

Natural Interventions for Asthma: The Evolving Role of Nutraceuticals in Respiratory Care

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Abstract

Asthma is a chronic inflammatory airway disease characterized by reversible airflow obstruction, bronchial hyperresponsiveness, and airway remodelling. Despite advances in pharmacotherapy, incomplete symptom control, steroid resistance, and adverse effects persist, creating a need for complementary approaches. Nutraceuticals—bioactive compounds derived from food—offer both nutritional and pharmacological benefits that target key mechanisms such as oxidative stress, inflammation, and immune imbalance in asthma. This review explores the therapeutic role of major nutraceuticals including omega-3 fatty acids, vitamin D, and curcumin, along with antioxidants and herbal agents such as *Nigella sativa*, saffron, and *Adhatoda vasica*. These compounds modulate inflammatory mediators (IL-4, IL-5, TNF- α), inhibit NF- κ B and STAT3 pathways, enhance antioxidant defenses, and reduce airway hyperresponsiveness. Clinical studies demonstrate improvements in lung function and symptom control, though results vary due to differences in formulations and dosages. Furthermore, pharmacists play a vital role in educating patients about appropriate nutraceutical use, potential interactions, and their adjunctive nature alongside conventional therapies. While nutraceuticals are not replacements for standard asthma medications, they represent a promising integrative strategy to improve respiratory health, minimize inflammation, and enhance quality of life when used under professional guidance.

Keywords— Nutraceuticals, Asthma, Oxidative Stress, Omega-3 Fatty Acids, Vitamin D, Curcumin, Inflammation.

1. Introduction: Nutraceuticals are bioactive compounds that bridge the gap between nutrition and medicine. The term “Nutraceutical” was coined in 1989 by Dr. Stephen De Felice, founder and chairman of the Foundation for Innovation in Medicine, Cranford, New Jersey, USA. He defined nutraceuticals as “a food or part of a food that provides pharmacological benefits, including the prevention and treatment of disease” [1,2]. Although widely used in marketing, the term still lacks a uniform regulatory definition [3]. Nutraceuticals are derived from food sources that provide both nutritional and therapeutic benefits. They include a wide range of preparations such as fortified foods, dietary supplements, herbal extracts, probiotics, and isolated phytochemicals. These products are gaining popularity due to their ability to improve health, prevent chronic diseases, and support conventional medical therapy [4,5].

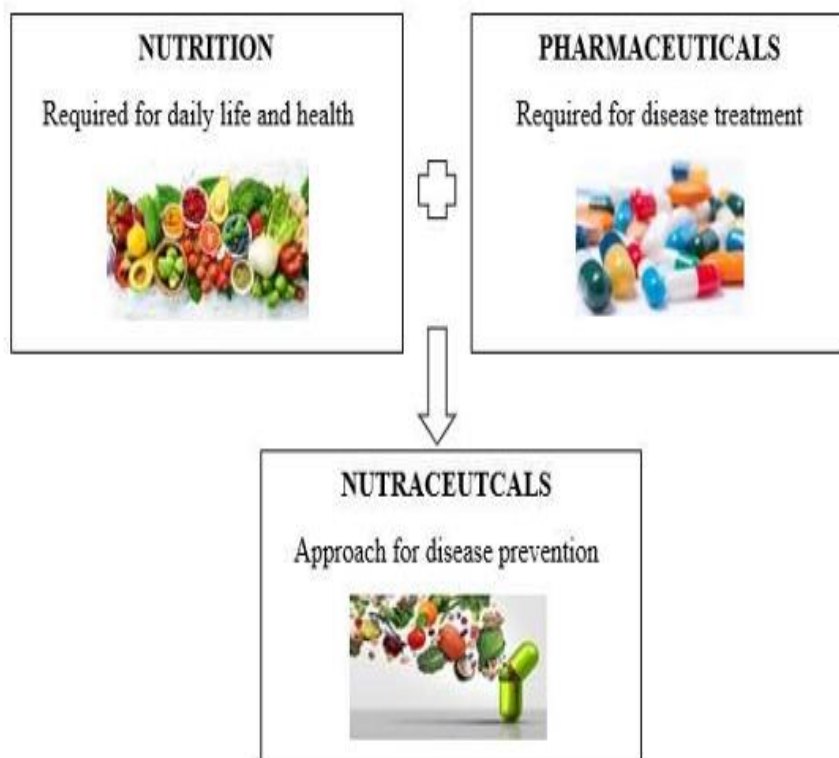


Fig.1: Concept of Nutraceutical

1.1 Need and objectives of Nutraceuticals

- Supporting disease prevention and management (e.g., diabetes, asthma, cancer, arthritis, cardiovascular disease).
- Enhancing immune function, sleep quality, and mental sharpness.
- Reducing dependency on synthetic drugs and minimizing side effects.
- Improving quality of life by promoting vitality and delaying aging [4,5].

