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Review Paper

Therapeutic Potential of Selected Medicinal Plants in Bronchial Asthma: Current Evidence and Future Perspectives

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ABSTRACT

The symptoms of asthma, a chronic inflammatory airway disease, include bronchial hyperresponsiveness, reversible airflow restriction, and airway remodeling. Even if traditional medication successfully manages symptoms, prolonged usage is frequently linked to negative side effects and financial hardship. *Allium sativum*, *Glycyrrhiza glabra*, *Thymus vulgaris*, *Foeniculum vulgare*, *Hyssopus officinalis*, *Borago officinalis*, and *Clerodendrum serratum* are among the medicinal plants that have historically been used to treat asthma. The purpose of this review is to objectively assess their therapeutic potential. From scientific databases that concentrated on pharmacological, phytochemical, and mechanistic investigations, pertinent literature was gathered. Research indicates that these plants have anti-inflammatory, antioxidant, bronchodilatory, and immunomodulatory properties that are mediated via the suppression of histamine release, the inhibition of pro-inflammatory cytokines, and the modification of oxidative stress pathways. Their medicinal effects seem to be greatly influenced by bioactive components such terpenoids, phenolic compounds, flavonoids, and saponins. However, there are still a number of significant obstacles, such as inconsistent phytochemical content, a lack of standardized formulations, and a dearth of clinical trials. All things considered, medicinal plants offer a promising adjunct to asthma treatment; however, more carefully planned clinical and mechanistic research is needed to confirm their efficacy, safety, and translational relevance.

INTRODUCTION

People of all ages worldwide suffer from asthma, a potentially fatal respiratory condition. Inflammation and muscular constriction surrounding the airways create the disorder, which

manifests clinically as shortness of breath, coughing, chest tightness or pain, breathing difficulties, and a whistling sound (wheezing) when exhaling⁽¹⁾. It is believed that a mix of environmental and genetic variables contribute to asthma⁽²⁾. Asthma is thought to affect 300 million

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individuals globally, and in 2005, the illness killed roughly 255,000 people. Low and lower-middle-income nations accounted for 80% of asthma deaths. The Ayurvedic and Unani medical traditions in India have identified a number of herbs for the treatment of asthma. In a similar vein, tribal communities used indigenous knowledge that developed independently in many parts of the world to treat a variety of illnesses⁽³⁾. Antigen contact and inflammatory cell infiltration in the airway wall are hallmarks of the inflammatory process in asthma, which in turn raises the production and discharge of reactive oxygen

species (ROS) and inflammatory mediators. Th2 cells in allergic asthma release a range of cytokines, including IL-4, IL-5, and IL-13, which are important regulators of allergen-specific E production, eosinophil recruitment, airway remodeling, and airway hyperresponsiveness⁽⁴⁾. Due to the unsatisfactory results of current asthma treatment, individuals are turning to complementary and alternative medicine to manage their condition. Medicinal plants with anti-inflammatory, immunomodulatory, antihistaminic, smooth muscle relaxant, and allergy properties are used to treat asthma⁽⁵⁾.



Fig No. 1

Pathophysiology

The airway damage-repair processes involve a range of cells and cellular components, leading to airway remodeling, a significant pathophysiological characteristic of asthma. The main pathophysiological manifestations of airway remodeling in asthma include thickening of the airway wall, damage to the epithelium, reticular basement membrane fibrosis, airway smooth muscle hyperplasia and hypertrophy, mucus gland hypertrophy, and the regeneration and reconstruction of vascular tissues.⁽⁶⁾ Airway wall biopsies and bronchoalveolar lavage fluid from asthmatic patients show elevated levels of several inflammatory cell types, including eosinophils, but also basophils, mast cells, macrophages, and several types of lymphocytes⁽⁷⁾. Type 2 or T2-high

asthma is the most common type of the condition. T-helper 2 (Th2) cells, mast cells, and eosinophils play a major role in this variant's immunological response⁽⁸⁾. Mast cell activation is crucial for starting the acute bronchoconstrictor reactions to allergens and most likely other indirect stimuli like exercise, excessive breathing (via osmolality or temperature changes), and fog. Patients with asthma have a notably increased quantity of mast cells in their airway smooth muscle⁽⁹⁾. By releasing specific cytokines including interleukin (IL)-4, IL-5, IL-9, and IL-13, Th2 cell levels in the airways promote the production of immunoglobulin E (IgE) and eosinophilic inflammation. IgE production triggers the release of inflammatory mediators such as histamine and cysteinyl leukotrienes, which cause bronchospasm

(contraction of the smooth muscle in the airways), edema, and increased mucous secretion—the typical symptoms of asthma⁽¹⁰⁾.

