the antibacterial properties of 68 herbs traditionally applied to respiratory ailments, identifying 28 medicinal plants with inhibitory effects against Gram-positive bacteria, including *Streptococcus pneumoniae*, *Staphylococcus aureus*, and *Streptococcus pyogenes* (72). Additionally, a study of 44 Chinese herbs demonstrated the antiviral activity of 27 of these plants against the respiratory syncytial virus (73).

This review study evaluated the antiviral properties of medicinal plants traditionally recommended for respiratory disorders in Persian medicine. Of the 16 herbs investigated, experimental studies have confirmed antiviral activity. These plants, known to alleviate

respiratory symptoms, including those associated with COVID-19 (74), exhibit antiviral effects. Notably, *Glycyrrhiza glabra* and *Urtica dioica* have demonstrated efficacy against coronaviruses (75). Beyond their antiviral properties, these herbs can also mitigate symptoms of respiratory infections. For instance, glycyrrhizin, a triterpenoid saponin found in *Glycyrrhiza glabra* (licorice) root, has displayed potent antiviral effects against SARS-associated coronaviruses. Additionally, research suggests that *Withania somnifera* (L.) Dunal may be a promising therapeutic option for COVID-19. The withanolides present in this plant can bind to angiotensin-converting enzyme 2 receptors, preventing viral attachment. Furthermore, withanone, another withanolide, interacts with and inactivates the main proteases of SARS-CoV-2 (76). Moreover, the mechanisms of these herbal medicines include modulating immune responses, reducing inflammation in the respiratory tract, and possibly enhancing fluid clearance in the lungs, thereby facilitating better respiratory function (77). In addition, the mechanism of action of these plants includes stress reduction, antioxidant properties, and potential bronchodilation. These combined effects contribute to its potential benefits in treating respiratory infections and improving overall respiratory health (78).

Of the medicinal plants traditionally recommended for respiratory disorders, 17 have demonstrated antiviral activity against respiratory viruses. Further research is warranted to assess the antiviral potential of other suggested medicinal plants. Clinical trials are essential for the integration of these plants into clinical practice. Comparative studies evaluating the efficacy and safety of these herbs against conventional antiviral drugs are also necessary.

Limitations of the Study

This review was constrained by its focus on English and Persian language publications, potentially limiting the scope of included studies. Additionally, the web-based nature of the research may have resulted in a selection bias, potentially hindering the generalizability of the findings to broader populations.

Conclusion

The limitations of conventional treatments, including efficacy, safety, high costs, and limited global availability, have contributed to a growing interest in herbal medications for managing viral respiratory infections. This review highlights the antiviral potential of a significant number of medicinal herbs traditionally recommended for respiratory disorders. However, the efficacy of several of these plants in treating viral respiratory infections remains understudied. The scarcity of clinical research represents a primary challenge in this area, necessitating more rigorous investigations.

Acknowledgments

The authors would like to express their gratitude to the Clinical Research Development Unit of Imam Khomeini Hospital, Urmia University of Medical Sciences, for the English editing.

Authors' Contribution

Conceptualization: Farhad Behzadi
Investigation: Ali Zolfi Gol
Project Administration: Ali Zolfi Gol
Supervision: Farhad Behzadi
Original Draft Writing: Farhad Behzadi
Writing–Review and Editing: Ali Zolfi Gol

Competing Interests

The authors have no competing interests to declare that are relevant to the content of this article.

Ethical Approval

Considering that no patient was included in this study, there was no need to present the ethical code.

Funding

The authors received no support from any organization for the submitted work.

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