1.2 Classification of Nutraceuticals:

Nutraceuticals have broad classification depending on their origin, use and chemical structure. The generally accepted divisions are dietary supplements, functional foods, medical foods, probiotics,

prebiotics, antioxidants, phytochemicals, vitamins, minerals, amino acids and fatty acids. These groups are indicative of their various origins and health-enhancing capabilities of disease prevention and well-being. In general, the nutraceuticals are a wide category of bioactive natural products offering health benefits other than simple nutrition. This is a broad classifier that demonstrates the ascending role of nutraceuticals in nutrition and health.[4,5]:

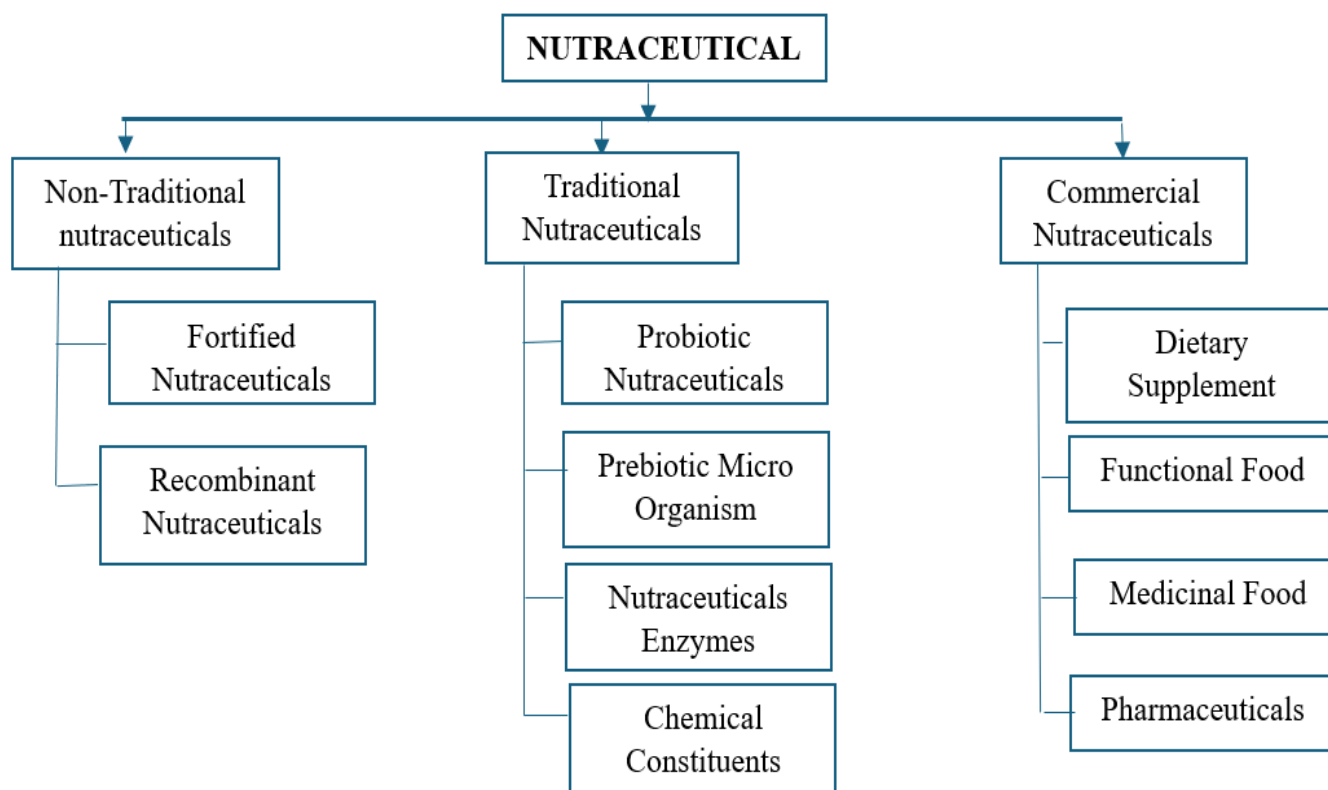


Fig 2: Classification based on food availability

Table 1. Classification of Nutraceuticals (based on various parameters)

Basis	Category	Example	Reference
Source	Traditional	Fruits, vegetables, herbs	[4,5]
Source	Non-traditional	Fortified milk, omega-3 eggs	[4,5]
Composition	Nutrients	Vitamins, minerals, amino acids	[4,5]
Composition	Phytochemicals	Flavonoids, carotenoids, curcumin	[4,5]
Function	Antioxidants	Vitamin E, selenium, polyphenols	[4,5]
Function	Immunomodulators	Vitamin D, probiotics	[4,5]

1.3 Therapeutics applications of Nutraceutical

Table 2. Major Therapeutic Applications of Nutraceuticals

Disease	Effective Nutraceuticals	Mechanism of action	Reference
Alzheimer's Disease	Lutein, lycopene, beta-carotene, curcumin	Reduce oxidative stress and neuroinflammation	[6]
Cancer	Sulphur compounds,	Antioxidant and apoptosis-	[7]

	carotenoids, flavonoids, curcumin	inducing activity	
Gastrointestinal Disorders	Probiotics, turmeric, aloe	Maintain gut flora, reduce inflammation	[8,9]
Osteoarthritis	Glucosamine, curcumin, Boswellia, collagen	Reduce inflammation, support cartilage repair	[10]
Parkinson's disease	Vitamin A, lycopene, omega-3, curcumin	Neuroprotection via antioxidant action	[11]
Diabetes mellitus	Isoflavones, cinnamon, green tea	Improve insulin sensitivity and glucose control	[12]
Cardiovascular disease	Omega-3 fatty acids, polyphenols	Lower cholesterol, improve endothelial function	[13]
Asthma	Omega-3, vitamin D, curcumin	Reduce airway inflammation and oxidative stress	[14-17]

2: Asthma: Definition, Pathophysiology, and Role of Oxidative Stress

2.1 Definition: Asthma is a chronic inflammatory disease of the airways that leads to reversible airflow obstruction and airway hyperresponsiveness to several triggers such as dust, smoke, allergens, exercise, or cold air. Common symptoms include wheezing, coughing, chest tightness, and shortness of breath, which vary in frequency and severity. [14,18].