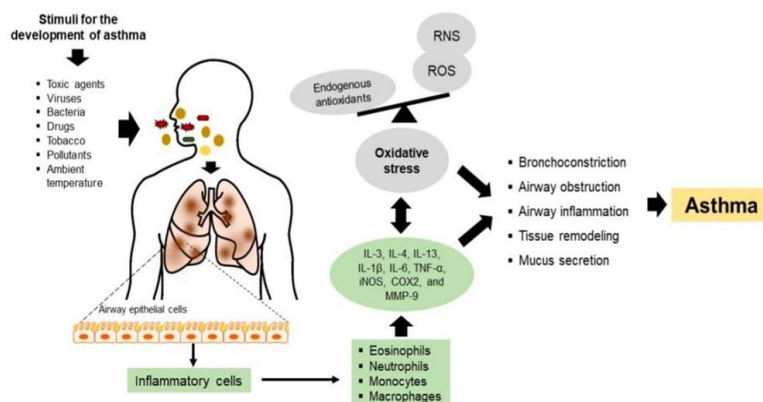


Fig No. 2

Herbal Drugs with Anti-asthmatic Potential

1) *Clerodendrum serratum* L.

Clerodendrum serratum Linn., commonly referred to as Bharangi, is a member of the Verbenaceae family and has been used historically to relieve different illnesses⁽¹¹⁾.

Because of its potent anti-inflammatory properties, *Clerodendrum serratum* helps individuals with asthma by reducing airway inflammation. Mechanistically, the extract's bioactive constituents—flavonoids, saponins, and phenolic acids were responsible for its antioxidant and anti-inflammatory properties. These compounds work by blocking the enzymes cyclooxygenase (COX) and lipoxygenase (LOX), which are involved in the synthesis of leukotrienes and inflammatory prostaglandins.

The extract lowers inflammation by blocking these enzymes, which encourage the synthesis of inflammatory mediators⁽¹²⁾. Both the root and the stem have demonstrated anti-allergic effects, only a high dosage of *Clerodendrum serratum* root demonstrated notable effectiveness when in contrast to dexamethasone. The alcoholic component of aqueous solution was continuously perfused into the sensitized isolated guinea pig lung, inhibiting the anaphylactic

bronchoconstrictor reaction. *Clerodendrum serratum* root extract with possible antiasthmatic effects⁽¹³⁾.



Fig No.3: *Clerodendrum serratum* L

2) *Hyssopus officinalis* L.

Particularly in the East Mediterranean regions of central Asia, *Hyssopus officinalis* L. (Lamiaceae) is a relatively common herb. Hyssop has dry and warm qualities⁽¹⁴⁾.

Polyphenolic acids, flavonoids, and essential oils are present in the raw materials.

H. officinalis exhibits strong antibacterial activity and a mild antioxidant impact against both Gram-positive and Gram-negative bacteria. In vitro, antiviral, antifungal, and insecticidal qualities were also discovered⁽¹⁵⁾. *Hyssopus officinalis* effectively regulates the imbalance of T helper (Th) 1/Th2 cytokines and the release of IL-4, IL-

17, and interferon- γ (IFN- γ) in a mouse model of asthma⁽¹⁶⁾. Hyssop inhibits the release of Eotaxin-2, which lowers the inflammatory response associated with asthma⁽¹⁴⁾.



Fig No.4: Hyssopus officinalis L.

3) **Borago officinalis L.**

The hairy annual plant *Borago officinalis* Linn. (family: Boraginaceae) is often referred to as "Borage," "Gaozaban," or "Lisan al-Thawr⁽¹⁷⁾." Gaozaban's floral methanolic extract exhibits mild anti-inflammatory and anticancer effects in addition to antioxidant and antibacterial activity. To justify some of the traditional uses, the antispasmodic, bronchodilator, vasodilator, and cardiac depressant properties of *Borago officinalis* L. crude leaf extract were examined⁽¹⁸⁾.



