**PHARMA RESEARCH BULLETIN**

Open Access Journal (ISSN: 2582-676X)

*Review article*

**Volume 4, Issue 1, 2025, 35-44**

# Nutraceutical's Role of Dietary Antioxidants in Pulmonary and Respiratory Diseases

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**Received: 20 February 2025; Accepted: 25 March 2025; Published: 30 March 2025**

**Abstract:** Dietary antioxidants are essential for reducing oxidative stress, which is a key factor in the development of several respiratory and pulmonary conditions, such as asthma, pulmonary fibrosis, and chronic obstructive pulmonary disorder (COPD). Reactive oxygen compounds (ROS) and the body's antioxidant defenses are out of balance during oxidative stress, which results in inflammation, airway remodeling, and compromised lung function. The potential of nutraceuticals—bioactive substances present in food and supplements—to reduce inflammation and oxidative stress in the respiratory tract has drawn interest. Important antioxidants that have shown protective effects in clinical and preclinical trials include vitamins C and E, flavonoids, carotenoids, and polyphenols. These antioxidants enhance lung function, lower inflammatory cytokines, and neutralize free radicals. Vitamin C, for example, is a strong water-soluble antioxidant that may help individuals with COPD experience fewer exacerbations. Fruit and vegetable polyphenols have also been shown to have bronchodilatory and anti-inflammatory effects. Additionally, nutraceutical therapies may have synergistic advantages in the management of chronic respiratory disorders, particularly when paired with a balanced diet. Although dietary antioxidants are a potential approach to respiratory health, more clinical research is required to determine the best dosage and the long-term effectiveness associated with these nutraceuticals in the treatment of lung diseases.

**Keywords:** Oxidative stress, Anti-inflammatory, Pulmonary fibrosis, Flavonoids.

## 1. Introduction

The words "nutrition" (a nutritious diet or food component) and "pharmaceuticals" were combined to create the concept "nutraceuticals". Dr. Stephen De Felice, the founder and head of the Foundation for Advancement in Medicine, invented the term "nutraceutical" in 1989 [1]. The strong nutritional and therapeutic effects and safety of nutraceuticals have gained a lot of attention. Various disorders are treated and prevented with nutritional supplements. Major components of nutraceuticals contain nutrients, natural medicines, and food supplements. These substances function to remain healthy, fight against various medical conditions, and enhance life quality [2]. Nutraceuticals have proven their capacity to improve health and prevent disease, and they should be used at their acceptable consumption. Optimal health, long life, and high quality of life can all be promoted with the use of nutraceuticals, particularly in the treatment and prevention of acute and chronic pathological conditions. However, the purity, safety, prolonged side effects, and toxic effects of the product, as well as clinical trials involving humans and supplemental research, will determine the way it is developed. Consumer satisfaction in nutraceutical products is increasing with the establishment of precisely described and research-proven goods [3-4].

## 2. Respiratory and Pulmonary Diseases

The most common cause of mortality worldwide, Respiratory and Pulmonary diseases, is a serious and spreading global health issue [5]. Around 20% of people over 40 are currently affected; this number increases to 50% in heavy smokers [6]. The elevation in COPD (Chronic obstructive pulmonary disease) is most pronounced in poor nations, where exposure to polluted indoor air, such as biofuel smoke, is just as frequent as smoking cigarettes as a disease risk [7]. There is increasing realization that the disease is mainly driven by increased oxidative stress inside the lungs, which is induced by many and interlinked molecular processes [8]. The existence of reactive oxygen species impairs and overwhelms antioxidant enzyme responses, resulting in oxidative stress [9-10]. Considering that COPD does not go away only when exposure to cigarette smoke is discontinued, it has been proposed that additional endogenous variables, such as autoimmunity or chronic disease, may also be responsible for the disease's progression [11]. Many of the pathogenetic processes underlying COPD and its development seem to be controlled by oxidative stress. This shows that increasing endogenous antioxidants or using antioxidants to decrease oxidative stress might be a helpful treatment strategy. The degree of oxidative stress in the lungs is expanding, it has been challenging to find reliable and secure antioxidants for COPD. The goal of treatment is to return the lungs' redox balance to normal while maintaining the advantages of oxidant activation [11].