2.2 Pathophysiology of Asthma: Asthma mainly affects the lower respiratory tract, including the trachea, bronchi, and bronchioles. Inflammation, bronchoconstriction, and airway remodelling are the key pathological features [18–20].

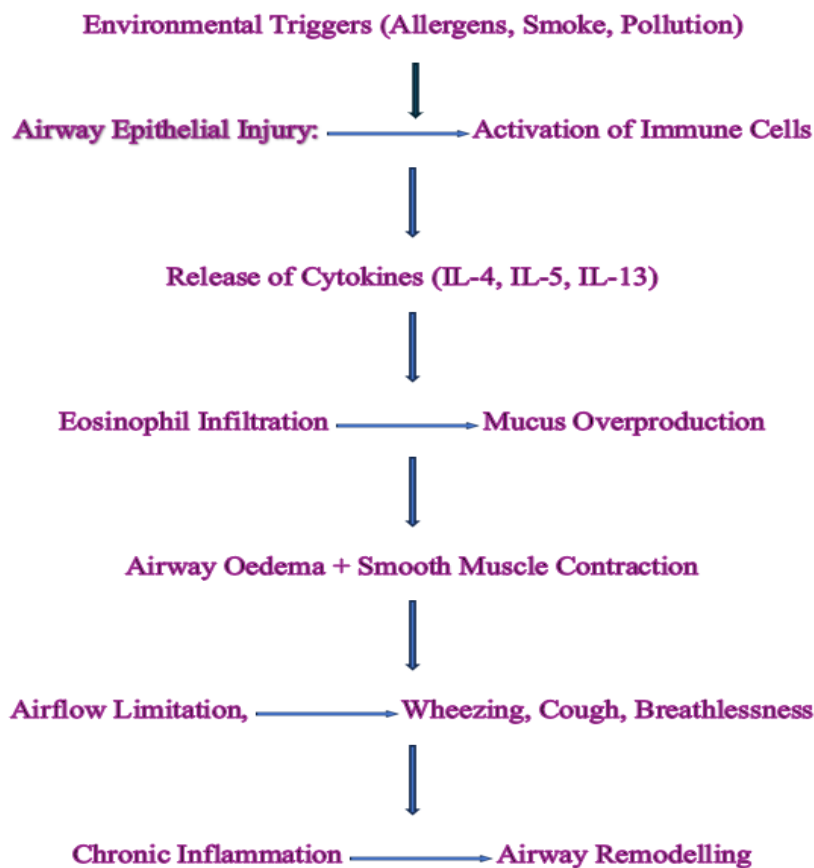


Fig. 3: Flowchart – Pathophysiology of Asthma (This sequence shows how repeated inflammatory episodes lead to structural changes and persistent airway obstruction)

2.3 Role of Oxidative Stress in Bronchial Asthma

Oxidative stress occurs when the production of reactive oxygen species (ROS) exceeds the body's antioxidant defense. In asthma, this imbalance contributes to airway inflammation, mucus hypersecretion, and tissue damage [21–23].

Mechanisms by which ROS Worsen Asthma:

- A. **Cellular Injury:** ROS damage epithelial cells, proteins, and DNA, leading to further inflammation [24,25].
- B. **Activation of Redox-sensitive Pathways:** ROS activate transcription factors like NF- κ B and AP-1, which increase cytokine and chemokine production [26].
- C. **Smooth Muscle Effects:** ROS induce contraction of airway smooth muscles, enhancing bronchospasm [27].
- D. **Reduction in Antioxidant Defenses:** Levels of glutathione and superoxide dismutase (SOD) are lower in asthmatic airways, correlating with disease severity [29,30].
- E. **Exhaled Biomarkers:** Higher concentrations of hydrogen peroxide and 8-isoprostane are found in exhaled breath condensate of asthma patients, serving as indicators of oxidative stress [32–35].

Animal studies show that eliminating ROS can prevent allergic airway inflammation, confirming that oxidative stress is not a by-product but a driving force in asthma pathogenesis [36].

Table 3. Effects of Oxidative Stress in Asthma

Effect	Mechanism	Outcome in Asthma	Reference
Epithelial cell damage	ROS attack cell membranes and DNA	Loss of barrier protection, increased allergen sensitivity	[24–26]
Cytokine release	Activation of NF-κB, AP-1	Chronic inflammation, immune activation	[25,26]
Mucus hypersecretion	Stimulation of goblet cells	Airflow obstruction	[24,27]
Reduced antioxidants	Low SOD, GSH	Poor oxidative balance, worsened symptoms	[29,30]
Elevated oxidative markers	Increase of H ₂ O ₂ , 8-isoprostane in exhaled air	Biomarker of disease severity	[32–35]

2.4 Importance for Nutraceutical Research

The presence of oxidative stress in asthma highlights why antioxidant and anti-inflammatory nutraceuticals (e.g., omega-3 fatty acids, vitamin D, curcumin, vitamin E, resveratrol) are increasingly studied. By neutralizing ROS and regulating inflammatory pathways, these compounds may reduce airway inflammation and improve lung function [37–39].

3: Anti-inflammatory Nutraceuticals in Asthma

Asthma is a chronic airway inflammatory disease that involves complex immune and oxidative mechanisms. Modern pharmacotherapy controls symptoms but may cause side effects or show incomplete response. Hence, certain nutraceuticals with anti-inflammatory and antioxidant actions- especially omega-3 fatty acids, vitamin D, and curcumin—are being explored as complementary therapies [40].

