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(Review Article)

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Exploring herbal medicine for anti-asthmatic activity: A review

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Abstract

Asthma is a chronic inflammatory syndrome affecting 155 million people worldwide. Despite advances in modern medicine, herbal drugs remain a popular choice, with 70% of India's population using non-allopathic systems of medicine. Ayurveda and other Indian literature mention plants with anti-asthmatic properties. Research has focused on evaluating traditional herbal remedies for asthma treatment. India has 45,000 plant species, many with medicinal properties. The study suggests isolating active chemical constituents and identifying key elements with pharmacological activity. Future research can focus on developing herbal treatments for asthma, providing a safer alternative to allopathic drugs.

Keywords: Asthma; Treatment of Asthma; Traditional Medicinal Plants Used in Asthma; Allopathic drugs

1. Introduction

Asthma is a complex inflammatory disease characterized by airway narrowing and associated with changes in eosinophils, mast cells, lymphocytes, cytokines, and other inflammatory cell products. It is well known that asthma patients have elevated levels of specific IgE, which binds to receptors on mast cells and other inflammatory cells, triggering a cascade of inflammatory reactions that release mediators like histamines, prostaglandins, and leukotrienes. These mediators cause airway smooth muscle contraction and bronchoconstriction. Asthma is a prevalent disease affecting approximately 300 million people globally, Asthma is a global public health concern, with projections suggesting an additional 100 million cases by 2025, particularly in industrialized countries. Since the 1970s, the prevalence, morbidity, mortality, and economic burden of asthma have significantly increased, especially among children. Medicinal plants used for asthma treatment should exhibit anti-inflammatory, immunomodulatory, antihistaminic, smooth muscle relaxant, and anti-allergic properties. According to Ayurveda, effective anti-asthmatic drugs should have anti-kapha and anti-vata properties, while antioxidant supplements help reduce bronchoconstriction severity by neutralizing reactive oxygen and nitrogen species. Current asthma therapies often face limitations due to adverse effects, leading patients to seek complementary and alternative medicine. Quercetin, a widely consumed dietary flavonoid, has shown potential in managing asthma by inhibiting mast cell degranulation and the subsequent release of histamine [1,2,3].

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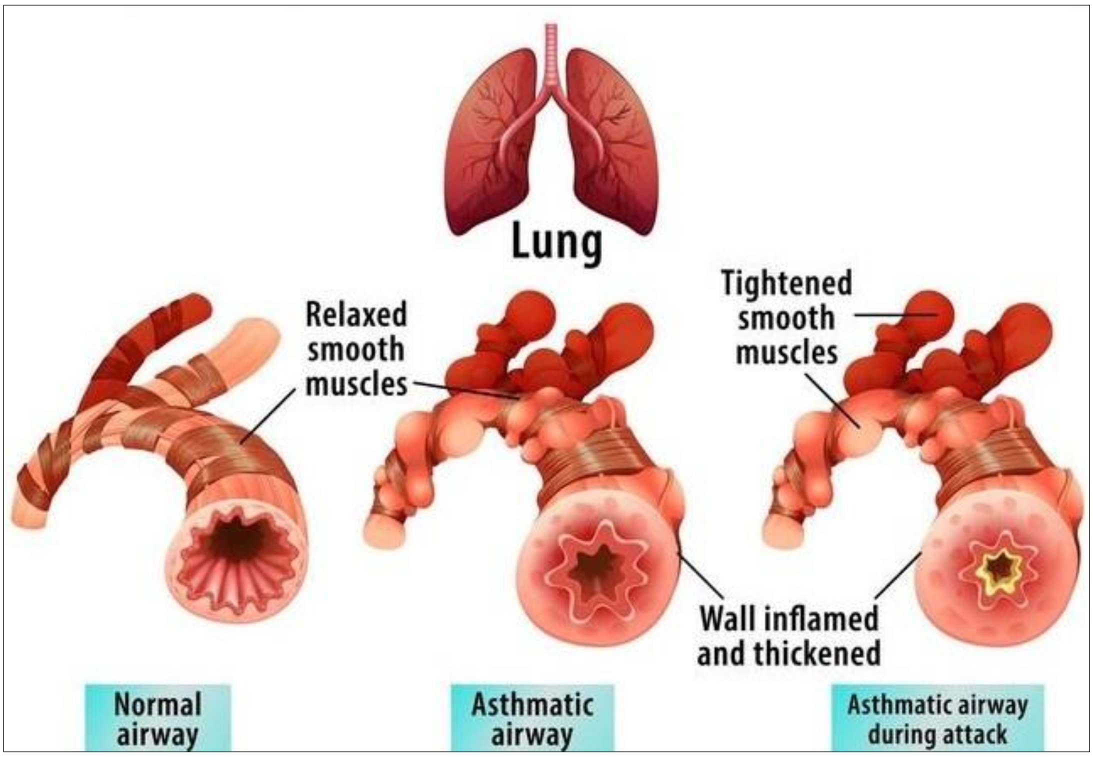

Figure 1 Asthma

2. Epidemiology

Asthma is a common condition that affects roughly 4 of the global population. Its prevalence has risen over the once many decades. According to epidemiologic studies by the Centers for Disease Control and Prevention (CDC), the frequency of asthma in the United States increased from 3.0 in 1970 to 7.8 between 2006 and 2008. Presently, asthma affects 8.1 of grown-ups and 8.4 of children in the U.S. It's also a leading cause of exigency room visits, with 1.7 million visits in 2015 alone. Between 2001 and 2016,asthma- related deaths in the U.S. dropped from 15 to 10 per million people. Still, asthma mortality remains nearly five times advanced in grown-ups than in children. Significant ethnical and gender difference persist in both asthma morbidity and mortality. Women and non-Hispanic Black individualities are particularly affected, with non-Hispanic Blacks being two to three times more likely to die from asthma than other ethnical groups. In terms of pathophysiology, asthma is believed to affect from a combination of gene- terrain and gene-gene relations. Crucial threat factors in its development include exposure to tobacco bank, air pollution, respiratory viral infections, and rotundity. Also, inheritable factors play a significant part in the condition's onset. As we dish study set up that individualities with a family history of atopic asthma are four times more likely to develop the condition. Farther exploration has also shown that children of asthmatic parents are at a advanced threat of developing asthma themselves. As whole genome sequencing continues to identify new genes, the number of genes associated with asthma is steadily adding . Epidemiological studies also punctuate the frequent co-occurrence of asthma and other upper airway conditions. For case, over 80 of individualities with asthma report having rhinitis, which is characterized by vexation and inflammation of the nasal mucous membranes. Again, 10 – 40 of people with rhinitis also develop asthma. Those with rhinitis face a threefold increased threat of developing asthma, anyhow of whether they're atopic. A study by Linneberg et al. set up that sensitization to imperishable allerges significantly increases the threat of asthma development in individualities with antipathetic rhinitis(AR), compared to those exposed to seasonal allergen[(4)].

