

# Comprehensive Review on Nutraceuticals Along with Therapy Support

Dr. Anil Batta<sup>1\*</sup><sup>1</sup>Professor and Head, Department of Biochemistry, Muzaffarnagar Medical College, MuzaffarnagarDOI: <https://doi.org/10.36347/sasjm.2026.v12i08.012>

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\*Corresponding author: Dr. Anil Batta

Professor and Head, Department of Biochemistry, Muzaffarnagar Medical College, Muzaffarnagar

## Abstract

## Review Article

Nutraceuticals, a blend of nutrition and pharmaceuticals, are products derived from food sources that offer health benefits beyond basic nutrition. They include dietary supplements, functional foods, and herbal products, and are recognized for their role in disease prevention and health promotion. Nutraceuticals, including vitamins, probiotics, and plant extracts, are increasingly studied for their role in managing respiratory disorders by potentially modulating inflammatory pathways. While these agents offer a promising, cost-effective, and safe approach to treating chronic conditions, consultation with a healthcare provider is essential due to variations in efficacy and potential interactions with standard therapies [5,6,8]. For more detailed, peer-reviewed studies on the pharmacological properties of specific nutrients, explore academic databases. Hence, the onus is now on employing disease-alleviating strategies in which natural substances play a crucial role. Nutraceuticals, such as food supplements, vitamins, minerals, and herbal products, are increasingly used by healthcare providers because they are not only safer but also efficacious in certain situations, particularly for chronic diseases. In addition to their efficacy and safety, Food and nutrients, probiotics and prebiotics, vitamins and minerals, polyunsaturated fatty acids, medicinal plant extracts and their important phytoconstituents, etc., are being extensively used by both traditional and modern systems of medicine for the treatment of various disease states, including respiratory illnesses.<sup>1,2,3</sup> This chapter provides an update on some of the issues relating to nutraceuticals and their applications in respiratory and allied diseases.

**Keywords:** Nutraceuticals, Respiratory diseases, Anti-inflammatory, Oxidative stress, Mucositis/Mucus clearance, Dietary supplements.

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## INTRODUCTION

Nutraceuticals help manage respiratory and allied diseases by providing antioxidant, anti-inflammatory, and immunomodulatory benefits. Key agents include vitamins (C, D, E), omega-3 fatty acids, and N-acetylcysteine (NAC). These compounds reduce airway inflammation, clear mucus, and combat oxidative stress in chronic conditions.

### Mechanisms of Action

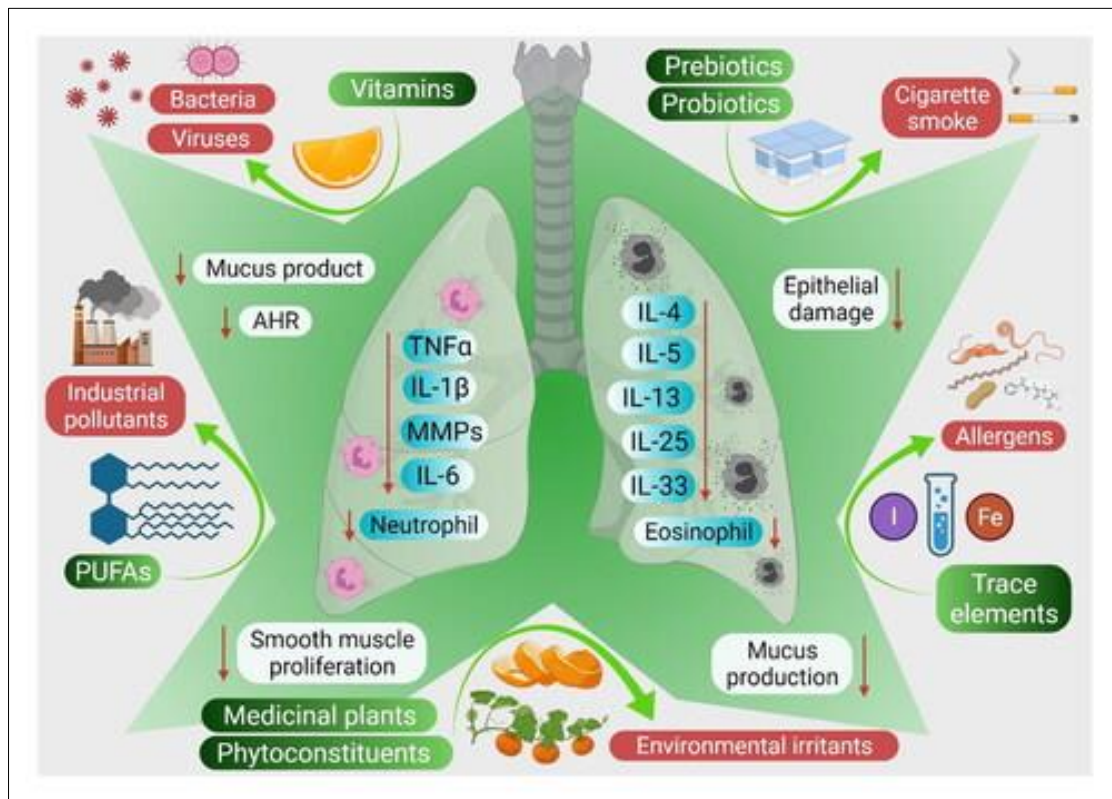
- **Oxidative Stress Reduction:** Vitamins C and E scavenge free radicals and protect lung tissue from damage.
- **Mucus Clearance:**