3.1 Omega-3 Fatty Acids

3.1.1 Overview

Omega-3 polyunsaturated fatty acids (PUFAs) are essential long-chain fatty acids that cannot be synthesized in sufficient quantities by the human body. The two most biologically active forms are EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid). They are known to suppress airway inflammation, inhibit synthesis of pro-inflammatory mediators, and improve respiratory health [37,38,41].

3.1.2 Sources of Omega-3 Fatty Acids

Omega-3 fatty acids occur naturally in both plant and marine sources and are also added to fortified foods [47–50].

Table 4. Dietary Sources of Omega-3 Fatty Acids

Source Type	Examples	Major Component	Reference
Plant Sources	Flaxseed, chia seed, walnut, perilla seed oil, rapeseed oil	Alpha-linolenic acid (ALA)	[48]
Marine Sources	Salmon, mackerel, sardine, herring, tuna	EPA & DHA	[49]
Fortified foods	Omega-3 enriched eggs, milk, yogurt, infant formulas	Mixed EPA/DHA	[47]
Single-cell oils	Microalgae, yeast oils	DHA (vegetarian source)	[50]

3.1.3 Mechanism of Action in Asthma

Various biochemical pathways of asthma are regulated by omega-3 polyunsaturated fatty acids in terms of inflammation and oxidative balance. They inhibit the production of pro-inflammatory eicosanoids and enhance the production of anti-inflammatory lipid mediators as resolvins and protectins. The action of omega-3 PUFAs on immune cells involves the reduction of eosinophil inflammation and cytokine production. Moreover, they assist in preserving cell membrane integrity and augmenting antioxidant protections, decreasing oxidative stress, airway hyperresponsiveness and chronic airway inflammation. They also suppress major inflammatory signal pathways with the resultant low activation of transcription factors that mediate asthma pathogenesis. Additionally, omega-3 PUFAs contribute to airway remodelling regulation through a reduction in smooth muscle growth and mucus secretion, which results in better lung performance and total asthma management over the long-term. They also assist in restoring the balance of pro-inflammatory and anti-inflammatory immune response, enhance sensitivity to conventional treatment, stabilize mast cells, minimize leukotrienes, and eventually promote long-term respiratory condition[37,39]

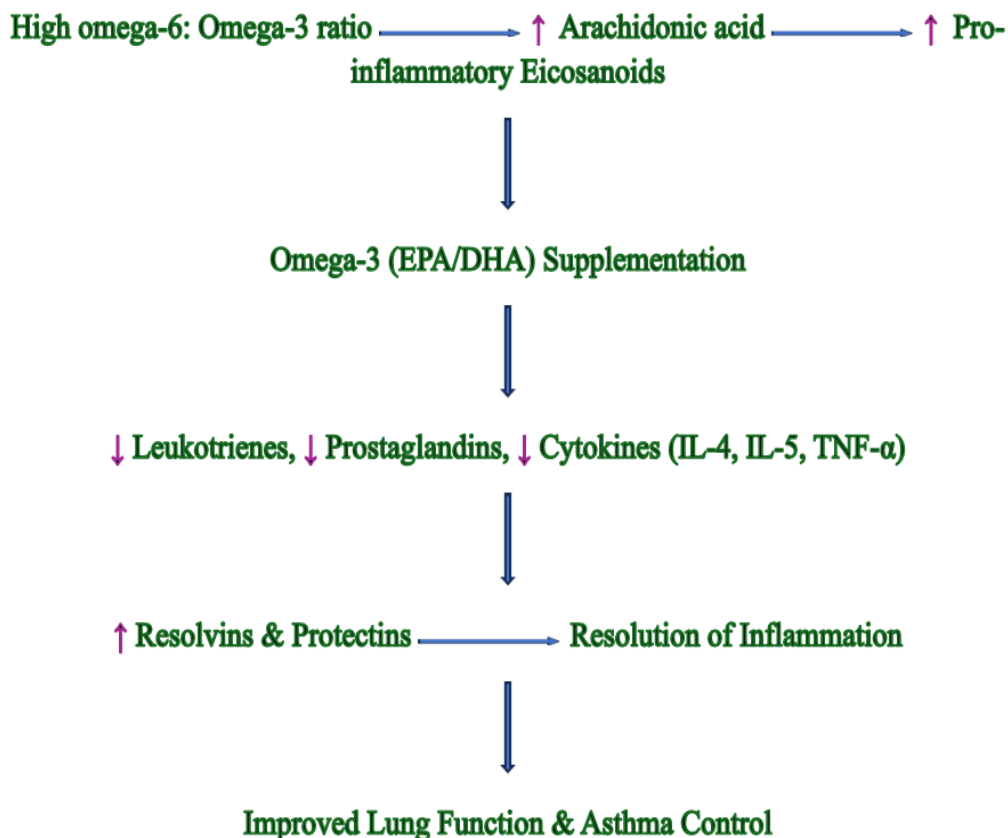


Fig. 4: Mechanism of Omega-3 Fatty Acids in Asthma

3.1.4 Evidence from Clinical and Experimental Studies

Table 5. Summary of Omega-3 Studies in Asthma

Study/Model	Intervention	Key Findings	Reference
Arm <i>et al.</i> , 1988	Fish-oil lipids in mild asthma	Reduced bronchial hyperresponsiveness, improved FEV ₁	[39]
Mickleburgh <i>et al.</i> , 2004	Omega-3 supplementation (3 g/day)	Lowered inflammatory markers, fewer exacerbations	[37]
Serhan <i>et al.</i> , 2000 (preclinical)	EPA/DHA → resolvin formation	Demonstrated anti-inflammatory lipid mediators	[38]
Saidane <i>et al.</i> , 2018 (review)	Dietary intake correlation	Positive association with asthma control	[46]

3.1.5 Clinical Considerations

- **Dosage:** Most studies use 1–4 g/day of combined EPA + DHA.
- **Formulation:** Fish-oil capsules, microencapsulated powders, or algal DHA capsules.
- **Safety:** Generally well tolerated; mild GI disturbance possible.
- **Precaution:** Very high doses may increase bleeding risk in patients on anticoagulants [49].