3. Etiology

3.1. Genetics

The different phenotypes of asthma likely result from complex relations between environmental and inheritable factors. Twin and family studies have shown that heredity significantly influences the development of disinclinations and asthma, probably through several genes with moderate goods (i.e., genes associated with relative pitfalls in the range of 1.2 – 2). Genome-wide association studies have linked labels near the ORMDL sphingolipid biosynthesis controller 3(

ORMDL3) and gasdermin B (GSDMB) genes on chromosome 17q21, which render ORM1- suchlike protein 3 and gasdermin- suchlike protein, as being linked to nonage- onset asthma. Other inheritable correlations include the IL- 1 receptor- suchlike 1(IL1R1), interleukin- 33(IL33), and a new vulnerability locus at the IF- inducible protein X(PYHIN1) gene, particularly applicable in individualities of African descent. Increased expression of thymic stromallymphopoietin (TSLP) is also observed in asthmatic cases. Genetics can impact asthma treatment, as cases with the HSD3B1 genotype are more likely to repel glucocorticoids. Also, bronchodilator response (BDR) in Black children is linked to single- nucleotide polymorphisms in SPATA13- AS1 and PRKG1. Variability in concordance rates among monozygotic halves highlights the significant part of environmental factors in asthma onset. Environmental exposures, similar as secondary bank, can modify the goods of specific alleles, as shown in the association between the NAT1 gene and nonage asthma. A study of 983 children set up that certain genotypes at the 17q21 locus (GSDMB and ORMDL3) give both inheritable threat and environmental protection against asthma[5].

3.2. Threat factors

The Canadian Healthy child Longitudinal Development (CHILD) study linked several threat factors for asthma and disinclinations. Preterm birth, youthful motherly age, vitamin D insufficiency during gestation, and viral-convinced gasping in immaturity increase asthma threat. Beforehand- life rotundity, puberty, and exposure to adulterants further complicate this threat. Adult- onset asthma is associated with rhinitis, atopy, smoking, and occupational exposures, with slight frequency increases in postmenopausal women on hormone relief remedy. Occupational asthma can affect from sensitizers like proteins and chemicals or annoyances similar as feasts and smothers. Asthma threat is told by colorful factors. Smoking, both active and secondary, increases asthma frequency, worsens symptoms, and reduces treatment effectiveness, particularly in women and children. Pollution, including out-of-door particulate matter(PM) and nitrogen dioxide (NO_2), as well as inner sources like smoking and gas appliances, exacerbates asthma, especially in civic areas. Rotundity contributes to more severe asthma through seditious pathways and reduced lung function. Occupational exposures and early- life microbial factors, similar as respiratory infections or altered microbiomes, also heighten asthma threat. Also, limited microbial exposure during nonage (hygiene thesis) and habitual stress with inheritable tendencies further complicate asthma, especially in women [6].

4. Types of asthma

The Education and Prevention of Asthma-disease at National position distributed this complaint in colorful types grounded on inflexibility, these are as follows

- Intermittent- asthma
- Mild patient- asthma
- Moderate patient- asthma
- Severe patient- asthma

Intermittent- asthma: If without any treatment any one of the factors given below prevails also it must be true, also the asthma is as intermittent- asthma. Traits difficulty in breathing, cardiovascular affiliated problems, etc. Other traits encompass nightly events being like rise in body temperature, etc. The pathological test of estimating the functionality of lungs generally decrypt the normal values at case when the asthmatic- attack is absent.

Mild patient- asthma: It's associated with the given factors In this type of asthma, the marks tend to do on diurnal-base and the specifics like thickset-acting inhalational specifics are used regularly. These traits intrude the day- to-day conditioning. The pathological test determining the functionality of lungs generally decrypt the normal values at case when the asthmatic- attack is not prevailing.

Moderate patient- asthma: It's set up to be persistently-moderate when in the absence of any treatment any of the following factors are set up to be valid or considered to be true. The particularity are innovated to be associated with diurnal base and are treated with the use of inhalational specifics of asthma. The particularity tend to intrude with the diurnal conditioning. Lung function determination test is set up to be normal.

Oppressively patient- asthma: It's generally decrypted to be persistently severe if it doesn't prevail without treatment and the given points are set up to be valid in similar cases it's considered to be true. Nightly traits are veritably frequent. Lung function test is set up to parade abnormal results.

4.1. Classification of asthma by Etiology

- Foreign or antipathetic asthma,
- Natural asthma,

- Mixed asthma,
- Potentially fatal asthma,
- Aspirin- convinced asthma,
- Occupational asthma,
- Exercise- convinced asthma,
- Cough- fellow,
- Factitious asthma,
- Cases with habitual obstructive pulmonary complaint (COPD).

- Acute asthma language
  - Acute severe asthma,
  - Life hanging asthma,
  - Near-fatal asthma.

- Common asthma subtypes
  - Nightly asthma,
  - Occupational asthma,
  - Antipathetic asthma,
  - Non/ antipathetic asthma,
  - Cough variant asthma and cough predominant asthma,
  - Adult- onset(late- onset) asthma,
  - Asthma with patient tailwind limitation,
  - Asthma with rotundity,
  - Eosinophilic asthma (7, 8, 9, 10).