N-acetylcysteine acts as a mucolytic and replenishes lung glutathione to thin thick phlegm in chronic bronchitis and COPD. They also impose significant socio-economic burdens. Some reasons, including virus outbreaks, the emergence of drug-resistant pathogens, air pollution, smoking, and low immunization rates, have designated respiratory

ailments as one of the leading causes of mortality worldwide. Various prevention and control strategies have been adopted to reduce the burden of respiratory illnesses. Among them, nutraceuticals, also known as functional foods, have emerged as one of the most effective choices for supporting respiratory health. Nutraceuticals, including polyunsaturated fatty acids, vitamins, dietary fibers, minerals, and polyphenolic compounds with anti-inflammatory, antioxidant, and immune-modulating properties, have shown promise in managing respiratory diseases by reducing airway inflammation and oxidative stress to improve lung function and disease symptoms [12-14]. As supplemental therapies, they also maximize the benefits of traditional pharmaceutical treatments while reducing their side effects. Although nutraceuticals appear promising, further studies are needed to determine their optimal formulations and dosing regimens for achieving prolonged benefits. To guarantee the safety and effectiveness of nutraceutical products, standardization and

regulatory control are also essential. This chapter first briefly outlines major respiratory illnesses affecting human health. Then, it discusses the functions of promising nutraceuticals in sustaining

respiratory health, followed by a highlight of the challenges and considerations associated with their usage [9-11].



### Graphical Abstract

A nutraceutical is the antithesis of an additive found in junk food. Nutraceuticals are substances found in food or dietary components that have medicinal or health benefits, such as the ability to treat or prevent disease, which amounts to 4.3 billion people, depends on such phytochemicals as a nutritional ingredient or as functional food. The term “functional food” alludes to common foods that, in addition to their strictly nutritional effect, also provide additional medical or physiological benefits as a result of the addition of certain component ingredients (Das *et al.*, 2012) [8,9].

### TURMERIC

Along with its main chemical component, curcumin, which gives turmeric its bright yellow color, Indian spice turmeric has experienced a meteoric rise in the nutraceutical market in recent years. The Global Curcumin Association surveyed consumers in 2018 about a variety of ingredient categories. According to research, the typical curcumin user is more likely to be female, to earn more money, and to be “somewhat less racially diverse.” [7,8,9] Customers want more nuanced, “earthy,” flavour profiles in food and drink, as well as vibrant, colorful colors, said Brian Zapp, creative director for Austin, Texas. The golden-yellow spice turmeric satisfies this need by giving any beverage or

snack item a vibrant colour and a flavour that will set it apart from the crowd. An Indian medical system called Ayurveda developed plant-based medicinal techniques or formulations to treat a variety of illnesses, including cancer. As a staple spice and part of ceremonies, turmeric is utilised in Southeast Asia. Due of its unique yellow hue, turmeric is frequently referred to as “Indian saffron [5,6,8].” More than 3,000 study articles on turmeric have been published in the previous 25 years, showing that modern medicine has begun to comprehend its effects (Ahamad *et al.*, 2014; Nwosu & Ubaoji, 2020).

