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Therapeutic Properties of *Moringa oleifera* in Pulmonary Diseases like Asthma and Bronchitis

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Abstract

***Moringa oleifera*, known as the drumstick tree or "miracle tree," is native to India and widely used in Ayurveda. Rich in vitamins, minerals, flavonoids, and phenolics. It is recognized for its nutritional and therapeutic properties. Traditionally, it has been employed to treat various ailments, including inflammation, infections, digestive disorders, and respiratory conditions such as asthma and bronchitis. Its leaves, seeds, bark and roots are used in diverse preparations, reflecting its versatility as a natural remedy.For pulmonary diseases like asthma and bronchitis, *Moringa oleifera* demonstrates anti-inflammatory, antioxidant, and bronchodilatory effects. It reduces airway inflammation, suppresses oxidative stress, and alleviates bronchospasms, while its mucolytic properties help clear mucus, offering relief in bronchitis.Despite these benefits, modern scientific validation is crucial. Rigorous clinical trials are needed to confirm its efficacy, develop standardized formulations, and ensure consistent results, bridging traditional knowledge with evidence-based medicine for effective respiratory disease management.**

Keywords: *Moringa oleifera* ,anti-inflammatory , bronchodilatory ,oxidative stress, respiratory diseases

1. INTRODUCTION

1.1 Background on *Moringa oleifera* and Its Use in Respiratory Ailments in Traditional Medicine

*Moringa oleifera*commonly referred to as the drumstick tree or "miracle tree," is native to India and has been a cornerstone of traditional medicine systems like Ayurveda, Siddha, and Unani for centuries. Known for its extensive range of medicinal applications, it is celebrated for its rich nutritional content, which includes essential vitamins (A, C, and E), minerals (calcium, potassium, and iron), and bioactive compounds such as flavonoids, phenolics, and isothiocyanates[1].

In traditional medicine, *Moringa oleifera* has been widely used to treat respiratory ailments such as asthma, bronchitis and other conditions involving airway inflammation and obstruction. Ayurvedic texts classify it as a *Kapha*-balancing herb, making it particularly beneficial for clearing excess mucus from the respiratory tract. Its anti-inflammatory properties are well documented in traditional practices, where it is used to alleviate symptoms of airway swelling, cough and breathlessness[2].

Different parts of the *Moringa oleifera* plant are utilized for promoting respiratory health. The leaves are commonly boiled to make a decoction or consumed as juice to alleviate cough and help clear mucus. The seeds possess expectorant properties and are used to aid in the expulsion of phlegm. The roots and bark are included in herbal formulations for their bronchodilatory and antimicrobial properties, providing support in managing infections that worsen respiratory conditions[1].

The use of *Moringa oleifera* in respiratory care is also linked to its immune-boosting properties. By enhancing the body's natural defenses, it helps prevent recurrent infections, which are common in chronic respiratory ailments. Traditional healers have long relied on its ability to sooth the respiratory tract, improve airflow, and provide relief from wheezing and congestion[2].

While these practices have been validated by anecdotal evidence and centuries of use, modern scientific studies are increasingly exploring the mechanisms underlying these effects. This growing body of research seeks to bridge traditional knowledge with contemporary medical applications, offering promising avenues for integrating *Moringa oleifera* into mainstream respiratory care[1].

1.2 Survey of Prevalence of Asthma and Bronchitis Globally and Their Impact on Public Health

1.2.1 Asthma:

- Prevalence:
  - Asthma affects approximately 262 million people worldwide, according to the World Health Organization [14]. It is one of the most common chronic respiratory diseases, with varying prevalence across regions due to environmental, genetic and socio-economic factors.
  - Developed countries like the United States report higher asthma prevalence, with around 8% of the population affected. However, the condition is rising in low and middle-income countries due to increasing urbanization and pollution [14].
- Public Health Impact:
  - Asthma is a leading cause of hospitalizations and missed school/workdays, significantly burdening healthcare systems.
  - It is responsible for approximately 455,000 deaths annually, mainly in low-resource settings where access to healthcare and medications like inhaled corticosteroids is limited[14].
  - Poorly controlled asthma can lead to reduced quality of life, increased healthcare costs and productivity losses.