5. Pathophysiology of asthma

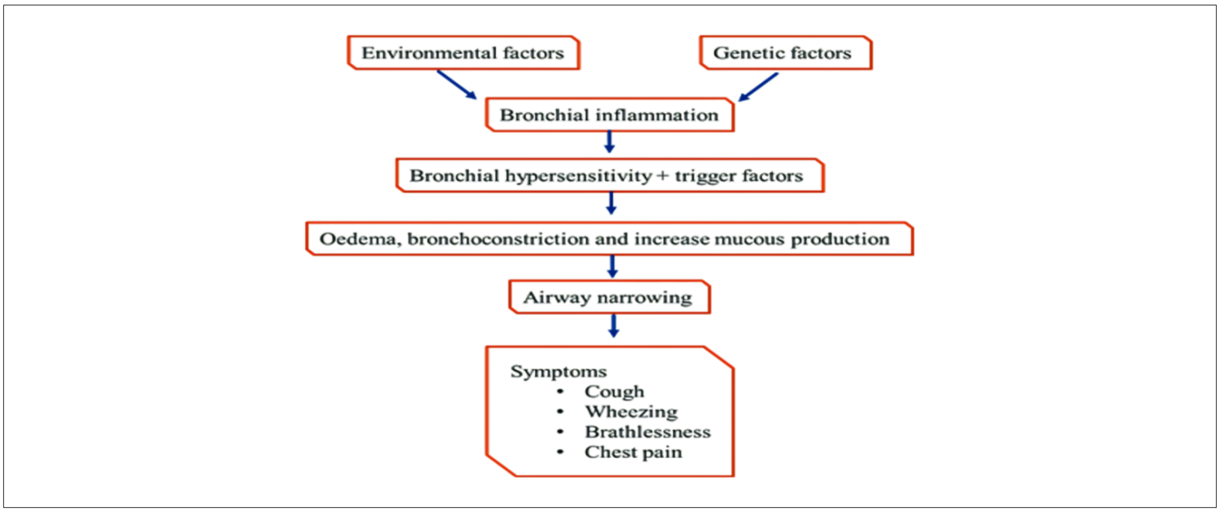

Figure 2 Pathophysiology of Asthma

Asthma results from habitual inflammation of the conducting zone of the airways, particularly the bronchi and bronchioles. This inflammation leads to increased contractility of the girding smooth muscles. Colorful common allergens, similar as pollen, dust diminutives, certain food accoutrements , and specific medicines, can precipitate asthmatic attacks. These factors contribute to bouts of airway narrowing, causing the classic symptom of gasping. The narrowing of airways is generally reversible with or without treatment. Still, in some cases, the airways suffer structural changes. Upon exposure to allergens, the product of IgE (immunoglobulin E) is stimulated, which binds to mast cells. On re-exposure to the same allergens, IgE triggers the degranulation of mast cells, releasing seditious intercessors similar as histamine, prostaglandins, leukotrienes, and bradykinins. Characteristic changes in the airways include an increase in eosinophils and thickening of the lamella reticularis. Other changes involve elevated situations of tenacious mucus, bloodied mucociliary function, mucosal lump caused by increased vascular permeability, and vascular traffic. These differences lead to bronchial hyperresponsiveness. Chronically, the smooth muscle of the airways may hypertrophy, and the number of mucus glands may increase. These changes are n't invariant throughout the lungs but are indigenous, leading to increased intrapleural and alveolar gas pressure. This causes dropped perfusion of alveoli, performing in hypoxia. A late- phase asthma response can do after significant allergen exposure. Symptoms may reappear 4 – 12 hours after the original attack due to patient cellular activation and can be more severe than the original occasion [11].

6. Signs and symptoms

Asthma is marked by repeated episodes of wheezing, shortness of breath, chest tightness, Tachycardia (100 beats/min), High Blood Pressure (more than 140/110mmHg), Chest tightness, Runny or stuffed up nose, Sore throat, Headache, Sneezing, Heavy sweating especially at night time, Trouble in speaking, Fatigue, Severe pain in back, neck and abdomen, Confusion , Coma and coughing. Sputum may be produced from the lungs through coughing but is often difficult to expel. During recovery from an asthma attack, the sputum may appear pus-like due to high levels of eosinophils, a type of white blood cell. Symptoms are typically worse at night, early in the morning, or in response to exercise or cold air. While some individuals with asthma rarely experience symptoms and only in response to specific triggers, others may frequently react and suffer from persistent symptoms [5, 11].

7. Diagnosis (1)

This chart outlines the typical steps and tests that may be used in diagnosing asthma, based on the patient's symptoms, medical history, and additional diagnostic requirements.

Table 1 List of diagnosis in asthma

Step	Description	Purpose	Examples/Tests
Medical History & Symptoms	Review of symptoms, triggers, and family history	Identify common asthma symptoms and triggers	Wheezing, shortness of breath, chest tightness, coughing - Allergies, respiratory infections, environmental triggers - Family history of asthma/allergies
Physical Examination	Physical examination of lungs and signs of allergies	Detect respiratory signs and possible allergy indicators	Listening to lungs for wheezing - Checking for eczema or nasal allergies
Initial Lung Function Test	Measure airflow obstruction and reversibility	Assess baseline lung function and response to medication	Spirometry: Measures amount and speed of exhaled air - Peak Flow Meter: Measures peak expiratory flow rate
Bronchodilator Reversibility Test	Repeat spirometry after using a bronchodilator	Determine if symptoms improve with medication	- Increased airflow after bronchodilator use may confirm asthma
Additional Testing	Additional tests as needed based on initial findings	Further assess inflammation, sensitivity, and asthma control	Methacholine Challenge: Tests airway hyperreactivity - FeNO Test: Measures nitric oxide in breath to detect inflammation - Oscillometry: Measures resistance in smaller airways
Imaging (if needed)	Imaging to rule out other conditions	Assess structural lung changes or exclude other diseases	HRCT or MRI: Used to visualize airways and lung structure
Allergy Testing	Identify potential allergens that trigger symptoms	Detect allergic causes and guide treatment	Skin prick tests - Blood tests for specific IgE antibodies
Other tests		Imaging tests, Sputum ecsinophils tests, Nitric-oxide tests, Provocative tests.	

8. Management and treatment of asthma

Treatment of Asthma: Asthma operation focuses on long- term control and preventative measures. Effective strategies include relating and avoiding triggers, using specifics, and incorporating specific exercises.

8.1. Anti-asthmatic medicines

- **Bronchodilators**: Include β- adrenergic agonists, anticholinergics, and methylxanthines to relax bronchial muscles.

- **Steroidalanti-inflammatory agents**: Similar as corticosteroids and anti-leukotrienes to reduce inflammation.

8.2. Medication for Asthma

Asthma specifics are distributed into quick- relief medicines for immediate symptom relief and long- term control specifics to help exacerbations. Antibiotics aren't generally needed for asthma operation.

8.3. Quick- Relief specifics

- **SABAs(Short- Amusement Beta2- Agonists)**
  - *Example*: Salbutamol (albuterol) is the first- line treatment for acute symptoms and exercise-convinced asthma.
  - Frequently combined with anticholinergics like ipratropium for moderate to severe cases.
  - Sidegoodstemblors, pulsations, and agitation when combined with anticholinergics.

