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Chronic obstructive pulmonary disease: Plant-based remedies

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Abstract
Chronic Obstructive Pulmonary Disease (COPD) is a prevalent lung condition characterized by airflow limitation, primarily caused by smoking and environmental exposures. Current treatments focus on man0061ging symptoms and slowing disease progression, but plant-based remedies offer promising therapeutic potential. This review explores the mechanisms and benefits of various plant-based compounds, including Curcumin, ginger, garlic, and thyme, in reducing inflammation, oxidative stress, and bronchoconstriction associated with COPD. These natural compounds target multiple pathways, offering multi-targeted therapeutic benefits. Curcumin has anti-inflammatory and antioxidant properties, while ginger's antioxidant characteristics may help prevent illnesses linked to inflammation. Garlic's immunomodulatory and antioxidant effects also show potential in reducing COPD symptoms. Thyme has been traditionally used to treat respiratory conditions, including bronchitis and whooping cough. Understanding the mechanisms of these plant-based remedies can provide valuable insights into their therapeutic potential and safety profiles.

Keywords: COPD, bronchodilators, asthma, anti-inflammatory agents, thyme

1. Introduction
One prevalent lung condition that is detrimental to human health is chronic obstructive pulmonary disease (COPD). In 2020, COPD from the fourth most common cause of death globally to the third [1]. Now, COPD is the third most common cause of death worldwide, with a frequency of 10.1%. It affects individuals in low-income, middle-class, and wealthy countries [2]. Because many viruses and toxic substances from the environment are easily breathed, chronic respiratory disorders are a serious global health concern. These diseases include interstitial lung disease, pulmonary sarcoidosis, bronchial asthma, pulmonary TB, chronic obstructive pulmonary disease (COPD), and pneumoconiosis, which includes asbestosis and silicosis [3, 4]. COPD is caused by a prolonged inhalation of irritants and chemicals, which damages the lungs alveolar structures and causes chronic airway inflammation. This leads to diseases including emphysema, chronic bronchitis, and chronic bronchiolitis. Edema, peribronchiolar fibrosis, increased smooth muscle, submucosal inflammatory cell infiltration, hyperplasia and hypertrophy of mucus-secreting glands in big airways are all linked to chronic bronchitis [5]. Acute bronchitis and chronic obstructive pulmonary diseases (COPD), which include emphysema, chronic asthma, and chronic bronchitis, are examples of lung inflammatory disorders. Specifically, COPD ranks as the sixth most common cause of mortality globally [6]. Chronic obstructive pulmonary disease (COPD) and asthma are distinguished as distinct illnesses with distinct characteristics and processes. Asthma is an anti-inflammatory condition that can strike children and adults alike. It is distinguished by hyperactive reactivity of the airways, which results in reversible inhibition of the airways [7]. Although it is challenging to characterize clinically, testing of small airway function (i.e., in airways of 2 mm diameters or less) may be able to identify chronic bronchiolitis, which is defined as the presence of an inflammatory response in the respiratory bronchioles. In emphysema, the alveolar wall is destroyed, air gaps expand, and elastic recoil is lost [8].

2. Pathophysiology of COPD
The pathophysiology of this disease demonstrates that the loss of the lungs parenchyma and small airways, which results in imbalance issues between the lung's protease and antiprotease, is the cause of airflow restriction.