1.2.2 Bronchitis:

- Prevalence:
  - Acute bronchitis is a common condition affecting individuals of all ages, with higher incidences during cold seasons and in regions with high air pollution levels.
  - Chronic bronchitis, a component of chronic obstructive pulmonary disease (COPD), impacts about 65 million people globally with significant prevalence in smokers and individuals exposed to occupational hazards or biomass smoke [15].
- Public Health Impact:

- Acute bronchitis leads to increased visits to healthcare providers and overuse of antibiotics, despite most cases being viral in origin.
- Chronic bronchitis contributes to the global COPD burden, a leading cause of disability and the third leading cause of death worldwide, according to the WHO.
- The condition strains healthcare resources due to frequent exacerbations, hospitalizations and long-term treatment requirements.

1.2.2Shared Challenges and Health Burden:

- Both asthma and bronchitis are exacerbated by environmental factors such as air pollution, allergens and smoking, highlighting the importance of preventive measures.
- These conditions disproportionately affect vulnerable populations, including children, the elderly, and those in low-income regions.
- The economic burden includes direct healthcare costs (medications, hospitalizations) and indirect costs (lost productivity and premature deaths).

1.2.3 Public Health Implications:

- Addressing asthma and bronchitis globally requires robust public health strategies, including:
  - Early diagnosis and effective management by providing access to medications and healthcare services.
  - Public education on triggers and preventive measures, such as reducing exposure to allergens and pollutants.
  - Policy interventions to tackle air pollution and promote clean energy sources.

Asthma and bronchitis represent a significant global health challenge, affecting millions of lives and imposing a heavy burden on public health systems. Collaborative efforts at individual, community and policy levels are essential to reduce their prevalence and improve outcomes for those affected.

2. EXPLORING THE ROLE OF *MORINGA OLEIFERA* IN MANAGING PULMONARY DISEASES

2.1 Therapeutic Properties in Pulmonary Health

2.1.1 Anti-inflammatory Effects:

- Pulmonary diseases such as asthma and bronchitis are characterized by airway inflammation.
- *Moringa oleifera* contains bioactive compounds like flavonoids, phenolics, and isothiocyanates that inhibit pro-inflammatory cytokines (e.g., IL-6, TNF-α), reducing inflammation and airway hyperresponsiveness[1].

2.1.2 Antioxidant Activity:

- Oxidative stress exacerbates inflammation and tissue damage in respiratory diseases.

- The high levels of antioxidants (vitamins A, C, and E) in *Moringa oleifera* scavenge free radicals, protecting lung tissues and reducing oxidative damage[3].

2.1.3 Bronchodilatory Effects:

- Bronchospasm, a hallmark of asthma and bronchitis, is alleviated by the smooth muscle relaxant properties of *Moringa oleifera*[1].
- Preclinical studies indicate its ability to improve airflow and reduce breathing difficulty[1].

2.1.4 Mucolytic and Expectorant Properties:

- Excess mucus production obstructs airways in bronchitis. *Moringa oleifera* aids in thinning and clearing mucus, facilitating easier breathing[3].

2.1.5 Immune Modulation:

- Frequent respiratory infections exacerbate pulmonary diseases. *Moringa oleifera* supports the immune system, enhancing resistance to infections and reducing disease severity[1].

2.2 Evidence Supporting Its Role

2.2.1 Traditional Knowledge:

- Ayurvedic texts advocate the use of *Moringa oleifera* for respiratory ailments like cough, wheezing and bronchial congestion.
- Decoctions made from leaves or powdered seeds are commonly used in traditional remedies[1].

2.2.2 Preclinical Studies:

- Animal studies reveal significant reductions in airway inflammation and oxidative stress markers following *Moringa oleifera* extract administration[1].
- Experimental models show bronchodilatory effects, suggesting its potential as an alternative to synthetic bronchodilators[3].

2.2.3 Clinical Research:

- Although limited, early clinical studies have demonstrated improvements in lung function and symptom relief in asthma patients[1].

2.3 Challenges in Application

- Limited Clinical Validation: Clinical trials particularly in humans are required to confirm preclinical findings.

- Bioavailability Issues: Compounds like isothiocyanates may have limited absorption, requiring advanced formulations[1].
- Standardization of Preparations: Variability in phytochemical concentrations affects therapeutic consistency[3].

2.4 Future Research Directions

- Clinical Trials: Large-scale, randomized controlled studies to assess efficacy in asthma and bronchitis.
- Advanced Formulations: Development of encapsulated or targeted delivery systems to enhance bioavailability[1].
- Mechanistic Insights: Investigations into the molecular pathways underlying its therapeutic effects[3].