3.2 Vitamin D and Asthma

3.2.1 Overview: Vitamin D is a fat-soluble secosteroid that regulates calcium metabolism and exerts multiple anti-inflammatory and immunomodulatory effects. It is obtained mainly from sunlight exposure, dietary intake, and supplements. Recent research links vitamin D deficiency with increased asthma incidence, airway inflammation, and higher risk of exacerbations [51–54]. Therefore, vitamin D is now considered an important nutraceutical for respiratory health.

3.2.2 Sources of Vitamin D

Vitamin D occurs in two principal forms:

- **Vitamin D₂ (ergocalciferol)** — from plant and fungal sources.
- **Vitamin D₃ (cholecalciferol)** — synthesized in human skin and found in animal foods.

Table 6. Major Sources of Vitamin D [50–54]

Source Type	Examples	Form of Vitamin D	Comment
Sunlight Exposure	UV-B radiation on skin	D ₃ (synthesized in skin)	10–20 min/day of sun exposure maintains adequate levels
Animal Foods	Fatty fish (salmon, mackerel, sardine), egg yolk, liver	D ₃	Rich natural sources
Fortified Foods	Milk, plant-based milks, breakfast cereals, butter spreads	D ₂ or D ₃ (added)	Important in low-sun regions
Supplements	Capsules, drops (400–2000 IU daily)	D ₂ or D ₃	Used to correct deficiency

3.2.3 Mechanisms of Action in Asthma

The biological actions of vitamin D take place via the vitamin D receptor (VDR), which is a nuclear receptor that controls the expression of genes that control inflammation, immune responses, and airway structure. Vitamin D also enhances airway epithelial integrity and decreases airway remodelling, thereby leading to improved lung functioning and asthma tolerance.[51–53].

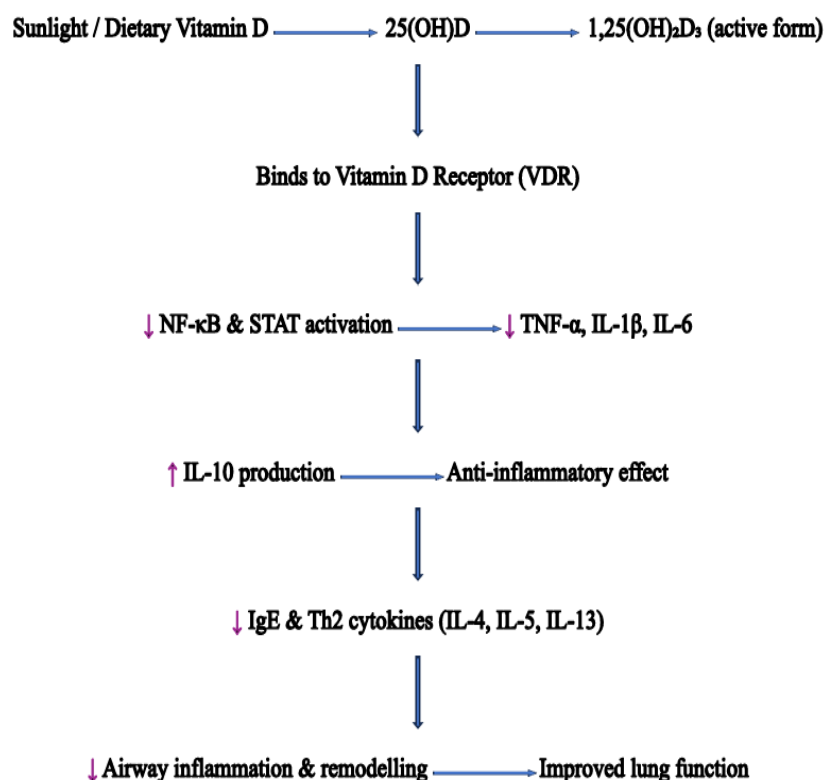


Fig. 5: Mechanism of Vitamin D in Asthma

3.2.4 Evidence from Clinical and Observation studies

Numerous epidemiological and interventional studies support the role of vitamin D in asthma control [51–55].

Table 7. Selected Clinical Studies on Vitamin D in Asthma

Study	Population / Design	Intervention	Main Outcome	Reference
Ali <i>et al.</i> , 2017	100 adults with persistent asthma (RCT)	2000 IU D ₃ daily for 12 weeks	Fewer exacerbations and lower IL-6 levels in deficient patients	[51]
Maretzke <i>et al.</i> , 2020	Children with vitamin D deficiency	Supplementation + standard therapy	Reduced hospitalizations and steroid use	[53]
Deepika <i>et al.</i> , 2025	Narrative review on vitamin D immunity link	Literature review	Vitamin D linked to lower infection-induced asthma attacks	[54]
Alwarith <i>et al.</i> , 2020	Meta-analysis (>1000 patients)	Pooled data on vitamin D supplementation	25–30 % reduction in severe exacerbations risk	[52]

3.2.5 Clinical and Practical Considerations

- **Deficiency Assessment:** Measure serum 25(OH)D; values < 20 ng/mL require correction.
- **Supplementation Dose:** 400–2000 IU/day (typical range), adjusted per deficiency status and medical supervision.
- **Safety:** Vitamin D is generally safe; hypercalcemia occurs only with excessive long-term intake.
- **Adjunct Role:** Use with standard asthma medication rather than as a replacement.
- **Pharmacist Counselling:** Ensure compliance, educate about sun exposure and dietary sources to maintain optimal levels.