## 3. Role of Nutraceuticals in Respiratory Disorder

Individuals of all ages are affected by respiratory illnesses, which are one of the primary causes of death and disease and represent a major worldwide health issue. This includes the lungs along with the bronchi, alveoli, nasal and air passages ways etc. The cause of these conditions may be inflammation, allergy, infection and cancer. The most common respiratory conditions include likely bronchospasm, pulmonary tuberculosis, pneumonitis, rheumatic diseases, lung disease, COPD and pneumoconiosis. COPD is driven by prolonged exposure to irritants and poisons in the air, which leads to ongoing airway inflammation and lung damage in the alveolar tissues. Ultimately, this leads to diseases including emphysema, chronic bronchitis, and chronic bronchiolitis [12]. The mainstays of therapy for both asthma and COPD are anti-inflammatory drugs and antioxidants. According to research, a number of health factors, including stress, toxins, viral agents, and radiation, can also cause chronic inflammation by altering the levels of pro-inflammatory molecules such as chemokines, cytokines, enzymes, etc. Many people are becoming aware of the connection between nutrition and health as well as the value of natural ingredients and dietary supplements in preventative care [13]. Products known as nutraceuticals are those that are used to maintain health as well as to prevent and treat disease. They have basic nutritional value as well. Alternately, any chemical that benefits physiological function or offers defence against chronic diseases may be regarded as a nutraceutical. They can be used to support the body's structure or function, enhance health, slow down the ageing process, avoid chronic diseases, and prolong life expectancy. Because they have the potential to significantly lower the high prices and safety concerns of contemporary medications, which are utilised worldwide to treat pathophysiological conditions, nutraceuticals are of special interest today. Nutraceutical chemicals are naturally bioactive chemical substances with therapeutic qualities that help in ailment prevention and cure of disease states, despite being largely utilised in functional foods and dietary supplements. Thus, nutritional supplements could offer effective therapeutic choices and have been suggested for the management of respiratory illnesses. The word is used by the food industry to refer to any nontoxic food ingredient that has been shown to have positive health effects, including the treatment and prevention of disease. Due to their high margin of safety and possible nutritional and therapeutic benefits, nutraceuticals have also attracted a lot of research [14-15]. The classifications of nutraceuticals are depicted in **Figure 1**.

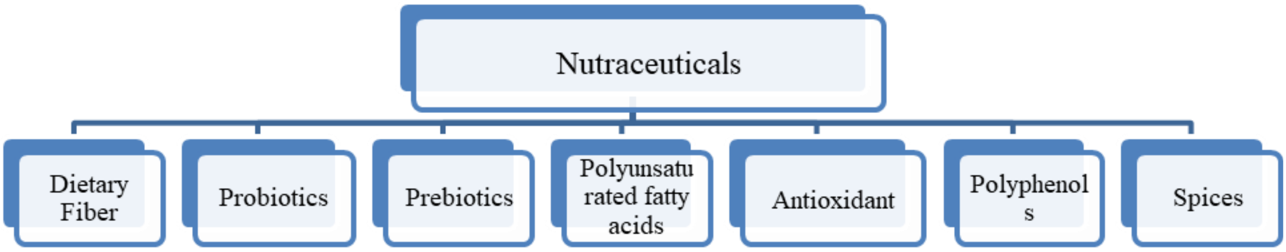


**Figure 1:** Classifications of Nutraceuticals.

### *4.1 Antioxidants*

Antioxidants free radicals are thought to be a major factor in cell damage, which contributes to ageing and the development of illness. Antioxidants are essential for maintaining ideal health and well-being since they act as our first layer of protection against free radical damage. Oxygen can react with other elements to form possibly hazardous substances called "free radicals." The body's healthy cells can be attacked by free radicals, which can result in them losing their respective design and action. Free radicals can be regulated or made inactive by antioxidants prior to damaging cells. The Antioxidants are certainly necessary to keep cellular and systemic health and wellbeing at their best. A highly complex and effective antioxidant defence mechanism has evolved in humans. It consists of several elements, both endogenous and external in origin, that interact with one another and work together in harmony to neutralise free radicals. Vitamin C(Ascorbic acid), vitamin E( tocopherols and tocotrienols), carotenoids(tetraterpenoids), etc., are a few examples of these components. Antioxidant enzymes that catalyse the processes that quench free radicals include superoxide dismutase, glutathione peroxidase, and glutathione reductase. Iron and copper ions that are free and capable of catalysing oxidative processes are sequestered by metal-binding proteins like lactoferrin (eg, lysozyme, trypsin, lactoalbumin), ferritin (eg, hemoglobin, transferrin, fibrinogen), caeruloplasmin(ferroxidase enzyme), and albumin. There is a range of additional antioxidant phytonutrients found in plant diets [15]. Lower lung damage and fewer local infections are anticipated outcomes of reduced oxidative stress, which will slow the course of COPD. Lower lung damage and fewer local infections are anticipated outcomes of reduced oxidative stress, which will slow the course of COPD [16].