### GREEN TEA

Everywhere in the world, green and black tea made from the *Camellia sinensis* plant is consumed. But out of all of them, it has been discovered that drinking green tea has the biggest beneficial effect on human health. The first green tea arrived in Japan from India in the 17th century. [11,12,13] Globally, it is estimated that 2.5 million tons of tea are produced year, 20% of which is green tea, which is largely favored in Asia, some parts of North Africa, the United States, and Europe. Green tea and black tea go through different manufacturing procedures. Green tea is a kind of panacea due to its abundance of flavonoids, caffeine, and catechins (epigallocatechin-3-gallate (EGCG) and epigallocatechin (EGC)) [7-9]. It has been found that the

main bioactive for health restoration is EGCG. The arguments that nutritional intervention helps manage a variety of disorders are supported by epidemiological evidence. Due to reports of synthetic medications having fatal side effects, people are turning to natural products like green tea. There are numerous health benefits of having green tea.

## NATURAL ANIMAL PRODUCTS

There are many types of nutraceuticals, a phrase formed from nutrition and pharmaceuticals, that enhance immune response and lower the risk of disease through various modes of action. Food is typically connected with a product that has been extracted in its purified form from solid food materials available in some medicinally useful forms (Li *et al.*, 2020; Yu-Yaa & Yuan, 2018) [3-5]. The use of nutraceuticals, which are defined as “any substance that is food or part of a food and provides medical or health benefits, including the prevention and treatment of disease,” is currently considered to be a feasible option for providing the cure and even prevention and palliation of some human diseases. The presence of numerous bioactive compounds in food satisfies the human stomach and protects against various illnesses [12-14]. They are referred to as “functional foods.” For a person to grow and develop, they need access to healthy food, a good diet, and good nutrition. Diet, eating habits, and lifestyle all affect world health. Before Hippocrates’ 2,500-year-old proclamation that “Let food be thy medicine and medicine be thy food,” humans were well aware of the superior therapeutic properties of food. A healthy population and suitable nutrition are essential for effective national development (John *et al.*, 1996).

## FISH OIL

Fish oil is typically obtained from a variety of fish species; this oil contains omega-3 fatty acid content provides various benefits over other oils. Generally speaking, fish include mackerel, tuna, and salmon. These unique fish contain higher oil concentrations. Omega-3 fatty acids also lessen pain and oedema while preventing excessive blood clotting. 1–2 servings of fish should be ingested each week, according to WHO records. This is due to the numerous health advantages of fish’s omega-3 fatty acids, which include illness prevention. Omega-3 fatty acids make up about 30% of fish oil, while other fats make up the remaining 70%. Additionally, fish oil typically includes some vitamin D and A. • Support Heart Health: Several heart disease risk factors seem to be reduced by consuming fish or fish oil. Introduction and Different Applications of Nutraceuticals [11] • Reduce Inflammation: In order to heal wounds and fight infection, the immune system uses inflammation [2,9,10]. There are times when higher inflammation is brought on by things like increased stress or weight. In two earlier studies, one in obese adults and the other in people under stress, it was found that fish oil decreased the production of cytokines. • Support Healthy Skin: The largest organ in your body, your skin, is rich in omega-3

fatty acids. Your skin’s health might deteriorate throughout your life, particularly as you become older or have had too much sun. However, fish oil supplements may be helpful for a variety of skin conditions, such as psoriasis and dermatitis. • Improve Asthma: May lessen allergy and asthma symptoms risk Infants are experiencing an increase in the prevalence of asthma, which can lead to lung enlargement and breathing difficulties. Numerous research have suggested that fish oil may improve asthmatic symptoms; however, not all of these studies have found the same results. In an older assessment of over 100,000 people, it was discovered that a mother’s consumption of fish or omega-3 fatty acids can lower the risk of asthma in children.