3. PHYTOCHEMICAL PROFILE OF *MORINGA OLEIFERA*

3.1 Key Bioactive Compounds:

3.1.1 Flavonoids (e.g., Quercetin, Kaempferol):

- Flavonoids are abundant in *Moringa oleifera* leaves and seeds, with quercetin and kaempferol being the most notable[1].
- Quercetin: Known for its potent anti-inflammatory and antioxidant properties, it neutralizes free radicals and reduces the production of pro-inflammatory cytokines like TNF-α and IL-6[4].
- Kaempferol:Exhibits anti-inflammatory effects and supports cellular protection against oxidative stress, making it beneficial for maintaining lung health[3].

3.1.2 Alkaloids:

- Alkaloids in *Moringa oleifera*, though less characterized, are reported to have bronchodilatory effects, aiding in relaxing airway smooth muscles and improving airflow[1].

3.1.3 Polyphenols and Terpenoids:

- Polyphenols contribute to *Moringa oleifera*'s high antioxidant capacity, protecting against oxidative damage in lung tissues[3].
- Terpenoids exhibit antimicrobial and anti-inflammatory properties, further enhancing its therapeutic potential for respiratory ailments[1].

3.1.4 Vitamins A and C:

- Vitamin A: Essential for maintaining the integrity of respiratory epithelium and preventing infections by strengthening the immune response[4].

- Vitamin C: A powerful antioxidant that scavenges reactive oxygen species, reducing oxidative stress in inflamed airways[3].

3.2 Overview of anti-inflammatory and antioxidant properties of these compounds

3.2.1 Anti-inflammatory Properties:

- The bioactive compounds in *Moringa oleifera* inhibit pro-inflammatory pathways by suppressing cytokines like IL-1β, IL-6, and TNF-α[1].
- They also modulate the nuclear factor-kappa B (NF-κB) pathway, which is critical in controlling inflammation, especially in chronic respiratory conditions like asthma and bronchitis[4].

3.2.2 Antioxidant Properties:

- Flavonoids, polyphenols and vitamins A and C work synergistically to reduce oxidative stress, a major factor in the progression of pulmonary diseases[3].
- By neutralizing free radicals and reactive oxygen species, these compounds protect lung tissues from damage, improve overall respiratory function, and prevent exacerbation of conditions like asthma and bronchitis[1].

4. PATHOPHYSIOLOGY OF ASTHMA AND BRONCHITIS

4.1Asthma

- Underlying Mechanisms:
  - Airway Inflammation: Asthma is characterized by chronic inflammation of the airways, primarily driven by an immune response to allergens or irritants. This involves the activation of T-helper 2 (Th2) cells, mast cells, and eosinophils, leading to the release of pro-inflammatory cytokines like IL-4, IL-5, and IL-13[4].
  - Bronchoconstriction**:** Exposure to allergens or irritants causes the smooth muscle lining the airways to contract excessively, resulting in narrowing of the airways and difficulty in breathing[6].
  - Mucus Hypersecretion**:** Goblet cells in the airway epithelium produce excessive mucus in response to inflammation, further obstructing airflow and exacerbating symptoms like wheezing and coughing[4].

4.2 Bronchitis

- Underlying Mechanisms:
  - Inflammation of Bronchial Tubes: Bronchitis involves inflammation of the bronchi, typically triggered by viral or bacterial infections or chronic irritants like cigarette smoke. The inflammation causes swelling and narrowing of the airways, impairing airflow [4, 5].

- Excessive Mucus Production: In response to the inflammation, mucosal glands in the bronchial lining become hyperactive, producing excessive mucus. This mucus accumulates in the airways, leading to coughing, congestion and difficulty in clearing the airways[4].

4.3 Role of Oxidative Stress and Inflammation

4.3.1 Oxidative Stress:

- In both asthma and bronchitis is an imbalance between the production of reactive oxygen species (ROS) and the body's antioxidant defense mechanisms leads to oxidative stress[4].
- ROS generated by inflammatory cells like neutrophils and eosinophils cause damage to the airway epithelium, impairing its barrier function and exacerbating inflammation[5].
- Oxidative stress amplifies airway remodelling, mucus hypersecretion, and smooth muscle hyperreactivity in asthma and bronchitis[4].