### *4.2 Antioxidants and COPD*

Antioxidant imbalance leads to higher oxidant load in Chronic obstructive pulmonary disease patients, Several peer reviews have indicated the efficacy of antioxidant amplification in defending lung airways as well as tissues from the more destructive effects of oxidative agents [17-18]. Numerous studies support the idea that increasing Ascorbic acid (Vitamin C), tocopherols (vitamin E), and other antioxidant-reinforced food intake can significantly enhance pulmonary function in COPD patients as measured by increased FEV1. Some research fell short of demonstrating vitamin E's beneficial impact [19-20].

### *4.3 Role of oxidative stress in COPD pathogenesis*

A protease/antiprotease imbalance and oxidative stress. Oxidizing chemicals, such as those produced by leukocytes or those present in cigarette smoke, have antiprotease enzymes as one of their targets. These substances inhibit antiproteases, which leads to increased protease activity, which is the primary factor responsible for the onset of emphysema [21-22]. Methionine is oxidised in its active site by oxidative chemicals, rendering 1-antitrypsin inactive as a result. This decreases antiprotease activity and increases protease activity, which further damages the lungs' histological architecture. However, these events are only seen in vivo as soon as a person smokes a cigarette, not at a later time [23]**.** Weather influences cause many forms of stress, which cause emphysema and small airways lesions as well as the activation of inflammatory cells and autoimmune responses. Autoimmunity promotes immunogenicity that enhances and sustains the inflammatory process, and neutrophils produce more inflammatory stress. Reduced respiratory oxygen stress due to antioxidants [24].

### *4.4 Additional Physiological Antioxidants*

#### *4.4.1 Dietary Antioxidants*

Various classifications of Dietary antioxidants include vitamin C (ascorbic acid), vitamin E (tocopherols and tocotrienols), β-carotene and other carotenoids (tetraterpenoid) and polyphenols (flavonoids, flavonols, flavones and  Proanthocyanidins).

#### *4.4.2 Classification of antioxidants*

The classifications of antioxidants [25] are depicted in **Figure 2**.

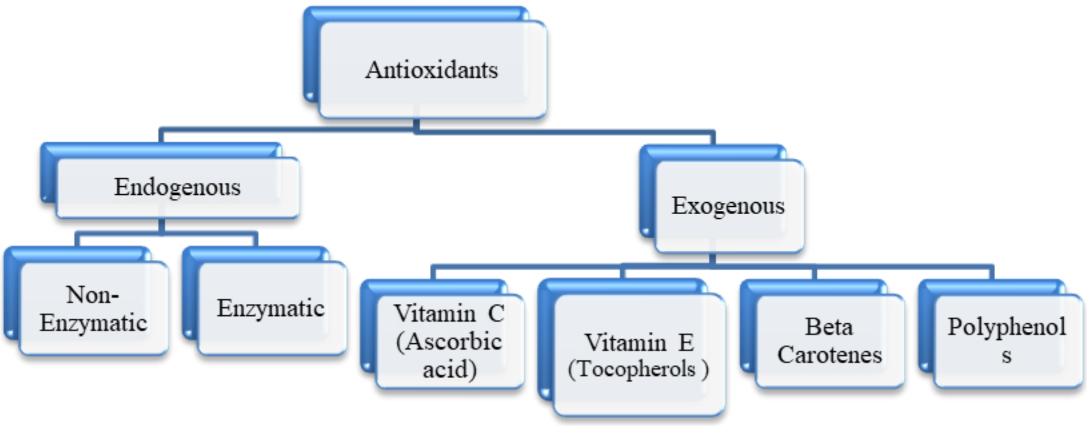


**Figure 2:** Classifications of Antioxidants.

#### *4.4.3 Sources and Benefits of Different Antioxidants*

The various sources and benefits of different antioxidants [26] are given in **Table 1**.