- **Anticholinergics**
  - *Give added benefit with SABA or asdruthers for those intolerant to SABAs.*
  - *Limited benefit for children under certain conditions.*
- Corticosteroids(Short- Term)
- Systemic corticosteroids can reduce relapse rates after acute exacerbations.

8.4. Long- Term Control specifics

8.4.1. Gobbled Corticosteroids(ICS)

- *Example:* Fluticasone and beclomethasone.
- Utmost effective for habitual control; oral forms are reserved for severe cases.

8.4.2. LABAs(Long- Amusement Beta- Agonists)

- *Examples*: Salmeterol and formoterol.
- Effective when combined with ICS; should n't be used without corticosteroids due to severe side- effectpitfalls.
- Anti-Leukotriene Agents
- *Examples:* Montelukast, zafirlukast, and zileuton.
- Beneficial as add-ons to ICS for perfecting lung function and reducing exacerbations, particularly inpatient asthma.
- Limited benefit for acute exacerbations or as standalone remedy for certain age groups.

8.4.3. LOX Impediments

- Example Zileuton, used for mild to moderate habitual asthma in aged children and grown-ups.

These curatives are acclimatized grounded on individual requirements, with consideration for age, inflexibility, and response to former treatments.

8.5. Fresh Asthma Treatments

- Aminophylline(IV)
- Doesn't ameliorate bronchodilation compared to gobbled beta- 2 agonists and has further adverse goods.

- Mast Cell Stabilizers
- *Example*: Cromolyn sodium.
- These aren't preferred druthers to corticosteroids for asthma operation.

8.6. Combination remedy(ICS LABA)

- For well- controlled asthma in children, stopping LABA and using ICS-only treatment may have uncertain benefits and pitfalls.
- In grown-ups, discontinuing LABA can increase the threat of asthma exacerbation staking oral corticosteroids, but its effect on overall asthma control and quality of life is minimum.
- The effect of stopping LABA on serious adverse events or hospitalizations is still uncertain.

8.7. Anticholinergic specifics

- *Example*: Ipratropiumplatitude.
- Not salutary for treating habitual asthma in children over 2 times and not routinely used for habitual asthma in grown-ups.

8.8. Chloroquine and Methotrexate

- Neither is recommended as backups for oral corticosteroids for asthma operation due to limited effectiveness and significant side goods.
- Methotrexate is specifically not suggested due to adverse goods and minimum symptom relief.

8.9. Detector Avoidance

Identifying and avoiding asthma triggers can significantly reduce symptoms and help exacerbations. Common triggers include:

- **Allergens**: Pollen, dust diminutives, earth, pet dander, and cockroach patches.
- **Annoyances**: Bank, air pollution, strong odors, and certain cleaning products.
- **Respiratory Infections**: snap, the flu, and sinus infections.
- **Exercise**: For exercise-convinced asthma, pre-treatment with a short- acting beta- agonist(SABA) may be recommended.
- **Weather Changes**: Cold air, high moisture, or unforeseen temperature shifts can complicate asthma symptoms.

8.10. Variations in life

- Quitting Smoking: Smoking and exposure to secondary bank can worsen asthma. Quitting smoking is pivotal for better asthma operation.
- Exercise: Regular physical exertion can ameliorate overall health and lung function. For individualities with exercise-convinced asthma, pre-treatment with a short- acting beta- agonist(SABA) may be necessary before physical exertion.
- Weight Management: Losing weight can significantly ameliorate asthma control in individualities with rotundity-related asthma.
- Vaccines: To help respiratory infections that could spark asthma exacerbations, individualities with asthma should stay up to date with their vaccinations
- Influenza Vaccine: Annual flu vaccination is recommended.
- Pneumococcal Vaccine: The pneumococcal vaccine is also important, particularly for individualities at advanced threat of respiratory infections.

8.11. Managing violent Asthma

- **Early Recognition**: Cases should be educated to fete early warning signs of worsening asthma, similar as an increased need for deliverance inhalers, night symptoms, or briefness of breath.
- **Step- up Therapy**: If symptoms worsen, oral corticosteroids and deliverance specifics (e.g., SABA) may be needed.
- **Emergency Care**: Emergency medical attention is necessary if deliverance specifics don't relieve symptoms or if peak in flow measures are dangerously low.

8.12. Special Consideration for Severe Asthma

- **Fresh curatives**: For individualities with severe asthma who don't respond to conventional treatments, then suing options may be considered.
- **Biologics**: As mentioned before, birth specifics similar as mepolizumab and omalizumab target specific asthma phenotypes to help control symptoms.
- **Bronchial Thermoplasty:** This minimally invasive procedure reduces the smooth muscle in the airways, helping to drop the frequency and inflexibility of asthma attacks.
- **Referral to Specialists:** In cases of severe asthma, referral to a pulmonologist or asthma specialist may be necessary for advanced care and operation.

8.13. Education and tone- Control

- **Long- term Control**: Effective long- term asthma operation relies on educating cases about their condition, their specifics, and the proper use of inhalers.
- **Healthcare Visits:** During medical movables, tone-operation strategies are corroborated, and inhaler ways are routinely reviewed to insure proper use.

The case and healthcare provide to manage asthma effectively, fastening on long- term control, precluding exacerbations, and icing high- quality care.

9. Future directions for asthma

Future directions in asthma management and research aim to improve treatment outcomes, enhance patients' quality of life, and potentially discover a cure. Advances in technology, personalized medicine, and a deeper understanding of the underlying mechanisms of asthma are shaping the future of asthma care.

Here are some key areas of development

9.1. Precision Medicine and Phenotyping

- *Tailored Treatments:* Given that asthma is a heterogeneous disease, research is increasingly focused on personalized treatment approaches based on specific asthma phenotypes and biomarkers. By targeting therapies to the patient's unique type of asthma (e.g., eosinophilic asthma, allergic asthma), treatment effectiveness is expected to improve.

- *Biomarkers:* Identifying biomarkers, such as blood eosinophil levels, periostin, or fractional exhaled nitric oxide (FeNO), can help guide treatment decisions, enabling more precise and individualized care.

9.2. Advances in Biologic Therapies

9.2.1. Next-Generation Biologics

- Current biologic therapies (e.g., anti-IL-5, anti-IL-4, and anti-IgE) have significantly advanced the treatment of severe asthma. Future research is focused on developing new biologics that target additional inflammatory pathways or mechanisms of airway hyperresponsiveness in asthma.