4.3.2 Inflammation:

- Chronic inflammation is a key driver in both conditions. In asthma, inflammation is largely allergen-induced and mediated by Th2 cells, while in bronchitis, it is often triggered by infections or irritants and dominated by neutrophil activity[4].
- Pro-inflammatory mediators, including cytokines, chemokines and leukotrienes, perpetuate the inflammatory cascade, worsening symptoms and tissue damage [4, 6].
- Persistent inflammation contributes to airway remodelling, characterized by thickened airway walls, fibrosis, and reduced lung elasticity, leading to chronic respiratory dysfunction[4].

Asthma and bronchitis share common features of airway inflammation and mucus overproduction but differ in their underlying triggers and immune responses. Oxidative stress and chronic inflammation play pivotal roles in exacerbating these conditions, highlighting the need for therapies targeting these mechanisms to alleviate symptoms and improve respiratory health[5].

5. THERAPEUTIC EFFECTS OF *MORINGA OLEIFERA* IN PULMONARY DISEASES

5.1 Anti-inflammatory Properties

- Reduction of Pro-inflammatory Cytokines:
  - *Moringa oleifera* exhibits significant anti-inflammatory effects by inhibiting the production of key cytokines involved in airway inflammation, such as IL-6 and TNF-α[5].
  - These cytokines play a critical role in perpetuating inflammation in conditions like asthma and bronchitis, leading to airway narrowing and obstruction[7].

- Suppression of Oxidative Stress Markers:

- Bioactive compounds in *Moringa oleifera*, such as flavonoids and phenolic acids, reduce oxidative stress by inhibiting lipid peroxidation in addition to downregulating oxidative stress markers in pulmonary tissues[8].
- This dual anti-inflammatory and antioxidant action alleviates tissue damage and supports lung function[5].

5.2 Bronchodilatory Effects

- Smooth Muscle Relaxation:
  - Studies indicate that Moringa oleifera extracts relax airway smooth muscles, potentially through the inhibition of calcium ion influx, leading to bronchodilation [6]. This effect improves airflow, making it beneficial in managing asthma symptoms such as wheezing and breathlessness [7].
- Reduction of Bronchospasm:
  - The plant's alkaloids and other bioactive compounds show potential in reducing bronchospasm, a key feature of bronchitis, by relaxing constricted bronchial muscles and restoring normal breathing patterns [6].

5.3 Antioxidant Activity

- Free Radical Scavenging:
  - The rich antioxidant profile of Moringa oleifera, including vitamins A, C, and E, along with flavonoids and polyphenols, neutralizes free radicals that contribute to oxidative stress [8].
  - By protecting pulmonary tissues from oxidative damage, it helps maintain lung integrity and function, especially in chronic respiratory diseases [5].
- Prevention of Oxidative Damage:
  - The plant's antioxidant activity reduces ROS-mediated damage to lung tissues, thereby mitigating the progression of airway remodelling and inflammation in asthma and bronchitis [5].

5.4 Mucolytic and Expectorant Properties

- Mucus Clearance:
  - *Moringa oleifera* aids in thinning and clearing excess mucus from the airways, addressing one of the primary symptoms of bronchitis [5].
  - This mucolytic effect is particularly valuable in relieving chest congestion and improving breathing efficiency [6].
- Symptom Relief:
  - The expectorant properties of *Moringa oleifera* help in expelling phlegm, further alleviating respiratory discomfort and promoting airway clearance [6].

5.5 Immune Modulation

- Enhanced Immune Response:
    - *Moringa oleifera* supports the immune system by stimulating the production of immune cells and enhancing the body's defense mechanisms [5].
    - A stronger immune response reduces susceptibility to respiratory infections, which are common triggers for exacerbations in asthma and bronchitis [7].
- Protection Against Recurrent Infections:
    - The antimicrobial properties of its bioactive compounds help combat pathogens, preventing recurrent infections that worsen pulmonary conditions[5].

Moringa oleifera offers a multifaceted approach to managing pulmonary diseases, addressing key pathological features such as inflammation, bronchospasm, oxidative stress, mucus accumulation and immune dysfunction. Its anti-inflammatory, bronchodilatory, antioxidant, and mucolytic properties, combined with immune modulation, make it a promising natural remedy for asthma, bronchitis and related respiratory ailments. Further clinical validation is essential to optimize its therapeutic potential and integrate it into mainstream respiratory care [5], [6], [7], [8].