Fig No.5: Borago officinalis L

1) **Thymus vulgaris L.**

T. vulgaris L. or thyme, known as "garden thyme" is an aromatic and perennial flowering plant belonging to the *Lamiaceae* family. The

Southern European medicinal and culinary herb *Thymus vulgaris* Linn. has been known for its anti-inflammatory, immunomodulatory, gastroprotective, cardioprotective, and anti-infective qualities since the Egyptian era⁽¹⁹⁾. The most significant active component of *Thymus vulgaris*, which contains a variety of phytochemical substances such as terpenoids, phenolics, and tannins, is thyme oil. Additionally, the primary active ingredients of thyme oil, thymol, carvacrol, p-cymene, and linalool, which have antibacterial, anti-inflammatory, and antioxidant qualities, are responsible for the majority of its effects. Therefore, by modifying their inflammatory and apoptotic signaling pathways, thyme oil can lessen chronic inflammatory disorders. Furthermore, by inhibiting the expression of IL-4, IL-5, IL-13, TNF- α , and nuclear factor- κ B in a variety of disorders, it can reduce the synthesis of proinflammatory mediators and restore their secretion⁽²⁰⁾. By raising the volume and decreasing the weight of secretions, *thymus vulgaris* inhalation therapy lowers the concentration of secretions in the airways⁽²¹⁾.



Fig No.6: Thymus vulgaris L

5) **Allium sativum L.**

Garlic (*Allium sativum* L.), a plant belonging to the Liliaceae family, has gained a reputation as a preventative and curative medicinal herb in several cultures. Garlic was suggested by traditional Chinese and Indian medicine to improve digestion

and breathing⁽²²⁾. Garlic increases Th1 cytokines and decreases Th2 cytokines to lessen airway inflammation. Moreover, NF- κ B activity is associated with IgE. The phosphorylation of NF- κ B and the decline in IL-13 and IL-4 production were also suppressed by the garlic fraction treatment's lowering of IgE. By blocking the IL-6/PI3K/Akt/NF- κ B pathway, the garlic extract altered the anti-inflammatory response⁽²³⁾.



Fig No.7: Allium sativum L.

6) *Glycyrrhiza glabra*

Many pharmacological effects, including anti-inflammatory, antiviral, antitumor, and hepatoprotective properties, have been linked to *Glycyrrhiza glabra*⁽²⁴⁾. It was determined that *Glycyrrhiza glabra* is an efficient herbal remedy for asthma illness and that, at greater concentrations, it is comparable to the Standard Drug in terms of its effect on mast cell degranulation in sensitized albino rats⁽²⁵⁾. According to numerous studies, the flavonoids in licorice reduce immunoglobulin (IgE), interleukin (IL)-13, IL-5, IL-3, and eosinophilic lung inflammation while also increasing interferon gamma activity. By activating TNF α , ganoderic acid, another substance that was extracted from licorice, has an anti-asthma action⁽²⁶⁾. The scientific name for licorice, a plant in the Leguminosae family, is *Glycyrrhiza glabra*. A common ayurvedic herb is *G. glabra*.

This therapeutic herb can be found in parts of Europe and throughout Asia⁽²⁷⁾.



Fig No.8: Glycyrrhiza glabra

7) *Foeniculum vulgare*

Around the world, fennel, or *Foeniculum vulgare*, is commonly grown in both tropical and temperate climates. It is a member of the Apiaceae family. *Foeniculum vulgare* showed bronchodilatory action on guinea pig tracheal chains that were constricted. It is possible that *foeniculum vulgare* is causing respiratory tract depression in guinea pigs. High antioxidant levels in fennel extract make it suitable for medical usage⁽²⁸⁾. *F. vulgare* extracts and isolated chemicals are assessed for a variety of properties, including expectorant, anti-inflammatory, and antiallergic⁽²⁹⁾.



Fig No.9: Foeniculum vulgare

Mechanism of Herbal action

Table No. 1

Herbal Plant	Action
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1	<i>Clerodendrum serratum</i>	suppressing TNF- α , IL-4, and the proinflammatory mediators IL-1 β .
2	<i>Hyssopus officinalis</i> L.	control immunity by preventing EOS infiltration and lowering IgE levels in lung tissue, which has an anti-inflammatory effect.
3	<i>Borago officinalis</i> L.	suppress the main symptoms of asthma, including as coughing, dyspnea, hyperresponsiveness of the airways, and nighttime symptoms
4	<i>Thymus vulgaris</i> L.	reduces inflammatory cells and T2 cytokines (IL-4, IL-5, and IL-13) to reduce allergic airway and AHR inflammation.
5	<i>Allium sativum</i> L.	via altering inflammatory responses, antiviral cytokines, and other antioxidant and antiviral processes.
6	<i>Glycyrrhiza glabra</i>	reduced the production of mucus, MCP-1, IL-IL-4, IL-5, IL-13, TNF- α , INF- γ , and IgE.
7	<i>Foeniculum vulgare</i>	bronchodilatory activity