9.2.2. Expanded Use of Biologics

- As understanding of asthma phenotypes grows, biologics may be expanded for use in a broader range of asthma types, including non-eosinophilic and non-allergic asthma.

9.2.3. Combination Biologics

- Researchers are investigating the potential of combining different biologic therapies to target multiple pathways at once, which could improve outcomes for patients with severe asthma.

9.3. Gene Therapy and CRISPR Technology

9.3.1. Gene Therapy

- Research is ongoing to explore whether gene therapy could be used to correct genetic mutations linked to asthma. Although still in the early stages, this approach holds the potential for long-term or even permanent relief from asthma.

9.3.2. CRISPR

- The gene-editing technology CRISPR is being investigated as a tool to modify genes that contribute to airway inflammation or hyperresponsiveness. While clinical applications are still far from realization, CRISPR has the potential to revolutionize asthma treatment in th

9.4. Microbiome Research

9.4.1. Role of the Microbiome

- Emerging evidence suggests that both the gut and lung microbiomes play a significant role in the development and exacerbation of asthma. Future research is exploring how modifying the microbiome through probiotics, diet, or other interventions—might prevent asthma or reduce its severity.

9.4.2. Targeted Probiotics and Prebiotics

- If further research confirms their potential, probiotics and prebiotics could become part of asthma management by helping to modulate immune responses and reduce airway inflammation.

9.5. Improved Inhaler Technology

9.5.1. Smart Inhalers

- These devices are equipped with sensors and digital technology to track medication usage and improve adherence. They monitor when and how often patients use their inhalers, providing reminders or feedback to ensure correct usage. Data collected from smart inhalers can also be shared with healthcare providers to inform treatment decisions.

9.5.2. More Efficient Drug Delivery

- Future inhalers may be designed to deliver medications more effectively, potentially requiring lower doses and minimizing side effects.

9.6. Environmental Monitoring and Predictive Tools

9.6.1. Real-Time Trigger Monitoring

- Wearable technology and smartphone apps, integrated with air quality sensors, may alert patients to environmental conditions (e.g., pollen, pollution, humidity) that could trigger asthma. These tools could provide real-time, personalized recommendations to help patients avoid potential triggers.

9.6.2. Artificial Intelligence (AI) and Machine Learning

- AI and machine learning are being explored to predict asthma exacerbations by analyzing patient data, environmental factors, and lifestyle patterns. Predictive models could enable early intervention, potentially preventing asthma attacks.

9.7. Immunotherapy Advances

9.7.1. Allergen-Specific Immunotherapy

- Immunotherapy, which involves gradually exposing patients to increasing amounts of allergens to desensitize their immune response, may be enhanced to improve both effectiveness and safety for individuals with allergic asthma. Refinements in subcutaneous and sublingual immunotherapy could lead to better outcomes.

9.7.2. Vaccines for Asthma

- Ongoing research is focused on developing vaccines that could prevent or alter the progression of asthma, especially in children with high-risk genetics or early-life exposures.

9.8. Bronchial Thermoplasty Refinements

9.8.1. Non-Invasive Alternatives

- Although bronchial thermoplasty, which reduces airway smooth muscle, has shown promise for some patients with severe asthma, researchers are exploring less invasive alternatives that may provide similar benefits.

9.8.2. Long-Term Outcomes

- Ongoing research into the long-term effectiveness and safety of bronchial thermoplasty will be crucial in guiding its use and identifying potential improvements to the technique.

9.9. Climate Change and Asthma

9.9.1. Understanding Impact

- Research is increasingly focused on how climate change is influencing asthma prevalence and severity. Rising pollen levels, increased pollution, and extreme weather conditions are contributing to worsening asthma outcomes.

9.9.2. Mitigation Strategies

- Public health initiatives and policy changes aimed at reducing air pollution and addressing the health effects of climate change may play a central role in asthma management in the future.

9.10. New Anti-Inflammatory Drugs

9.10.1. Non-Steroidal Anti-Inflammatories

- Research is focused on developing new anti-inflammatory medications that are not corticosteroids, aiming to reduce the side effects associated with long-term steroid use.

9.10.2. Small Molecule Therapies:

- These drugs target specific inflammatory pathways involved in asthma and may offer alternative treatment options to biologics or standard therapies.

9.11. Asthma Prevention Strategies

9.11.1. Early Intervention in Children

- Research is ongoing to prevent asthma development in high-risk children. Strategies include modifying early-life exposures—such as reducing allergen and pollutant exposure, promoting breastfeeding, and potentially using prebiotics or probiotics to support immune system development.

9.11.2. Targeting Viral Infections

- Many asthma exacerbations are triggered by viral infections, particularly rhinovirus. Research is focused on developing antiviral treatments or vaccines to prevent virus-induced asthma flare-ups.

9.12. Global Asthma Initiatives

9.12.1. Access to Medications:

- Efforts are being made to improve access to essential asthma medications in low- and middle-income countries, where asthma care is often inadequate. Global health initiatives aim to reduce the asthma burden by enhancing diagnosis, expanding treatment availability, and increasing patient education.

9.12.2. Standardized Guidelines:

- The development of universal asthma management guidelines, adapted to different healthcare settings and available resources, is a key focus for improving global asthma outcomes[1].

9.12.3. Herbal remedies

- Certain medicinal plants are known to alleviate respiratory disorders like bronchial asthma and convulsive bronchitis. These herbs address symptoms caused by bronchial muscle contractions, mucosal edema, and excessive secretions,

10. Some herbal medicinal plants used to treat anti-asthmatic activity;(7,36,37)

The management of Asthma pharmacologically depends on use of Medicinal plants used in the treatment of Asthma are as follows:

- The leaves of the plant Abutilon-crispum are used as antiastmatic in the treatment of asthma.
- The seeds of the plant Abutilon indicum possess anti-asthmatic activity.
- The barks of the plant Acacia torta roxb are used as anti-asthmatic activity.
- The aerial parts of the plant Aerva. Lanata linn are found to exhibit anti-asthmatic activity.
- The leaves, roots, and stalk of the plant acalypha indica possess the activity of stabilizer of mast cell.
- The flowers of the plant Achillea. mellifolium tend to owe the action of broncho-dilator.
- The rhizomes of the plant Acorus. alamus are extensively used as mast-cell-stabilizer
- The leaves of the plant Ailanthus excels are found to exhibit the action of mast cell stabilizer.
- The fruits of the plant achyranthes aspera are used as anti-asthmatic.
- The leaves of the plant ageratum Conyzoides possess ant-asthmatic activity.
- The bulb of the plant Badhatoda vasica. nees are used as mast-cell-stabilizer.
- The bark of the plant Albizzia. lebbeck are used as COX inhibitor.
- The leaves of the Asystasia-gangetica are used as broncho-dilator.
- The seeds of the plant Ammi-visnaga are used as mast-cell-stabilizer.
- The barks of the plant Amburana-cearensis are used as broncho-dilator.
- The leaves of the plant Allium cepa are used as anti-inflammatory.
- The leaves of the plant Alstonia-scholaris used as broncho-dilator.
- The leaves of theplant Aloe vera L are used to anti-asthmatic activity.
- The stem of the plant Aquillaria-agallocha used as broncho-dilator.
- The stem of the plant Argemone amexicana used a bronchodilator.
- The stem of the plant Arstolochia indica are used as broncho-dilator.
- The roots of the plant Asclepias curassavica are extensively used as broncho-dilator.
- The leaves of the plant Asystasia gangetica are used as bronchodilator.
- The seeds of the plant Atropa bel-adonna tend to owe anti-asthmatic properties.
- The leaves of the plant Azadirachta indica are used as anti-asthmatic.
- The leaves of the plant Azima.tetracantha used as mast-cell-stabilizer.
- The leaves of the plant Bacopa-monnieri are used as mast-cell-stabilizer.
- The stem and bark of the plant Balanites-roxburghi are used as broncho-dilator.
- The leaves of the plant Barlieria buxifolia are used as anti-asthmatic activity.
- The fruits of the plant Benincasa-hispida are used as broncho-dilator.
- The roots of the plant Boerhavia- diifusa are widely used as broncho-dilator.
- The seeds of the plant Brassica- camperstris are used as anti-asthmatic agents.
- The seeds of the plant Biophytum. nervifolium are used as broncho-dilator.
- The leaves of the plant Cassia absus are used as broncho-dilator.
- The barks of the plant Casuarina equisetofolia are found to exhibit anti-asthmatic properties.
- The seeds of the plant Caesalpinia bonduc are used as Anti-tumor activity.
- The wood of the plant Cedrus-deodara are used as mast-cell-stabilizer.
- The wood of the plant Cnidium-monniera are used as broncho-dilator.
- The wood of the plant Curculigo-orchiodes are used as anti-asthmatic.
- The tubers of the plant Centipeda-minima are used as anti-inflammatory.
- The stem of the plant Clerodendron-phlomidis are used as mast-cell-stabilizer.
- The leaves of the plant Casuarina.equistefolia linn are used as anti-histaminic.

- The roots of the plant Chlorophytum. laxum are used as anti-histaminic.
- The tubers of the plant Cissus quadrangularis possess anti-histaminic activity.
- The whole plants of Clematis-smilacifolia possess anti-asthmatic property.
- The latex of the plant Clerodendrum-serratum possess anti-asthmatic activity.
- The seeds of the plant Coccinia-grandis possess anti-asthmatic property.
- The stem and bark of the plant Cynodont -dactylon used as anti-asthmatic.
- The roots of the plant Calotropis-procera used as anti-asthmatic.
- The rhizomes of the plant Cassia toral.inn are used as mast-cell-stabilizer.
- The rhizomes of the plant Clerodendron-serratum possess mast-cell-stabilizer activity.
- The leaves of the plant Cuminum-cyminum used as broncho-dilator.
- The bark of the plant Curcurma-longa used as broncho-dilator.
- The roots of the plant cynodont-dactylon tends mast-cell-stabilizer action.
- The leaves of the plant Cassia-sophera used as anti-asthmatic.
- The bark of the plant Dendropthe-falcate used as anti-asthmatic.
- The roots of the plants Desmodium gangetium used in asthma .
- The whole plant of Dhatura-metel used as anti-asthmatic.
- The fruits of the plant Elaeocarpus used as broncho-dilator.
- The stem of the plant Ephedra used as broncho-dilator.
- The leaves of the plant Eclipta are used as anti-asthmatic.
- The fruits of the plants Emblica officinalis used as anti-asthmatic.
- The aerial parts of the plant Euphorbia hirta used as anti-asthmatic.
- The bark of the plant Ficus-bengalensis used as anti-asthmatic.
- The root of the plant Ficus-exasperate are used as anti-asthmatic.
- The roots of the plant Glycyrrhiza glabra are found to exhibit anti-allergic activities. The roots of the plants Hemidesmus indica used as anti-asthmatic.
- The roots of the plants Innula racemose possess mast-cell-stabilizer.
- The leaves of the plant Labisia. pumila used as anti-asthmatic.
- The leaves and roots of the plants Leptadenia.reticulata are used in the treatment of asthma.
- The seeds of the plants Lepidium.sativum are used as broncho-dilator.
- The whole plants of Lannea-coromandelica are used as anti-asthmatic.
- The leaves of the plant Leucas-aspera are used as anti-asthmatic.
- The seed and bark of the plant Mangifera-indica are used as anti-asthmatic.
- The leaves of the plant Manilkara-hexandra found its use as anti-asthmatic agents.
- The leaves of the plant Mimosa-pudica are used as anti-asthmatic.
- The Leaves of the plant Melissa officinalis L are used to anti-inflammatory.
- The leaves of the plant Mentha are used as mast-cell-stabilizer.
- The bulbs of the plants Momordica-diociaare used as mast-cell-stabilizer.
- The seeds of the plant moringa are used as mast-cell-stabilizer.
- The seed of the plant Mucuna-pruriens are used as anti-allergic.
- The stem and bark of the plant Myristica used as broncho-dilator.
- The seeds of the plant Nigella possess anti-asthmatic activity.
- The stem and bark of the plant Nyctanthes are used as mast-cell-stabilizer.
- The leaves of the plant Ocimum-sanctum tends to owe broncho-dilator action.
- The leaves of the plant Ocimum-tenuflorium found its use as broncho-dilator.
- The ripe fruits of Olea are used as mast-cell-stabilizer.
- The leaves of the plant Orthosiphon-rubicundus used as mast-cell-stabilizer.
- The parts of whole plant of Oxalis-corniculate acts as mast-cell-stabilizer.
- The leaves of the plant Passiflora used in cough treatment.
- The leaves of the plant Paederia-foetida used as anti-asthmatic.
- The seeds of the plant Phaseolis radiaes used as anti-asthmatic.
- The seeds of the plants Physidis-angulate used as anti-asthmatic.
- The aerial parts of the plant Phymatodes used as anti-histaminic.
- The leaves of the plant Piper-betel used in the treatment of bronchitis.
- The leaves of the plant Pinus-roxburghi used as mast-cell-stabilizer.
- The fruit of the plant Piper-nigrum acts as broncho-dilator.
- The roots of the plant Picorrhiza acts as broncho-dilator .