6. COMPARISON OF *MORINGA OLEIFERA* WITH CONVENTIONAL THERAPIES IN PULMONARY DISEASES

6.1 Potential Advantages of *Moringa oleifera*

6.1.1 Fewer Side Effects Compared to Corticosteroids and Bronchodilators:

- Conventional therapies for asthma and bronchitis, such as corticosteroids and bronchodilators, are effective but often associated with side effects.
    - Corticosteroids: Prolonged use can lead to systemic effects like weight gain, osteoporosis, immunosuppression, and adrenal suppression.
    - Bronchodilators: Can cause tachycardia, palpitations and nervousness.
- *Moringa oleifera*, being a natural remedy, exhibits minimal adverse effects when used appropriately. Its bioactive compounds are generally well tolerated, making it a safer alternative, especially for long-term use[9].

6.1.2. Natural and Nutrient-rich Alternative:

- In addition to its therapeutic properties, *Moringa oleifera* provides essential nutrients like vitamins A, C, and E, minerals like calcium, potassium, and iron, which support overall health and immune function[9].
- These nutrients contribute to the maintenance of respiratory and systemic health, addressing deficiencies often seen in chronic respiratory conditions.

6.2 Synergistic Use with Conventional Therapies for Better Management

6.2.1. Enhancing Therapeutic Outcomes:

- *Moringa oleifera* cancomplement conventional therapies by addressing inflammation, oxidative stress, and mucus production, enhancing the efficacy of standard treatments [6].
- Its antioxidant properties can mitigate the oxidative stress induced by prolonged corticosteroid use [9].

6.2.2. Reducing Dependency on Pharmaceuticals:

- Incorporating *Moringaoleifera* into treatment regimens could allow for lower doses of corticosteroids or bronchodilators, potentially reducing the risk of side effects [6].
- This approach is particularly beneficial for patients with mild to moderate symptoms or thoseseeking holistic and integrative therapies [9].

6.2.3. Improving Patient Compliance:

- The natural origin and multi-nutritional benefits of *Moringa oleifera* may improve patient adherence to treatment, particularly among individuals preferring natural remedies over synthetic medications [9].

6.3. Challenges in Comparison:

- Limited Clinical Validation: While *Moringa oleifera* shows promise in preclinical studies, more extensive clinical trials are necessary to establish its equivalency or superiority to conventional therapies[6].
- Standardization Issues: Unlike pharmaceutical drugs, variability in *Moringa oleifera* formulations may affect consistency and efficacy[9].

Moringa oleifera offers several potential advantages over conventional therapies, including reduced side effects, nutritional benefits and suitability for long-term use. Its synergistic integration with standard treatments holds promise for enhanced management of pulmonary diseases like asthma and bronchitis. However, standardized formulations and further clinical validation are crucial for its wider acceptance in mainstream medicine[9].

7. CHALLENGES AND LIMITATIONS

7.1 Limited Clinical Trials:

- Despite promising preclinical evidence, there is a lack of robust clinical trials specifically investigating *Moringa oleifera*'s efficacy in pulmonary diseases like asthma and bronchitis. This limits its validation for use in mainstream respiratory care[6].

7.2 Variability in Bioavailability and Efficacy:

- The therapeutic effects of *Moringa oleifera* can vary due to differences in preparation methods, plant parts used and environmental factors affectingbioactive compound concentrations[10].

7.3. Need for Standardized Dosages and Formulations:

- The absence of standardized dosing regimens and formulations for respiratory conditions poses challenges in ensuring consistent and effective treatment outcomes[10].

Addressing these limitations through targeted research and standardization efforts is essential to optimize *Moringa oleifera*'s potential as a reliable therapeutic option for pulmonary diseases.

8. FUTURE DIRECTIONS FOR *MORINGA OLEIFERA* IN PULMONARY DISEASE MANAGEMENT

8.1 Development of Targeted Formulations

8.1.1 Inhalers:

- Designing inhalable formulations of *Moringa oleifera* extracts can directly target the respiratory tract, ensuring localized delivery of bioactive compounds. This approach minimizes systemic exposure while maximizing therapeutic effects such as bronchodilation, reduction of inflammation and oxidative stress[11], [12].
- Advances in nanoparticle-based delivery systems could further enhance the stability and bioavailability of key compounds like quercetin and isothiocyanates [9].