## HEPARIN

Heparin is renowned for its ability to change how the human circulatory system reacts to blood clotting. Heparin, which slows the rate of blood clot formation, is a natural chemical that requires a prescription for obtainment. Blood clots can lead to serious, potentially fatal issues. Heparin is used to treat deep vein thrombosis, pulmonary embolism, and other conditions involving excessive blood clotting. It is also used to prevent blood clots from forming after surgery and in other situations. Heparin works by blocking procollagen fibers from cross-linking, which is how it works. Over scarring and fibrotic development could not proceed in the absence of the crosslinking of procollagen fibers [3-5]. After experimental vascular damage, smooth muscle cell hyperplasia can be stopped by using different heparin fractions. Heparin is a medication used to treat and prevent blood clots brought on by specific illnesses or medical procedures. It is possible to utilize a different heparin product as a catheter lock flush [13-15]. When heparin is used improperly to flush a catheter, it might cause a deadly hemorrhage.

## NANOPARTICLES

Numerous uses of nanotechnology in the area of drug delivery systems are becoming more common <sup>16</sup>. The newly created nanoparticles have radically different chemical, electrical, mechanical, and physical properties from one another. Nanotechnology is widely used in the fields of medications and dietary supplements in the modern world. Because of this, the present market share in nanotechnology, especially in the pharmaceutical businesses are somewhere about one billion dollars. In addition to this, it was anticipated that the market share would rise to more than 20 billion dollars in the coming decade (Jeevanandam *et al.*, 2018). By utilizing a water-in-benzyl alcohol emulsion medium, Facchi *et al.* have produced encapsulated curcumin nanoparticles that were encapsulated [7,8,10]. This method resolved the difficulties associated with curcumin, also increased its solubility, reduced high crystallinity, and resolved low oral bioavailability (Facchi *et al.*, 2016).

## NANOSPHERE AND NANOCAPSULES

Possess a vesicular structure that is encased in a synthetic compound on all sides. Within the nanocapsule is the active component that is being used. The active substance is disseminated throughout the nanosphere's polymeric matrix, which is part of the nanosphere's dispersed structure (Helal *et al.*, 2019). **METAL NANOPARTICLES** Nanoparticles made of metal offer several desirable properties, including significantly larger surface area, with higher catalytic effects along with increased biocompatibility. In addition, metal nanoparticles have greater selectivity, and they are typically isolable, dispersible, and reusable as catalysts (Zahmakıran & Özkır, 2011) [13-15]

## COMPOSITE COLLOIDAL NANOPARTICLES

Nanocomposites exhibit novel electrical, magnetic, optical, or biological properties than their component nanoparticles. The inorganic core of composite nanoparticles (metal or metal oxide) is surrounded by an organic Introduction and Different Applications of Nutraceuticals 15 shell [8,9]. Composite nanoparticles are a type of hybrid nanoparticle (polymerized monomer, organic molecule, chromophore). Epigallocatechin-3-gallate (EGCG) was encapsulated into the zein-based composite colloidal nanoparticles that Dons and his colleagues manufactured. These nanoparticles are phobic and only weakly interact with the co-polymer zein. Because of this, sodium caseinate (NaCas), a dispersion stabilizer was utilized to improve the encapsulation deficiency. This strategy was said to slow down the pace of fat digestion and increase antioxidant activity.

## SELF-ASSEMBLY NANOPARTICLES

Controlling the self-organization of nanoparticles can be accomplished with the help of a technology known as self-assembly, which is both an effective and cost-efficient method. By adjusting the attraction and repulsion forces that exist between the particles, this technique can be used to create a wide range of nanoparticle self-assembled structures. Polyaspartic acid (PAA) and chitosan (CS) are two examples of substances that can self-assemble into nanoparticles. Because of its potential for low production costs, ease of preparation, and high level of biocompatibility, self-assembled nanoparticles have garnered a significant amount of interest in the field of nutraceuticals.