**Table 1:** Sources and Benefits of Different Antioxidants

| Types | Source | Potential Benefit |
|---|---|---|
| Vitamin C (Ascorbic acid) | Orange, Broccoli, Strawberries, Kiwi, Pineapple | Antioxidants for healthy bones, gums, and skin |
| Vitamin E (Tocopherol) | Almond, Avocado, Peanuts, Spinach, Sunflower seeds | Antioxidants help from blood cells, lung and nerve tissue |
| Beta carotene | Carrots, Fruits and vegetables (orange, avocado) | Antioxidant activity, which neutralizes free radicals |
| Polyphenols | Citrus fruits, Soyabean, tea, apples, grapes | Antioxidants counteract inflammation in the body, and reduce the formation of cancer |

### *4.5 Vitamin C*

Ascorbic acid, usually known as vitamin C, is a micronutrient that humans need but cannot generate on their own [27]. However, it can be accumulated by devouring fruits and vegetables every day [28]. Vitamin C is recognised to play a crucial role in the synthesis of collagen, and a deficit results in the clinical symptoms of scurvy. This vitamin is especially well-known for its contentious role in the prevention and treatment of the "common cold.” [29]. Numerous ailments may benefit from the use of vitamin C. Ascorbic acid(Vitamin C) can also function in the lungs as an antioxidant. The longest frequently affected organs are the lungs. Species of Reactive Oxygen (ROS) [30]. These ROS play a crucial part in the etiology of many congenital and acquired respiratory illnesses, including COPD, pneumonia, asthma, and CF (cystic fibrosis) [31]. Numerous physiological effects of vitamin C include anti-inflammatory effects, antioxidant effects, increased nitric oxide generation, and perhaps a contribution to immunity. On these grounds, exogenous vitamin C supplementation may be utilised to treat a variety of respiratory conditions. For instance, oxidative stress, which is defined as the antioxidant/oxidant disequilibrium, is a significant pathogenic component in COPD, a significant factor of illness along with death globally [32]. Free radicals' resting plasma concentration is reduced by vitamin C therapy, and this reduction is inversely linked with the ratio of FEV1/FVC [33]. In addition, it was discovered that a higher proportion of COPD exacerbations were linked to decreased vitamin C levels. Beyond its role as an antioxidant, vitamin C has further advantages in COPD. There have been numerous more defensive mechanisms proposed, such as its part in collagen formation, endothelium repair, and alveolar proliferation. Each of these procedures is required for tissue injury healing and regeneration. Chronic asthma is a different disease that vitamin C supplements may benefit. In addition to severe oxidative stress, this chronic inflammatory condition of the airways [34-35]. Asthma patients produce more ROS, which causes pro-inflammatory mediators to be released [36]. These defects of inflammation brought on by other free radicals as well as mediators are, in fact, pathognomonic in asthmatic patients [37]. Studies on Vitamin C in Asthma Patients have shown that Asthma Patients frequently have low Vitamin C levels [38]. There is a negative correlation between ascorbic acid levels and wheeze or atopic sensitization in asthma, according to other studies [39]. Furthermore, it has been found that a vitamin C shortage is associated with atypical spirometric characteristics and impaired lung function [40-42]. Pulmonary infections can benefit from vitamin C treatment. Additionally, the severity of the sickness was correlated with such an increase. Vitamin C reduced TNF- and IL-6 levels, which in turn reduced ROS and DNA damage scores. Anti-infection properties of vitamin C for influenza viruses [43]. When vitamin C is used to treat pulmonary genetic diseases like cystic fibrosis, it commonly shows considerable oxidative stress brought on by chronic inflammation, recurrent infections, and inadequate fat-soluble vitamin absorption [44-45]. The levels of vitamin C decreased in cystic fibrosis patients are related to higher symptoms of oxidative damage as well as inflammation [46]. Results show that vitamin C supplements can improve the course of several respiratory problems.

### *4.6 Vitamin E*

The antioxidant activity of vitamin E, which is thought to be its primary biological function, is attributed to its reactivity to organic peroxyl radicals and is connected to the redox characteristics of the chromane ring. Compared to healthy persons, COPD patients exhibit reduced plasma antioxidant levels and activity and higher levels of systemic and airway oxidative biomarkers. Activation of NF-kB(Nuclear factor) and inflammation are at least partially responsible for this increased oxidant-to-antioxidant ratio. Antioxidant enzymes like catalase, superoxide dismutase, and glutathione peroxidase were found to positively correlate with lung function [47-48], inversely linked with oxidative stress, antioxidant vitamins, and consumption of antioxidant-rich fruits and vegetables. By preventing lipid peroxidation from starting and progressing, vitamin E belongs to a class of antioxidants that shield human cell membranes from damage brought on by radicals. Tocopherols and tocotrienols, each with four different isomers (α,β and ϒ ), make up the two groups that make up vitamin E [49].