3.3 Curcumin in Asthma Management

3.3.1 Overview

Curcumin is a natural polyphenolic compound derived from the rhizome of *Curcuma longa* (turmeric). It is well known for its anti-inflammatory, antioxidant, and immunomodulatory activities. For centuries, turmeric has been used in traditional medicine to treat respiratory and inflammatory diseases. Recent research supports curcumin's role as a nutraceutical adjunct in asthma therapy due to its ability to regulate oxidative stress and inflammatory pathways [55–60].

3.3.2 Sources and Composition

Turmeric powder contains 3–5% curcuminoids, mainly curcumin, demethoxycurcumin, and bisdemethoxycurcumin.

Curcumin (C₂₁H₂₀O₆) is the principal active component responsible for most pharmacological effects. It is extracted using solvent or supercritical methods and often formulated with piperine or lipid carriers to enhance absorption [55,57,59].

Table 8. Natural and Formulated Sources of Curcumin

Source Type	Examples	Features	Reference
Natural	Turmeric (<i>Curcuma longa</i>)	Contains curcumin + volatile oils	[56]
Extracted	Curcumin 95% standardized extract	Used in supplements and research	[55]
Enhanced Formulations	Curcumin + Piperine, Nano-curcumin	Improved bioavailability	[59]

3.3.3 Mechanism of Action in Asthma

Curcumin influences various inflammatory and oxidative stress pathways that lead to asthma pathogenesis. Curcumin has a role in the asthma pathogenetics in reducing airways inflammation and oxidative stress. It balances the production of inflammatory processes, reduces the production of pro-inflammatory cytokines, and prevents the oxidative stress of airway tissues. In such a way, curcumin helps to achieve better airway performance and fewer symptoms of asthma. It is also used to regulate immune responses that are involved in asthma hence limiting airway hypersensitivity. Moreover, curcumin helps in the health of the overall airways, by lessening tissue injury and enhancing the breathing capacity[55-58].

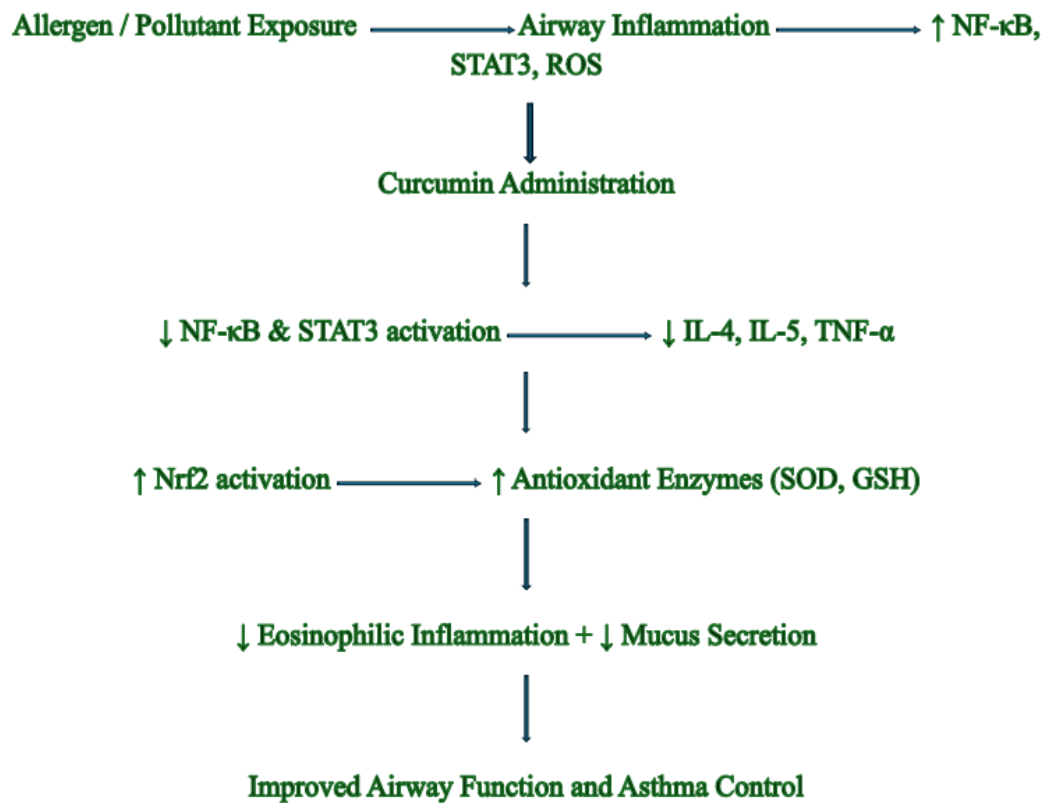


Fig. 6: Mechanism of Curcumin in Asthma

3.3.4 Evidence from Experimental and Clinical Studies

In animal models, preclinical research has demonstrated that curcumin has a major effect of suppressing airway inflammation, mucus secretion, and eosinophilic infiltration suggesting that it has anti-asthmatic properties. A number of human clinical trials have also tested its safety and effectiveness as an adjunct to standard asthma treatment and hint at the fact that curcumin can be used to enhance respiratory symptoms and general asthma management when administered as an adjunct to traditional medications. Such clinical trials also reveal that curcumin is widely tolerated and few side effects are attached to its use and thus, it is a promising complementary medication[57–60].