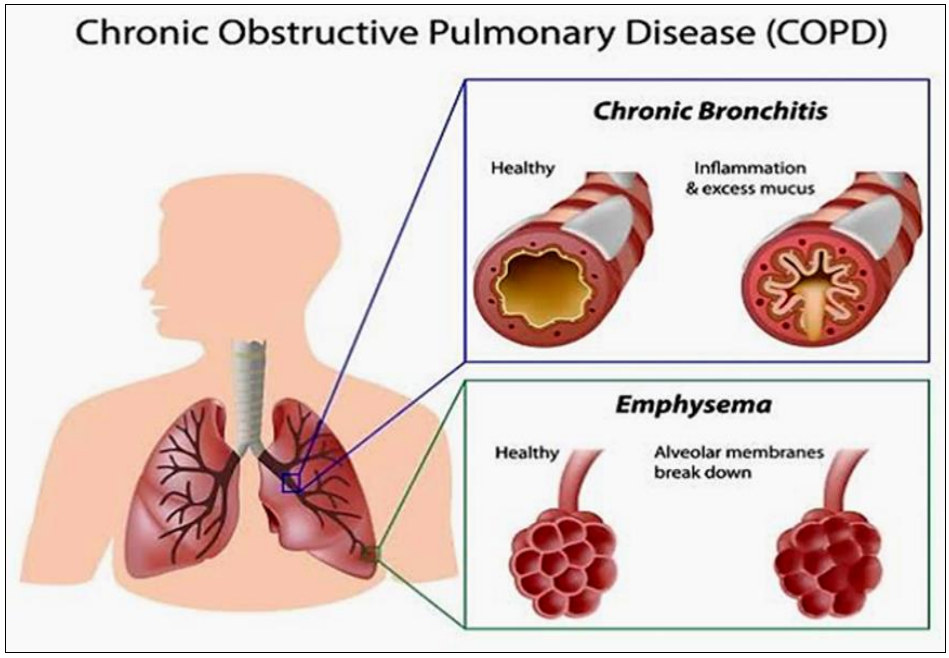

Fig 1: Chronic Obstructive Pulmonary Disease (COPD) [8]

The disease is divided into four stages, such as Stage 1: Mild COPD, Stage 2: Moderate COPD, Stage 3: Severe COPD, Stage 4: Very Severe COPD. Patients with COPD frequently experience symptoms like wheezing, shortness of breath, and whooping cough. Preventing the progression of the sickness, preserving symptoms, and enhancing the exercise tolerance test (ETT) are some methods for managing the condition. The first and most important step is to stop smoking. Beta-agonists, corticosteroids, methylxanthines like theophylline, and anticholinergics are used to treat this illness. Lung infections and air pollution are two of the biggest obstacles to preventing disease outbreaks [9]. Tremors, osteoporosis and fractures, electrolyte imbalances, elevated heart rates, and cardiac impacts are some of the side effects of these medications [10].

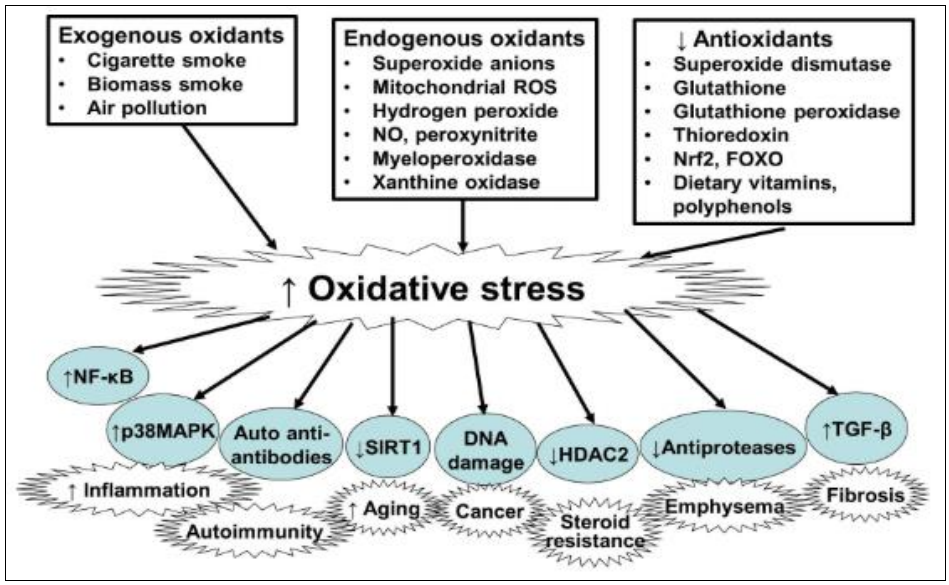

Fig 2: Increased oxidative stress in COPD and its consequences [13].

2.1 Chemokines

In COPD, chemokines are essential for drawing inflammatory cells from the bloodstream to the lung [15]. Eotaxins facilitate the growth of eosinophils in the bone marrow and their subsequent migration to the interstitium and lung mucosa. These chemokines work by activating the chemokine receptor CCR3, which is found in large numbers in eosinophils and causes them to be specifically drawn to inflammatory lung tissue [16]. Reduce pro-inflammatory cytokines and chemokines, improving lung function overall [17]. Increases in leukocytes (especially neutrophils, macrophages, CD8-T, and Th17 lymphocytes), airway epithelial cells, and fibroblasts in different lung regions are linked to the aforementioned COPD symptoms. After being activated by persistent irritants or toxins, these inflammatory cells release a range of mediators that can harm lung structures, including leukotriene (LT) B4, interleukin (IL)-8, tumor necrosis factor-α (TNF-α), interferon-γ (INF-γ), transforming growth factor beta (TGF-β), chemokines like CC (cysteine cysteine) and CXC (two N-terminal cysteines separated by one amino acid), neutrophil

elastase (NE), and matrix apolipoproteins (MMP)-2, 9, and 12. The pathophysiology of COPD also involves several additional mechanisms, such as an imbalance of proteinases and anti-proteinases in the lungs [5].