### *4.7 Beta carotene and other carotenoids and oxycarotenoids*

The extensive system of double-bonded conjugates in carotenoids is what gives them antioxidant properties. Additionally, it has been established that carotenoids can prevent the formation of free radicals. Tetralin and methyl linoleate, two model compounds, were found to be resistant to peroxyl radical oxidation at minimum concentrations and oxygen partial pressures, which are typical of most tissues in physiologic settings. It depends upon the synthesis of a stabilized resonance carbon-centered radical, 13-carotene's antioxidant activity, which would be shared by other carotenoids as well, may help shield membranes against lipid peroxidation [50]. After 13-carotene is exposed to free radicals, different kinds of oxidation products are produced as a result of the interaction between carotenoids and radicals. Epoxides at 13-ionone ring, as well as 13-apocarotenones (ketones) and 13-apo-carotenals (aldehydes )with various chain lengths, are produced as a result of the autoxidation of 13-carotene. The central double bond of the polyene chain formed an epoxide after 13-carotene was treated with a peroxyl radical generator [51-52].

### *4.8 Polyphenols*

Numerous publications have been published in recent years that emphasise the advantageous effects of phenolic compounds. Polyphenols have a wide spectrum of biological actions [53]. Flavonoids and phenolic acids are the two subcategories of polyphenols [54].

### *4.8.1 Flavonoids*

It has been proposed that flavonoids can guard against long-term lung illness. Polyphenols called flavonoids are present in plant-based foods naturally. Tea, fruits, and vegetables are the principal sources in a diet of the Western style. Flavonoids have been found to have antioxidant and anti-inflammatory properties. Flavonoids decrease the formation of two types of proinflammatory factors (leukotrienes, prostaglandins) by inhibiting cyclooxygenase as well as lipoxygenase, two enzymes involved in the metabolism of arachidonic acid [55]. Based on their chemical structures, flavonoids are polyphenolic chemicals divided into flavanones, flavones, flavonols, anthocyanidins, isoflavones, chalcones and catechins. The most significant category of phenolic chemicals, flavonoids are secondary metabolites made from plants and can be found in either an aglycone, which is not glycosylated, or connected to a sugar molecule (glycoside). As an antioxidant against the effects of UV radiation, photosynthesis.

Flavonoids have been classified as antioxidants because they guard against the harm done by free radicals. It has been proposed that flavan-3-ols and flavones are most efficient over reactive oxygen compounds. Moreover, flavonoids may act as antioxidants by enhancing or defending natural antioxidants. As glutathione-S-transferase, an enzyme shields cells from free radical injury by generating oxidative stress resistance, is stimulated by many of these substances, oxidative stress is reducedflavonoids like flavones, catechins and flavonolsare inversely correlated with symptoms like chronic cough, shortness of breath (not chronic), and phlegm and are positively correlated to force expiratory volume in one second increment. This suggests that catechins have a positive effect on COPD patients [56]**.** Antioxidants from food may guard against compromised ventilatory function. The dietary source of different flavonoids [57] is given in **Table 2**.

**Table 2**: Dietary Sources of Different Flavonoids

| Class | Flavanoid | Dietary Source |
|---|---|---|
| Flavanol(Flavan-3-ol) | (-)- Epicatechin<br>(+)- Catechin<br>Epigallocatechin | Coffee, wine, tea, onion,apple |
| Flavone | Rutin, Chrysin, luteolin, apigenin<br>Luteolin glycosides | Redwine, Fruit skin(apple), Fagopyrum esculentum |
| Flavanol | Kaempferol, quercetin,<br>Myricetin, Tamaraxitin | Red wine, Olive oil, Grape fruits, Berries |
| Flavanone | Naringin, naringenin,<br>Taxifolin, hesperidin | Lemon, Orange, Citrus fruits, Grapes |
| Isoflavone | Daidzin, Genistin | Soyabean, legume seeds, peas |

### *4.8.2 Proanthracynide*

A group of naturally occurring polyphenolic compounds, flavonoids known as proanthocyanidins, is present in a number of plant foods, including fruits, berries, beans, nuts, chocolate, and wine, making them an essential component in the human diet. Proanthocyanidins have anti-inflammatory, antioxidant properties, and they may have impacts on blood lipid levels [58]. A type of flavonoid chemical known as grape seed proanthocyanidin extract (GSPE) is made up of catechins, epicatechins, catechins, and epigallocatechins [59].