8.1.2 Syrups and Liquid Preparations:

- Syrups enriched with *Moringa oleifera* extracts can serve as palatable and user-friendly options, particularly for children and elderly patients with respiratory conditions like asthma and bronchitis[13].
- These formulations can be combined with honey or other soothing agents to provide additional relief from throat irritation and cough[9].

8.2 Large-Scale Clinical Trials

8.2.1 Validation of Traditional Claims:

- Conducting rigorous, large-scale randomized controlled trials is essential to substantiate the therapeutic effects observed in traditional medicine and preclinical studies [11], [13].
- Trials should focus on key outcomes such as improvement in lung function, reduction in inflammation and symptom relief in asthma and bronchitis patients [12].

8.2.2 Long-term Safety and Efficacy Studies:

- Longitudinal studies are needed to evaluate the safety of prolonged use of *Moringa oleifera* in chronic respiratory conditions [9].
- Investigations should also address optimal dosing regimens and potential side effects in diverse populations [13].

8.3 Exploration of Synergistic Effects

8.3.1 With Other Herbs:

- Research into combining *Moringa oleifera* with complementary herbs such as turmeric (*Curcuma longa*) or holy basil (*Ocimum sanctum*) may reveal enhanced anti-inflammatory, antioxidant and mucolytic effects[12], [13].
- Synergistic combinations could provide a holistic approach to managing pulmonary diseases, leveraging the strengths of multiple plant-based therapies[9].

8.3.2 With Conventional Therapies:

- Combining *Moringa oleifera* with standard treatments like corticosteroids or bronchodilators can enhance therapeutic outcomes[11].
- For instance, its antioxidant properties may counteract oxidative stress caused by prolonged corticosteroid use, reducing dependency on higher drug doses and minimizing side effects[12].

9. Additional Research Opportunities

9.1 Mechanistic Studies

- Detailed investigations into the molecular pathways modulated by *Moringa oleifera* (e.g., NF-κB suppression, cytokine regulation) can provide deeper insights into its therapeutic potential.

9.2 Personalized Medicine

- Exploring the role of genetic and environmental factors in the efficacy of *Moringa oleifera* could pave the way for personalized therapeutic approaches.

9.3 Sustainability and Standardization

- Developing sustainable cultivation practices and standardized processing methods will ensure consistent quality and availability of *Moringa oleifera* for medical use.

Focusing on targeted formulations, robust clinical trials, and synergistic applications will be key to unlocking the full potential of *Moringa oleifera* in pulmonary disease management. Integrating

traditional knowledge with modern scientific advances can make *Moringa oleifera* a cornerstone of effective, natural respiratory care.

10. CONCLUSIONS

Moringa oleifera holds significant potential as a natural therapeutic agent for managing asthma and bronchitis. Its multifaceted properties such as anti-inflammatory, antioxidant, bronchodilatory, and mucolytic effectively address key pathological features of these pulmonary diseases, such as airway inflammation, oxidative stress, bronchospasm, and mucus overproduction. These therapeutic effects, coupled with its nutritional benefits, make *Moringa oleifera* a promising alternative or complementary option to conventional treatments. However, the integration of *Moringa oleifera* into mainstream pulmonary disease management requires further research, including large-scale clinical trials, development of standardized formulations and exploration of synergistic combinations with conventional therapies. This will ensure its safety, efficacy, and broader accessibility for respiratory care.