- The roots of the plant Polygala used in chronic asthma.
- The whole plant of Portulaca oleracea used as broncho-dilator.
- The leaves and other parts of the plant rauwolfia used as mast-cell-stabilizer.
- The leaves of plant Rivea-hypocratooriformis used in the treatment of asthma.
- The leaves of the plant Sansevieria-roxburghiana acts as mast-cell-stabilizer.
- The fruits of the plant Semecarpus-anacardium used in the treatment of cough-cold. The roots of the plant solanum nigrum are used as mast-cell-stabilizer.
- The seeds of the plant Solanum-surattense used as anti-asthmatic.
- The roots of the plant solanum Xanthophorium used as mast-cell-stabilizer.
- The flowers of the plant Sphaeranthus used as broncho-dilator.
- The whole plant Striga orabanchioides Benth used as anti-asthmatic.
- The leaves of the plant Swertia-chirata used as anti-asthmatic.
- The leaves of the plant Tamarindus.indica used as anti-asthmatic.
- The leaves of the plant Taxus-baccata used as anti-asthmatic.
- The aerial parts of the plant Tephrosia purpurea used as broncho-dilator.
- The leaves of the plant Terminalia belerica used as anti-asthmatic.
- The stem of the plant Tinospora cordifolia used in the treatment of asthma.
- The fruits of the plant Trachyspermum used as mast-cell-stabilizer.
- The stem of the plant Tylophora used as anti-asthmatic.
- The leaves of the plant vitex used as mast-cell-stabilizer.
- The leaves of the plant Zanthoxylem used as anti-asthmatic.
- The rhizomes of the plant zingiber used in the treatment of asthma.

10.1. Some herbal medicinal plants used in treatment of asthma;(12 – 35)

Table 2 List of medicinal plants used in asthma

S.no	Image	Plant discription	Solvent & extraction	pre-clinical estimation
1.		Name: Abutilon indicum, Family: Malvaceae, Uses: Anti-inflammatory, Anti-microbial, Anti-diabetes, Hepatoprotective, Wound healing, Anti-diarrheal etc.	Solvent: Methanol, Extraction Method: Distillation (Soxhlet apparatus).	In vivo: Compound 48/40 induced rat paw edema. In vitro: Isolation of rat peritoneal mast cells.
2.		Name: Aconitum heterophyllum, Family: Ranunuculaceae, Uses: Cough, Diarrhea and infectious disease.	Solvent: Methanol, Extraction: Hydro-methanolic extract.	Guinea pig model of ovalbumin,
3.		Name: Asystasia gangetica T. Adams, Family: Acanthaceae, Uses: Anthelmintic, Hypertension, Rheumatism, Diabetes, Stomachache, Anti-hyperlipidaemic, anti-	Solvent: n-hexane, ethylacetate and methanol. Extraction: Distillation (Sohxlet extractor) .	Guinea pig trachea, Rat stomach strip, Guinea pig ileal preparation, Anti-inflammatory tests.

		microbial and anti-oxidant.		
4)		Name: Artocarpus heyerophyllus, Family: Moraceae, Uses: Diuretics, Anti-diabetic, Snakebies, Anti-diarrhea.	Solvent: Petroleum ether and Ethanol. Extraction: Distillation (Sohxlet apparatus).	Histamine-induced Bronchospasm in guinea pigs, Acetylcholine-induced bronchospasm in guinea pigs.
5.		Name: Bacopa monnieri, Family: Plantaginaceae, Uses: Alzheimer's diseases, Anxiety, Blood pressure, Epilepsy, Parkinson's disease.	Solvent: Ethanol, Extraction: Distillation (Soxhlet apparatus).	Histamine induced bronchoconstriction, OVA-induced bronchospasm.
6.		Name: Cassia sophera Linn, Family: Caesalpiniaceae, Uses: Diabetes, Anti-inflammatory, Anti-rheumatic, Ringworm, Expectorant, Psoriasis, Cough, Hepatoprotective activity, Antioxidant.	Solvent: Ethanol, Ethyl acetate and Chloroform. Extraction: Distillation (Soxhlet apparatus).	Carrageenan induced paw edema in mice, Histamine induced bronchoconstriction in guinea pigs, Milk induced leucocytosis and esinophilia in mice, Passive paw anaphylaxis in rats, Clonidine induced catalepsy Baloperidol induced catalepsy in mice.
7.		Name: Cyampsis tetragonoloba L., Family: Fabaceae, Uses: Anti-diabetic, Hypolipidemic, Laxative, Anti-cholinergic, Anti-ulerogenic and Anti-secretary activity.	Solvent: Alcohol, Extraction: Distillation (Soxhlet apparatus).	In vivo: Milk-induced Leukocytosis and Eosinophila in mice. Histamine induced bronchospasm in guinea pigs. In vitro: Studies on smooth muscle preparation.
8.		Name: Euphorbia hirta, Family: Euphorbiaceae, Uses: Anticancer activity, Antifungal, Antibacterial, Gastrointestinal disorders.	Solvents: Ethanol, Extraction: Distillation (Soxhlet extraction apparatus).	Histamine induced bronchoconstriction, OVA-induced bronchospasm.