## 5. Conclusion

Vegetables and Fruits are some natural sources of flavonoids, a wide group of low-molecular-weight polyphenolic secondary metabolites. Aglycone is the fundamental flavonoid structure. The effect of OS in the genesis of several chronic and inflammatory ailments suggests that antioxidant-based therapy may be effective for treating these conditions. For a long-term treatment, a therapeutic approach that raises a person's antioxidant capacity may be helpful. However, there are still several issues with antioxidant supplements in disease prevention. We have attempted to assess the function of proanthocyanidin and how they interact with the processes that regulate the weight of the body by investigating how proanthocyanidins affect the performance of Brown adipose tissue(BAT) mitochondria in a diet-induced obesity(fatness) paradigm.


## Acknowledgement

The authors are thankful to the management of G.D Goenka University, Gurugram, Haryana, for their valuable support.

## Funding

It was declared to be none.


## Conflict of interest

It was declared to be none.

## References


1. Torabally NB, Rahmanpoor HA. Nutraceuticals: Nutritionally functional foods an overview. Biomed J Sci Tech Res, 2019;15(4):11480–2.
2. Rajasekaran A, Sivagnanam G, Xavier R. Nutraceuticals as therapeutic agents: A review. Res J Pharm Technol, 2008;1(4):328–30.
3. Kramer K, Hoppe PP, Packer L, editors. Nutraceuticals in health and disease prevention. Boca Raton: CRC Press; 2001.
4. Maddi V, Aragade P, Digge V, Nitalikar M. Short review importance of nutraceuticals in health management. Phcog Rev, 2007;1(2).
5. Lozano R, Naghavi M, Foreman K, Lim S, Shibuya K, Aboyans V, et al. Global and regional mortality from 235 causes of death for 20 age groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet, 2012;380(9859):2095–128.
6. Gershon AS, Warner L, Cascagnette P, Victor JC, To T. Lifetime risk of developing chronic obstructive pulmonary disease: a longitudinal population study. Lancet, 2011;378(9795):991–6.
7. Salvi SS, Barnes PJ. Chronic obstructive pulmonary disease in non-smokers. Lancet, 2009;374(9691):733–43.
8. McGuinness AJ, Sapey E. Oxidative stress in COPD: sources, markers, and potential mechanisms. J Clin Med, 2017;6(2):21.
9. Sies H, Berndt C, Jones DP. Oxidative stress. Annu Rev Biochem, 2017;86(1):715–48.
10. Hogg JC, Timens W. The pathology of chronic obstructive pulmonary disease. Annu Rev Pathol, 2009;4:435–59.
11. Barnes PJ, Burney PG, Silverman EK, Celli BR, Vestbo J, Wedzicha JA, Wouters EFM. Chronic obstructive pulmonary disease. Nat Rev Dis Primers, 2015;1:15076.
12. Barnes PJ. Immunology of asthma and chronic obstructive pulmonary disease. Nat Rev Immunol, 2008;8(3):183–92.
13. Dillard CJ, German JB. Phytochemicals: nutraceuticals and human health. J Sci Food Agric, 2000;80(12):1744–56.
14. Das L, Bhaumik E, Raychaudhuri U, Chakraborty R. Role of nutraceuticals in human health. J Food Sci Technol, 2012;49:173–83.