Comparative Analysis

Herbal Drug v/s Synthetic Drug

1. Herbs have demonstrated intriguing outcomes in a number of target-specific biological actions, including immunomodulatory, bronchodilation, mast cell stabilization, anti-anaphylactic, anti-inflammatory, anti-spasmodic, anti-allergic, and mediator inhibition⁽³⁵⁾.
2. Traditional medicinal systems have demonstrated the efficacy of several plants in treating a variety of respiratory disorders, including asthma. The usage of natural products and therapeutic plants has grown significantly during the past 20 years worldwide. The synthetic medications now utilized in asthma pharmacotherapy are not able to work on all of the targets and phases of asthma. Nonetheless, certain herbal remedies

for asthma have been shown to alleviate symptoms and help slow the disease's progression⁽³⁶⁾.

3. Although the advent of contemporary chemotherapeutic drugs, such as corticosteroids and bronchodilators, has significantly improved the management of asthma, many patients continue to have uncontrollable symptoms or adverse drug reactions. The interest in complementary and alternative therapies, such the usage of herbal medicine, which are seen to be safer and more natural, is one of the factors driving that trend⁽³⁷⁾.

Limitations of Herbal Drugs

1. Herbal formulations can contain contaminants at different phases of manufacture, including intentional adulteration with synthetic pharmaceuticals. Microorganisms are a naturally occurring phenomenon. Therefore,



guidelines defining the maximum amount of aerobic bacteria in herbal products should be in place⁽³⁸⁾.

2. Lack of research and development for new products and processes. Challenges in marketing. Insufficiently skilled staff and equipment. Insufficient facilities for local equipment fabrication. Inability to obtain up-to-date market and technology information⁽³⁹⁾.
3. It is necessary to employ a variety of methods for the quality control inspection of the herbs, which can be controlled to obtain the necessary high-quality goods by establishing appropriate standards. The safer usage, efficient treatment, and necessary potency of the items will follow, benefiting society and humanity by offering means of well-being⁽⁴⁰⁾.
4. The active phytoconstituents required for treatment may be absent from substituted herbs. Variability in bioactive content impairs dose homogeneity, produces unpredictable results, and undermines the validity of outcome-based methods. Ineffective herbal remedies might conceal symptoms, postpone necessary medical attention, or cause illness to worsen as a result of mistaken therapeutic trust⁽⁴¹⁾.
5. Herbal medicine research faces a number of obstacles and limitations despite increasing interest and use. The absence of thorough clinical studies and established research techniques to determine the effectiveness, safety, and ideal dosages of herbal therapies is a significant drawback. The ability to reach firm findings is limited by the fact that many studies rely on observational data and conventional knowledge rather than randomized controlled trials. More mechanistic research is also required to comprehend the active ingredients and processes behind the therapeutic benefits of herbal medicine. Increased research funding,

cooperation between academics and practitioners of traditional medicine, and adherence to international research standards are all necessary to close these gaps⁽⁴²⁾.

FUTURE PROSPECTS

Clinical and Research Opportunities: There is no denying that many plants have untapped medicinal potential⁽³⁹⁾.

Under these circumstances, the usage and acceptability of herbal remedies and associated products continue to grow exponentially on a global scale. The market for herbal medications and other herbal healthcare products is expanding quickly and is experiencing rising demand in both developed and developing nations worldwide⁽⁴³⁾.

CONCLUSION

Asthma is still a long-term inflammatory airway condition that needs to be managed. The pharmacological potential of several medicinal plants, such as *Allium sativum*, *Glycyrrhiza glabra*, *Thymus vulgaris*, *Foeniculum vulgare*, *Hyssopus officinalis*, *Borago officinalis*, and *Clerodendrum serratum*, in the treatment of asthma was compiled in this review. Through cytokine modulation, reduction of histamine release, and suppression of airway hyperresponsiveness, the majority of these plants demonstrate anti-inflammatory, bronchodilatory, antioxidant, and immunomodulatory properties. Their medicinal properties are largely attributed to phytoconstituents such as terpenoids, phenolic compounds, flavonoids, and saponins. However, despite encouraging preclinical and experimental data, their incorporation into conventional medicine is hampered by issues such as inconsistent phytochemical composition, a lack of uniform dosage, Regulatory barriers and a dearth of extensive clinical studies. Demonstrating safety, effectiveness, and repeatability, future research



should concentrate on well planned randomized controlled clinical trials, molecular mechanism studies, pharmacokinetic profiles, and the creation of standardized herbal formulations. In summary, herbal remedies present a promising supplemental strategy for managing asthma; however, thorough scientific validation is necessary to guarantee their safe and successful clinical use.

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