3. Plant based remidies for COPD

Impairment is the Siddha name for *Acalypha indica* L. (Euphorbiaceae). Because of its therapeutic qualities, SSM uses Acalypha indica's leaves, roots, stem, and flowers. Respiratory ailments are cured by leaf powder. It also has antibacterial, emetic, anodyne, hypnotic, expectorant, cathartic, anthelmintic, and wound-healing qualities [8].

3.1 Turmeric (*curcumin*)

"The Indian Solid Gold" *curcumin* is known by the common names haldi, arishia, pasupu, haridra and kurkum [20]. *Curcumin*, also known as 1, 7-bis (4-hydroxy-3-methoxyphenyl)-1, 6-hepta-diene-3, 5-dione, is a chemical compound with anti-inflammatory, anti-oxidant, and anti-tumor properties [21, 22]. *Curcumin's* anti-inflammatory qualities are thought to be the foundation of its many biological actions and are crucial in the management of illnesses. The rhizome of *Curcuma longa L.* (*Turmeric*) of the Zingiberaceae and the root tuber of *Curcuma* aromatica Salisb are the primary sources of *curcumin*. These traditional Chinese medications, which have been used for a long time in China to treat pain, inflammation, and other illnesses, increase blood flow and eliminate blood stasis. A popular spice in India, *turmeric* has been used in Ayurveda to treat inflammatory conditions [23]. Due to its strong anti-inflammatory properties, *curcumin* has been the subject of several preclinical and clinical studies. Of these, research hotspots have focused on inflammatory bowel disease, arthritis, psoriasis, depression, atherosclerosis, and COVID-19. According to available data, *curcumin* effectively lowers inflammatory mediator levels, and its anti-inflammatory qualities may help treat various diseases (Figure 3) [24].

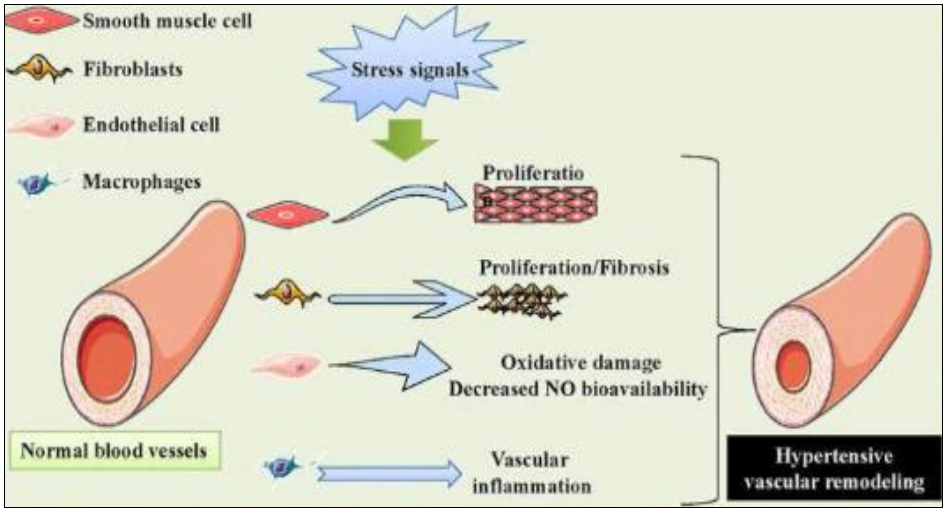

Fig 3: Benefits of *curcumin* in various conditions [25].

3.2 Ginger

The rhizome of *ginger (Zingiber officinale)* has long been utilized as a medicinal herb. The chemical components of ginger are known to have positive health effects, including anti-inflammatory and antioxidant properties that may also function as Immunomodulators [26]. Ginger's strong antioxidant characteristics add to its medicinal benefits. One of the main causes of inflammation and a contributing factor to the etiology of many chronic inflammatory illnesses is oxidative stress, which is defined by an excess of reactive oxygen species (ROS). Ginger and its active components have been shown in numerous studies to have anti-inflammatory qualities, which may help prevent illnesses linked to inflammation [27].