15. Verma G, Mishra MK. A review on nutraceuticals: classification and its role in various diseases. Int J Pharm Ther, 2016;7(4):152–60.
16. Repine JE, Bast A, Lankhorst I; Oxidative Stress Study Group. Oxidative stress in chronic obstructive pulmonary disease. Am J Respir Crit Care Med, 1997;156(2):341–57.
17. Schwartz J, Weiss ST. Relationship between dietary vitamin C intake and pulmonary function in the First National Health and Nutrition Examination Survey (NHANES I). Am J Clin Nutr, 1994;59(1):110–4.
18. Grievink L, Smit HA, Ocké MC, van't Veer P, Kromhout D. Dietary intake of antioxidant (pro)-vitamins, respiratory symptoms and pulmonary function: the MORGEN study. Thorax, 1998;53(3):166–71.
19. Dow L, Tracey M, Villar A, Coggon D, Margetts BM, Campbell MJ, et al. Does dietary intake of vitamins C and E influence lung function in older people?. Am J Respir Crit Care Med, 1996;154(5):1401–4.
20. Britton JR, Pavord ID, Richards KA, Knox AJ, Wisniewski AF, Lewis SA, et al. Dietary antioxidant vitamin intake and lung function in the general population. Am J Respir Crit Care Med, 1995;151(5):1383–7.
21. Janoff A, Carp H, Laurent P, Raju L. The role of oxidative processes in emphysema. Am Rev Respir Dis, 1983;127(2 Pt 2):S31–8.
22. Stockley RA. Proteases and antiproteases. In: Chronic Obstructive Pulmonary Disease: Pathogenesis to Treatment: Novartis Foundation Symposium 234. Chichester (UK): John Wiley & Sons, Ltd; 2000. p. 189–204.
23. Bieth JG. The antielastase screen of the lower respiratory tract. Eur J Respir Dis Suppl, 1985;139:57–61.
24. Alvarado A, Arce I. Antioxidants in respiratory diseases: Basic science research and therapeutic alternatives. Clin Res Trials, 2016;3(1):1.
25. Bajaj D, Ballal S. A review on antioxidant activity of coffee and its additives. J Pharm Res Int, 2021;33(25B):77–85.
26. Muredzi P. Food is Medicine: An Introduction to Nutraceuticals. Saarbrücken: LAP Lambert Academic Publishing; 2013.
27. Holley AD, Osland E, Barnes J, Krishnan A, Fraser JF. Scurvy: historically a plague of the sailor that remains a consideration in the modern intensive care unit. Intern Med J, 2011;41(3):283–5.
28. Koike K, Ishigami A, Sato Y, Hirai T, Yuan Y, Kobayashi E, et al. Vitamin C prevents cigarette smoke–induced pulmonary emphysema in mice and provides pulmonary restoration. Am J Respir Cell Mol Biol, 2014;50(2):347–57.
29. Gorton HC, Jarvis K. The effectiveness of vitamin C in preventing and relieving the symptoms of virus-induced respiratory infections. J Manipulative Physiol Ther, 1999;22(8):530–3.
30. Chabot F, Mitchell JA, Gutteridge JM, Evans TW. Reactive oxygen species in acute lung injury. Eur Respir J, 1998;11(3):745–57.
31. Park HJ, Byun MK, Kim HJ, Kim JY, Kim YI, Yoo KH, et al. Dietary vitamin C intake protects against COPD: the Korea National Health and Nutrition Examination Survey in 2012. Int J Chron Obstruct Pulmon Dis, 2016:2721–8.
32. Nicks ME, O'Brien MM, Bowler RP. Plasma antioxidants are associated with impaired lung function and COPD exacerbations in smokers. COPD, 2011;8(4):264–9.
33. Rossman MJ, Groot HJ, Reese V, Zhao J, Amann M, Richardson RS. Oxidative stress and COPD: The impact of oral antioxidants on skeletal muscle fatigue. Med Sci Sports Exerc, 2013;45(7):1235.
34. National Asthma Education and Prevention Program. Expert panel report 2: guidelines for the diagnosis and management of asthma. Bethesda (MD): National Heart, Lung, and Blood Institute; 1998.
35. Moorman JE, Akinbami LJ, Bailey CM, Zahran HS, King ME, Johnson CA, et al. National surveillance of asthma: United States, 2001–2010. Vital Health Stat 3. 2012;(35):1–58.
36. Dozor AJ. The role of oxidative stress in the pathogenesis and treatment of asthma. Ann N Y Acad Sci, 2010;1203(1):133–7.
37. Riccioni G, Barbara M, Bucciarelli T, Di Ilio C, D'Orazio N. Antioxidant vitamin supplementation in asthma. Ann Clin Lab Sci, 2007;37(1):96–101.
38. Nakamura K, Wada K, Sahashi Y, Tamai Y, Tsuji M, Watanabe K, et al. Associations of intake of antioxidant vitamins and fatty acids with asthma in pre-school children. Public Health Nutr, 2013;16(11):2040–5.
39. Bodner C, Godden D, Brown K, Little J, Ross S, Seaton A; Aberdeen WHEASE Study Group. Antioxidant intake and adult-onset wheeze: a case–control study. Eur Respir J, 1999;13(1):22–30.
40. Harik-Khan RI, Muller DC, Wise RA. Serum vitamin levels and the risk of asthma in children. Am J Epidemiol, 2004;159(4):351–7.