Table 9. Key Clinical Studies on Curcumin in Asthma

Study	Population / Design	Intervention	Outcome	Reference
Kim et al., 2011	77 patients with atopic asthma	Oral curcumin 1000 mg/day	Safe; no major spirometry improvement but reduced symptoms	[57]
Abidi et al., 2014	50 patients (mild–moderate asthma)	Curcumin 1000 mg twice daily for 8 weeks	Improved symptom score, reduced airway inflammation	[58]

Grow & Sadowski, 2021	Meta-analysis	Pooled data from multiple RCTs	Modest improvement in FEV ₁ and symptom control	[60]
Zhu et al., 2019 (animal)	Murine model of allergic asthma	Curcumin via PPAR γ pathway	Decreased mucus and inflammatory cytokines	[56]

3.3.5 Clinical Use and Considerations

- **Typical Dose:** 500–2000 mg/day of standardized extract, depending on formulation.
- **Safety:** Generally well tolerated; occasional mild GI discomfort reported.
- **Bioavailability:** Enhanced with piperine or lipid formulations.
- **Drug Interactions:** Caution with anticoagulants or anti-diabetic drugs due to additive effects.
- **Adjunct Role:** Should complement standard inhaler therapy, not replace it.

4: Other Nutraceuticals and Herbal Agents in Asthma

4.1 Overview

Beyond omega-3 fatty acids, vitamin D, and curcumin, several other nutraceuticals and herbal bioactives have shown potential benefits in asthma management. These compounds act mainly through antioxidant, anti-inflammatory, and bronchodilatory pathways that help reduce airway hyperresponsiveness and oxidative stress [61–66]. Many of these agents come from dietary or herbal origins, such as vitamin E, N-acetylcysteine (NAC), *Nigella sativa*, saffron, lycopene, and *Adhatoda vasica*, all of which have been investigated in experimental or clinical asthma models.

4.2 Key Nutraceuticals and Their Mechanisms

4.2.1 Vitamin E (Tocopherols)

Vitamin E is a lipid-soluble antioxidant that protects cell membranes from oxidative damage. It decreases airway inflammation by inhibiting Th2 cytokines (IL-4, IL-5, IL-13) and IgE synthesis, and by improving the balance of antioxidant enzymes [61]. Animal models show vitamin E supplementation can reduce airway hyperresponsiveness and improve lung histopathology.

4.2.2 N-Acetylcysteine (NAC)

NAC is a precursor of glutathione, the body's most important intracellular antioxidant. It acts as a mucolytic agent and directly scavenges ROS, thereby improving mucociliary clearance and lung function. In asthma, NAC may reduce oxidative injury, inhibit NF- κ B signalling, and lower mucus viscosity [61,68].

4.2.3 Lycopene

Lycopene is a carotenoid antioxidant found in tomatoes and other red fruits. It reduces neutrophilic airway inflammation and oxidative stress. In a crossover clinical trial, lycopene-rich tomato extracts improved asthma control scores and reduced markers of oxidative damage [64].

4.2.4 Saffron (*Crocus sativus*)

Saffron contains crocin and safranal, compounds with antioxidant, anti-inflammatory, and bronchodilatory effects. A randomized controlled trial (100 mg/day for 8 weeks) in mild-to-moderate asthma reported improved daytime breathlessness, reduced medication use, and better physical activity tolerance [62].

4.2.5 *Nigella sativa* (Black Seed)

Nigella sativa seeds contain thymoquinone, a potent antioxidant and immune modulator. It decreases FeNO (fractional exhaled nitric oxide), serum IgE, and airway inflammation. Clinical studies using 1–2 g/day for 3 months demonstrated significant improvement in FEV₁, FEF25–75%, and reduced eosinophilic inflammation [63].

4.2.6 *Adhatoda vasica* (Malabar Nut)

Adhatoda vasica contains vasicine and vasicinone, which show bronchodilator, expectorant, and anti-inflammatory activities. Traditionally used in Ayurvedic medicine, its extracts relax airway smooth muscles, reduce mucus secretion, and improve cough reflex sensitivity [66].

4.3 Summary Table — Selected Nutraceuticals and Herbs

Table 10. Other Nutraceuticals and Herbal Agents in Asthma

Agent / Source	Active Compound(s)	Mechanism / Action	Evidence	References
Vitamin E	Tocopherols	Antioxidant; inhibits Th2 cytokines; reduces IgE	Animal & limited clinical studies	[61]
N-acetylcysteine (NAC)	Glutathione precursor	Antioxidant, mucolytic; reduces oxidative stress	Experimental & clinical data	[68]
Lycopene	Carotenoid	Antioxidant; lowers neutrophilic airway inflammation	Human crossover trial	[64]
Saffron	Crocin, safranal	Anti-inflammatory; bronchodilator	RCT (100 mg/day × 8 weeks)	[62]
<i>Nigella sativa</i>	Thymoquinone	Antioxidant; ↓ FeNO, ↓ IgE; improves lung function	Human RCT (1–2 g/day × 12 weeks)	[63]
<i>Adhatoda vasica</i>	Vasicine, vasicinone	Bronchodilatory; anti-inflammatory	Preclinical & traditional use	[66]

4.5 Clinical Relevance

Though evidence is encouraging, nutraceuticals and herbal agents should complement—not replace—standard asthma therapy. Most clinical studies have small sample sizes or variable formulations, making it difficult to establish standard dosing. Still, these compounds offer safe, low-cost adjunctive options for enhancing asthma control, reducing inflammation, and improving antioxidant status [61–66].