## NANOSUSPENSION

A nanoparticle that is suspended in a surfactant-stabilized nanosuspension makes up a nanosuspension (Rabinow, 2004). The nanosuspension process improves the stability of the medicine and guarantees a high drug loading. The oral bioavailability of the substance is also increased as a function of its solubility. The capability of nanosuspension to encapsulate insoluble molecules is yet another significant advantage. As a result of this, numerous formulators working in the nutraceutical

industry have experimented with using nanosuspension as a delivery system (Shin *et al.*, 2016). [1,6]

## RESPIRATORY DISORDERS

ailments, both acute and chronic, which have placed a heavy socioeconomic burden on society in; persistent respiratory tract inflammation (Yighan *et al.*, 2021). The main components of the current treatment plans are the use of suitable bronchodilators and anti-inflammatory medications [8,9]. There are many different anti-inflammatory drugs and bronchodilators on the market today, but their usage is restricted due to the possibility of side effects. The potential role of food and compounds generated from food in treating various chronic inflammatory disorders has been discussed by several researchers. Herbs were frequently utilized in ancient China to treat coughs, decrease mucus production, and maintain respiratory health. Only a small number of herbs, however, were able to stop the fibrotic progression in its tracks. However, natural products from animals (NPFAs) have a greater chance of preventing the deposition of procollagen or extracellular matrix. For patients with respiratory problems, NPFAs may be useful functional foods because of these factors. Health care professionals are using nutraceuticals, such as food supplements, vitamins, minerals, and herbal items, more frequently because they are not only safer but also effective in some particular circumstances. Additionally, the popularity of these drugs has grown in underdeveloped nations because of their pharmacoeconomic viability (Gulati *et al.*, 2016) [9-11].

Nutraceuticals have established a critical final status as validated, pharmacoeconomically viable adjuvant therapies that mitigate chronic inflammation, minimize oxidative stress, and regulate immune responses in respiratory and allied diseases. While they do not replace standard primary pharmaceuticals, they serve as essential tools to improve lung function, ease airway hyperresponsiveness, and lower the required doses of symptom-managing drugs like corticosteroids, which often carry long-term toxicity risks.

## Core Pathophysiological Mechanisms

Research demonstrates that functional foods and nutraceuticals directly modulate the molecular pathways driving respiratory disorders:

- **Cytokine & IgE Suppression:** They directly target and downregulate pro-inflammatory cytokines (such as IL-4, IL-5, IL-13, and TNF- $\alpha$ ) and immunoglobulins (IgE) to control structural airway inflammation.
- **Cellular Pathway Inhibition:** Active components block key signaling cascades including NF- $\kappa$ B, MAPK, and STAT3, effectively reducing goblet cell hyperplasia and mucus overproduction.
- **Oxidative Stress Mitigation:** By neutralizing reactive oxygen species (ROS) through

pathways like Nrf2, they protect delicate lung epithelial tissues from environmental insults like pollution and tobacco smoke.

Key Categories and Clinical Roles

| Nutraceutical Category | Primary Bioactive Agents              | Targeted Respiratory & Allied Conditions         | Proven Clinical Effects                                                                      |
|------------------------|---------------------------------------|--------------------------------------------------|----------------------------------------------------------------------------------------------|
| Vitamins               | Vitamin C, Vitamin A, Vitamin D       | Allergic Asthma, Allergic Rhinitis, COPD         | Lowers eosinophil infiltration; preserves mucosal barriers; reduces histamine sensitivity.   |
| Phytochemicals         | Lycopene, EGCG (Green Tea), Bromelain | Pulmonary Fibrosis, Chronic Bronchitis           | Inhibits fibrotic tissue proliferation; provides robust antioxidant lung defense.            |
| Trace Minerals         | Magnesium, Selenium, Zinc, Iron       | Bronchial Asthma, Hyperresponsive Airways        | Magnesium induces bronchodilation; Zinc and Selenium optimize antioxidant enzyme defenses.   |
| Fatty Acids            | Polyunsaturated Fatty Acids (PUFAs)   | Inflammatory Airway Diseases, Allergic Disorders | Alters lipid mediator profiles to naturally lower baseline systemic and airway inflammation. |

Final Clinical Consensus & Outlook

Medical consensus frames nutraceuticals as highly efficient disease-alleviating strategies rather than standalone cures. Their final clinical status is defined by three factors:

- 1. **Steroid-Sparing Potential:** Integrating these nutrients helps patients minimize long-term reliance on heavy corticosteroids, avoiding risks like hyperglycemia or steroid resistance.
- 2. **High Safety Profile:** They offer structural and physiological protection with minimal to no side effects compared to traditional chemical bronchodilators. [
- 3. **Pharmacoeconomic Viability:** Because they are highly cost-effective, they are globally recognized as a sustainable option for managing chronic lung morbidity in developing nations.

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