41. Hernandez M, Zhou H, Zhou B, Robinette C, Crissman K, Hatch G, et al. Combination treatment with high-dose vitamin C and alpha-tocopherol does not enhance respiratory-tract lining fluid vitamin C levels in asthmatics. Inhal Toxicol, 2009;21(3):173–81.
42. Kurti SP, Murphy JD, Ferguson CS, Brown KR, Smith JR, Harms CA. Improved lung function following dietary antioxidant supplementation in exercise-induced asthmatics. Respir Physiol Neurobiol, 2016;220:95–101.
43. Cai Y, Li YF, Tang LP, Tsoi B, Chen M, Chen H, et al. A new mechanism of vitamin C effects on A/FM/1/47 (H1N1) virus-induced pneumonia in restraint-stressed mice. Biomed Res Int, 2015;2015:675149.
44. Castellani C, Cuppens H, Macek M Jr, Cassiman JJ, Kerem E, Durie P, et al. Consensus on the use and interpretation of cystic fibrosis mutation analysis in clinical practice. J Cyst Fibros, 2008;7(3):179–96.
45. Brown RK, Wyatt H, Price JF, Kelly FJ. Pulmonary dysfunction in cystic fibrosis is associated with oxidative stress. Eur Respir J, 1996;9(2):334–9.
46. Winklhofer-Roob BM, Ellemunter H, Frühwirth M, Schlegel-Haueter SE, Khoschsorur G, Van't Hof MA, et al. Plasma vitamin C concentrations in patients with cystic fibrosis: evidence of associations with lung inflammation. Am J Clin Nutr, 1997;65(6):1858–66.
47. Ahmad A, Shameem M, Husain Q. Altered oxidant-antioxidant levels in the disease prognosis of chronic obstructive pulmonary disease. Int J Tuberc Lung Dis, 2013;17(8):1104–9.
48. Ochs-Balcom HM, Grant BJ, Muti P, Sempos CT, Freudenheim JL, Browne RW, et al. Antioxidants, oxidative stress, and pulmonary function in individuals diagnosed with asthma or COPD. Eur J Clin Nutr, 2006;60(8):991–9.
49. Ji X, Yao H, Meister M, Gardenhire DS, Mo H. Tocotrienols: dietary supplements for chronic obstructive pulmonary disease. Antioxidants (Basel), 2021;10(6):883.
50. Burton GW, Ingold KU. β-Carotene: an unusual type of lipid antioxidant. Science, 1984;224(4649):569–73.
51. Handelman GJ, van Kuijk FJ, Chatterjee A, Krinsky NI. Characterization of products formed during the autoxidation of β-carotene. Free Radic Biol Med, 1991;10(6):427–37.
52. Mordi RC, Walton JC, Burton GW, Hughes L, Ingold KU, Lindsay DA. Exploratory study of β-carotene autoxidation. Tetrahedron Lett, 1991;32(33):4203–6.
53. Impellizzeri D, Talero E, Siracusa R, Alcaide A, Cordaro M, Zubelia JM, et al. Protective effect of polyphenols in an inflammatory process associated with experimental pulmonary fibrosis in mice. Br J Nutr, 2015;114(6):853–65.
54. Simioni C, Zauli G, Martelli AM, Vitale M, Sacchetti G, Gonelli A, et al. Oxidative stress: role of physical exercise and antioxidant nutraceuticals in adulthood and aging. Oncotarget, 2018;9(24):17181.
55. Tabak C, Arts IC, Smit HA, Heederik D, Kromhout D. Chronic obstructive pulmonary disease and intake of catechins, flavonols, and flavones: the MORGEN Study. Am J Respir Crit Care Med, 2001;164(1):61–4.
56. Lago JH, Toledo-Arruda AC, Mernak M, Barrosa KH, Martins MA, Tibério IF, et al. Structure-activity association of flavonoids in lung diseases. Molecules, 2014;19(3):3570–95.
57. Amer A. Biotechnology approaches for in vitro production of flavonoids. J Microbiol Biotechnol Food Sci, 2018;7(5):457.
58. Pajuelo D, Quesada H, Díaz S, Fernández-Iglesias A, Arola-Arnal A, Bladé C, et al. Chronic dietary supplementation of proanthocyanidins corrects the mitochondrial dysfunction of brown adipose tissue caused by diet-induced obesity in Wistar rats. Br J Nutr, 2012;107(2):170–8.
59. Lee T, Kwon HS, Bang BR, Lee YS, Park MY, Moon KA, et al. Grape seed proanthocyanidin extract attenuates allergic inflammation in murine models of asthma. J Clin Immunol, 2012;32:1292–304.

**How to cite this article:** Malik J, Rani N, Devi M. Nutraceutical's Role of Dietary Antioxidants in Pulmonary and Respiratory Diseases. Pharma Research Bulletin, 2025;4(1):35-44.