5: Clinical Evidence and Role of Pharmacist in Asthma management

5.1 Overview of Clinical Evidence

Nutraceuticals have gained significant attention as adjuncts in asthma therapy because they address two major components of the disease — oxidative stress and chronic inflammation. Several clinical and preclinical studies have evaluated nutraceuticals such as omega-3 fatty acids, vitamin D, curcumin, *Nigella sativa*, saffron, and other antioxidants for their therapeutic potential in asthma [61–66]. Overall, the findings suggest that nutraceutical supplementation can improve symptom control, lung function, and quality of life, particularly in patients with poor dietary antioxidant intake or high oxidative stress. However, variability in study designs, formulations, and doses means these agents should be considered supportive rather than replacement therapies.

5.2 Summary of Clinical Trials

Table 11. Key Clinical Studies on Nutraceuticals in Asthma

Nutraceutical / Agent	Study Design	Dosage & Duration	Main Findings	Reference
Omega-3 Fatty Acids	RCT, mild asthma (n=60)	3 g/day fish oil for 6 weeks	Reduced bronchial hyperreactivity and symptom severity	[39]
Vitamin D	Meta-analysis (1,000+ participants)	400–2000 IU/day for 3–6 months	Lowered risk of severe exacerbations, especially in deficient individuals	[51–55]
Curcumin	RCT (n=50, mild-moderate asthma)	1000 mg twice daily for 8 weeks	Improved symptom scores; safe and well tolerated	[58,60]
Saffron (<i>Crocus sativus</i>)	RCT (n=80, allergic asthma)	100 mg/day for 8 weeks	Reduced nocturnal breathlessness and medication use	[62]
<i>Nigella sativa</i>	RCT (n=92)	1–2 g/day for 12 weeks	Improved FEV ₁ and reduced airway inflammation	[63]
Lycopene	Crossover trial (n=42)	Tomato extract, 15 mg lycopene/day	Reduced neutrophilic airway inflammation	[64]

5.3 Oxidative Stress and Nutraceutical Benefits

Asthma is strongly associated with oxidative imbalance resulting from mitochondrial dysfunction and immune cell activation. Nutraceuticals with antioxidant activity can counteract this by neutralizing ROS and enhancing endogenous antioxidant systems.

Examples include:

- **Vitamin E:** Reduces Th2 cytokines and oxidative stress markers [61].
- **Curcumin and Resveratrol:** Improve mitochondrial efficiency and reduce NF- κ B–driven inflammation.
- **N-Acetylcysteine (NAC):** Replenishes glutathione, improving lung antioxidant status [68].

Studies show that combining these with standard inhaled corticosteroids or bronchodilators enhances overall control and reduces the need for rescue medications.

5.4 Role of Pharmacist in Nutraceutical Counselling

Table 12. Role of Pharmacists in Nutraceutical Counselling for Asthma

Pharmacist Activity	Impact on Patient Outcomes	References
Patient education on nutraceutical use	Increased awareness and correct usage	[67,68]
Assessment of drug–nutrient interactions	Improved safety and reduced side effects	[69]
Guidance on evidence-based nutraceutical selection	Ensures product quality and clinical relevance	[67,70]
Monitoring adherence to therapy	Enhances asthma control and reduces relapse	[68,70]

5.5 Integration of Nutraceuticals into Asthma Care

The inclusion of nutraceuticals in asthma management represents a holistic approach that combines nutrition and pharmacology. When guided by pharmacists and clinicians, nutraceuticals can help reduce inflammation, oxidative stress, and medication dependence. This integrative strategy improves patient satisfaction, symptom control, and quality of life without significant safety concerns [67–70].

5.6 Limitations and Considerations

- **Evidence Variability:** Most studies have small sample sizes or short duration.
- **Product Quality:** Many nutraceuticals lack strict standardization and may differ in potency.
- **Bioavailability:** Compounds like curcumin and resveratrol have limited absorption unless formulated appropriately.
- **Clinical Monitoring:** Regular follow-up and medical supervision are required to ensure efficacy and safety.

6.1 Conclusion

Asthma is a chronic inflammatory disorder involving airway obstruction and oxidative stress. Conventional therapies such as corticosteroids and bronchodilators are effective but have limitations, including side effects and incomplete control. Nutraceuticals, being food-derived bioactive compounds, offer a safe complementary approach to improve asthma outcomes. Among them, omega-3 fatty acids, vitamin D, and curcumin show strong evidence for reducing airway inflammation, oxidative stress, and immune imbalance. Herbal agents like *Nigella sativa*, *Adhatoda vasica*, and saffron also demonstrate bronchodilatory and antioxidant benefits. Although these agents should not replace standard treatment, they can enhance its effectiveness when properly guided. Pharmacists play a key role in educating patients, ensuring safe use, and promoting adherence. Overall, nutraceuticals provide a holistic, adjunctive strategy for improving lung health, reducing exacerbations, and enhancing the quality of life in asthma patients.

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Conflict of Interest:

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