9.		Name: Jatropha macrantha, Family: Euphorbiaceae, Uses: Anti-inflammatory, Antioxidant, Aphrodisiac, Skin ulcer, Antinelanogenic.	Solvent: Ethanol, Extraction: Maceration.	In vivo: Histamine induced bronchospasm in guinea pigs.
10.		Name: Leucas aspera, Family: Lamiaceae, Uses: Antimicrobial, Anti-inflammatory, Antioxidant, Anthelmintic, Antipyretic, Wound healing etc.	Solvent: Methanol, Extraction: Distillation (Soxhlet apparatus).	In vivo: Histamine induced bronchospasm in conscious guinea pig. Passive paw anaphylaxis in rat. In vitro: Degranulation of rat mesenteric mast cells.
11.		Name: Lignosus rhinoceros, Family: Polyporaceae, Uses: Anticancer, Anti-inflammatory, Wound healing, Immunomodulatory, Neuritogenesis.	Solvent: Water, Extraction: Ditillation (Soxhlet apparatus).	Eosinophils and inflammatory cell count. Measurement of total IgE in BALF. Measurement of Th2 cytokines in BALF.
12.		Name: Melissa officinalis, Family: Lamiaceae, Uses: Relieve stress, Anxiety, Insomnia, Indigestioin, Dementia.	Solvent: Methanol, Extraction: Hydro-alcoholic extract.	Determination of total and differential WBC cell counts. Determination of oxidative stress parameters.
13.		Name: Nigella sativa, Family: Ranunculaceae, Uses: Anti-cancer, Anti-diabetic, Anti-hypertensive, Anti-rheuatoid arthritis, Anti-bacterial etc.	Solvent: Methanol and Water Extraction: Decogtion.	Antiasthmatic effect of Theophylline and the extract, The effect of salbutamol on PFT values, Camparison of brochodilatory effect of thiophylline and the extract.

14.		Name: Pericarpium citri reticulatae, Family: Rutaceae, Uses: Anti-inflammatory, Antioxidant, Antiplatelet, Anti-tumor, Anticancer etc.	Solvent: Resins, Extraction: Ion exchange resins.	In vivo: Bronchial hyperreactivity test. In vitro: Spasmolytic activity tests of isolated trachea.
15.		Name: Piper longum linn, Family: piperaceae, Uses: pain reliver, Snake bite, Gonorrhea,Viral hepatitis, postpartum hemorrhage, Immunostimulant.	Solvent: petroleum ether, Extraction: Distillation (soxhelt apparatus).	Isolated Guinea pigs ileum preparation, Histamine-induced bronchospasm, Milk-induced leukocytosis, Haloperidol-induced catalepsy.
16.		Name: Pistacia integerrima. Family: Anacardiaceae. Uses:	Solvent: Methanol Extraction: Cold Maceration	In Vitro method: Isolated chicken ileum, Goat tracheal chain preparation
17.		Name: Portulace olerecea, Family: Portulecaceae, Uses: Anti-inflammatory, Anti-bacterial, Antioxidant, Antidepressant, Anti-apoptotic.	Solvent: Ethanol, Extraction: Hydro-ethanolic extracts.	Smooth muscle relaxant effects.
18.		Name: Sururus chinensis, Family: Saururaceae, Uses: Anti-inflammatory, Murine neuroleptic, Hepatoprotective, Hypercholesterolemia activites.	Solvent: Ethanol, Extraction: Decogtion.	Reverse transcription-polymerase chain reaction. Protocol for Allergen Sensitization. Determination of Eosinophil number.
19.		Name: Solanum xanthocarpum, Family: Solaneceae, Uses: Anti-inflammatory, Anti-bacterial, Hepatoprotective, Hypoglycemic etc.	Solvent: Ethanol, Extraction: Distillation (Soxhlet apparatus).	Histamine-induced bronchospasm in guinea pigs, Acetylcholine-induced brochospasm in guinea pig, Dextran-induced oedema in rats,

				Formaldehyde-induced hind paw volume Cotton pellet granuloma in rats .
20.		Name: Tamarindus indica linn, Family: Caesapiniaceae, Uses: Anti-diarrhoea, Dysentery, Biliousness, Vaginal and uterine complaints, Anti-inflammatory, Burning sensation.	Solvent: Methanol, Extraction: maceration.	Clonidine-induced mast cell degranulation in rats. Milk-induced Leukocytosis and Eosinophilia in mice. Clonidine-induced catalepsy in mice.
21.		Name: Tinospora cordifolia, Family: Menispermaceae, Uses: Anti-inflammatory, Antipyretic, Anti-spasmodic, Anti-leprotic, Antioxidant, Anti-diabetic, Anticancer, Anti-complementary, Immunomodulating activity etc.	Solvent: Petroleum ether, Extraction:Distillation (Soxhlet apparatus).	In vivo: Experimental design. In vitro: Induction of asthma. Experimental design.
22.		Name: Vitis vinifera L. Family: Vitaceae, Uses: Anti-diabetic, Anti-aging, Cardioprotective, Hypolipdemic, Anti-inflammatory and Antioxidant.	Solvent: Ethanol, Extraction: Rotary vacuum evaporator.	Lung function and bronchoconstriction test. Bronchoalveolar lavage fluid collection. Serum preparation and cell count. Histamine analysis in lavaged lung tissue.
23.		Name: Woodfordia fruticosa, Family: Lythraceae, Uses: Wound healing, Analgesic, antirheumatic, acrid, alexiritic, Anthelmintic properties, Anti-tumor, Aniviral, Antihyperglycemic, Hepatoprotective.	Solvent: Ethyl acetate, Acetone, Methanol. Extraction: Hydro-alcohol extract.	Carrageenan-induced rat paw edema. Egg albumin-induced rat paw edema.

24.		Name: Zingiber officinale, Family: Zingiberaceae, Uses: Anti-inflammatory, Antioxidant, Anti-epileptic, Anti-diarrhea, Heart problems etc.	Solvent: Aqueous, Extraction: Decogtion.	White blood cell and Eosinophils nalysis. Measurement of wet and dry weight of lungs.

11. Conclusion

Asthma is a significant health issue affecting a large population globally. While synthetic medicines are effective, they often have harmful side effects, prompting a shift toward herbal remedies. Herbs are cost-effective, widely available, and generally safer, though not entirely risk-free. Medicinal plants like Ma Huang, Khellin, and snakeroot have provided molecules such as ephedrine, cromolyn sodium, and reserpine, which are now key treatments for asthma and other conditions. Ayurveda offers promising control for asthma, particularly through "Amoksha Ayurveda," with a 98% success rate and no side effects. Many medicinal plants, especially in India, remain underexplored for clinical use, presenting a research opportunity. Herbal medicines, with fewer side effects than allopathy, are gaining popularity. Researchers are challenged to develop inhibitors targeting leukotrienes, key asthma mediators, for effective treatment. Integrated medicine combining traditional and modern approaches holds promise for asthma management.

Compliance with ethical standards

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The author declare that they have no competing interests.

Statement of informed consent

The author (s) read and approved the final manuscript.

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