BIBLIOGRAPHY

1. Pareek, A., Pant, M., Gupta, M. M., Kashania, P., Ratan, Y., Jain, V., Pareek, A., &Chuturgoon, A. A. (2023). Moringa oleifera: An Updated Comprehensive Review of Its Pharmacological Activities, Ethnomedicinal, Phytopharmaceutical Formulation, Clinical, Phytochemical, and Toxicological Aspects. International Journal of Molecular Sciences, 24(3), 2098. https://doi.org/10.3390/ijms24032098
2. Shahzad, Arfa & Tahir, Ammar & Kashif, Muhammad & Arshad, Muhammad & Nasir, Amar & Abbas, Mazzhar. (2024). Ethnopharmacological use of Moringa oleifera: an updated review. 4. 76-84.https://www.researchgate.net/publication/382996770
3. Anwar, F., Latif, S., Ashraf, M., & Gilani, A. H. (2006). Moringa oleifera: a food plant with multiple medicinal uses. Phytotherapy Research, 21(1), 17–25. https://doi.org/10.1002/ptr.2023
4. Barnes, P. J. (2017). Cellular and molecular mechanisms of asthma and COPD. Clinical Science, 131(13), 1541–1558. https://doi.org/10.1042/cs20160487
5. Prajapati, C., Ankola, M., Upadhyay, T. K., Sharangi, A. B., Alabdallah, N. M., Al-Saeed, F. A., Muzammil, K., & Saeed, M. (2022). Moringa oleifera: Miracle Plant with a Plethora of Medicinal, Therapeutic, and Economic Importance. Horticulturae, 8(6), 492. https://doi.org/10.3390/horticulturae8060492
6. Mehta, A., & Agrawal, B. (2008). Antiasthmatic activity of Moringa oleifera Lam: A clinical study. Indian Journal of Pharmacology, 40(1), 28. https://doi.org/10.4103/0253-7613.40486
7. Busse, W. W., &Lemanske, R. F. (2001). Asthma. New England Journal of Medicine, 344(5), 350–362. https://doi.org/10.1056/nejm200102013440507
8. Anwar, F., &Bhanger, M. I. (2003). Analytical Characterization of Moringa oleifera Seed Oil Grown in Temperate Regions of Pakistan. Journal of Agricultural and Food Chemistry, 51(22), 6558–6563. https://doi.org/10.1021/jf0209894
9. Babu, V., Basha, Y. B. C., Srinivasan, S., Sadik, S. B. S., & Pandurangan, A. K. (2024). A Comprehensive Review on the Phytochemical and Pharmacological Benefits of Moringa oleifera: An Update. Current Pharmacology Reports, 11(1). https://doi.org/10.1007/s40495-024-00383-x

10. Vongsak, B., Sithisarn, P., &Gritsanapan, W. (2013). Simultaneous HPLC Quantitative Analysis of Active Compounds in Leaves of Moringa oleifera Lam. Journal of Chromatographic Science, 52(7), 641–645. https://doi.org/10.1093/chromsci/bmt093
11. Giugliano, R., Ferraro, V., Chianese, A., Della Marca, R., Zannella, C., Galdiero, F., Fasciana, T. M. A., Giammanco, A., Salerno, A., Cannillo, J., Rotondo, N. P., Lentini, G., Cavalluzzi, M. M., De Filippis, A., &Galdiero, M. (2024). Antiviral Properties of Moringa oleifera Leaf Extracts against Respiratory Viruses. Viruses, 16(8), 1199. https://doi.org/10.3390/v16081199
12. Chiș, A., Noubissi, P. A., Pop, O., Mureșan, C. I., Tagne, M. a. F., Kamgang, R., Fodor, A., Sitar-Tăut, A., Cozma, A., Orășan, O. H., Hegheș, S. C., Vulturar, R., &Suharoschi, R. (2023). Bioactive Compounds in Moringa oleifera: Mechanisms of Action, Focus on Their Anti-Inflammatory Properties. Plants, 13(1), 20. https://doi.org/10.3390/plants13010020
13. Divya, S., Pandey, V. K., Dixit, R., Rustagi, S., Suthar, T., Atuahene, D., Nagy, V., Ungai, D., Ahmed, A. E. M., Kovács, B., & Shaikh, A. M. (2024). Exploring the Phytochemical, Pharmacological and Nutritional Properties of Moringa oleifera: A Comprehensive Review. Nutrients, 16(19), 3423. https://doi.org/10.3390/nu16193423
14. Cao, Y., Chen, S., Chen, X., Zou, W., Liu, Z., Wu, Y., & Hu, S. (2022). Global trends in the incidence and mortality of asthma from 1990 to 2019: An age-period-cohort analysis using the global burden of disease study 2019. Frontiers in Public Health, 10. https://doi.org/10.3389/fpubh.2022.1036674
15. Pahwa, P., Karunanayake, C. P., Rennie, D. C., Lawson, J. A., Ramsden, V. R., McMullin, K., Gardipy, P. J., MacDonald, J., Abonyi, S., Episkenew, J., &Dosman, J. A. (2017). Prevalence and associated risk factors of chronic bronchitis in First Nations people. BMC Pulmonary Medicine, 17(1). https://doi.org/10.1186/s12890-017-0432-4