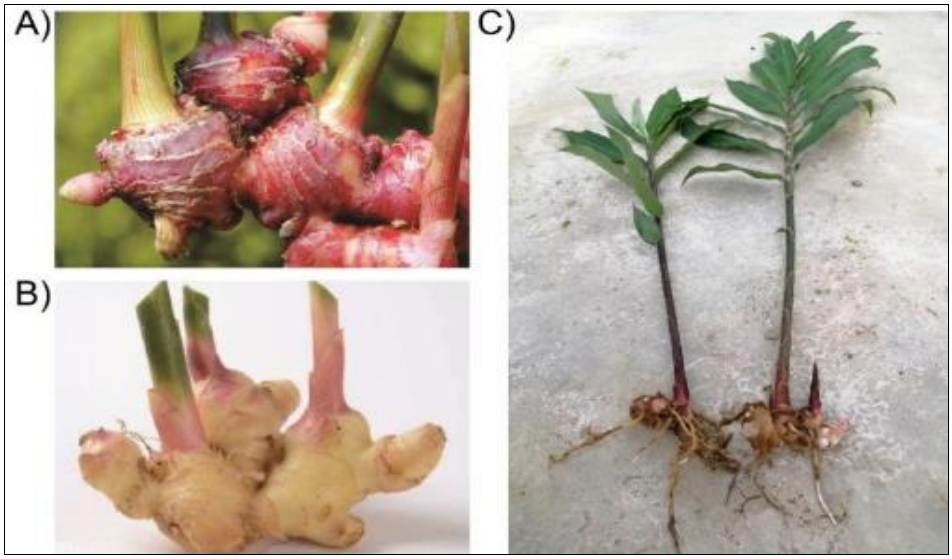

Fig 4: Ginger [28]

3.3. Garlic (*Allium sativum*)

Allium sativum, or garlic, is among the earliest plants. For more than 4,000 years, it has been utilized as a spice, food, and traditional medicine [29]. Age *Garlic* Extract (AGE) compounds effects on human health were primarily examined in terms of immunomodulation and antioxidant qualities. This information has important applications, especially for conditions like inflammatory bowel disease (IBD), which is marked by substantial inflammatory processes [30]. Garlic is a useful therapy in ancient Indian medicine that can be used as a tonic, roborans, to treat rheumatism, cough, skin conditions, hemorrhoids, and general weakness. Also, garlic emulsion can be applied to reduce inflammation in the muscles [31]. In several cultures, *garlic* (*Allium sativum* L.) has gained recognition as a preventative and curative medicinal herb. Throughout history, garlic has been used for both medical and nutritional purposes [32].

Fig 5: *Garlic bulbs* [33].

3.4 Thyme (*Thymus vulgaris* L.)

In traditional medicine, thyme has long been used to cure a variety of diseases. For example, it can be used to treat respiratory conditions including asthma, bronchitis, and whooping cough by inhaling steam or preparing tea, tincture, syrup, or ointment [34].

Fig 6: *Thyme* (*Thymus vulgaris* L) [28].

4. Mechanisms of action

Plant-based remedies act through multiple pathways that target the inflammation, oxidative stress, and bronchoconstriction involved in COPD pathophysiology. These natural compounds offer multi-targeted therapeutic benefits [29].

4.1 Anti-inflammatory agents

Apart from corticosteroids, a number of bioactive moieties derived from plants have shown encouraging anti-inflammatory properties that could be helpful in the treatment of COPD. Preclinical studies have demonstrated the anti-inflammatory qualities of substances including resveratrol, *curcumin*, and quercetin. Nano-formulation techniques can assist these delicate bioactive ingredients reach the inflammatory lung tissue more quickly, prevent their breakdown, and improve the effectiveness of COPD treatments].

4.2 Antioxidants

One of the main causes of COPD is oxidative stress, which results in inflammation and tissue damage. Antioxidants, both endogenous and exogenous, can reduce oxidative damage and neutralize free radicals [14]. Numerous antioxidants produced from plants, including quercetin from fruits and vegetables and epigallocatechin gallate (EGCG) from green tea, have demonstrated potential in lowering oxidative stress linked to COPD. By increasing the stability and bioavailability of antioxidants, nano-formulations can enhance their protective effects and facilitate more efficient delivery to the lungs [38].

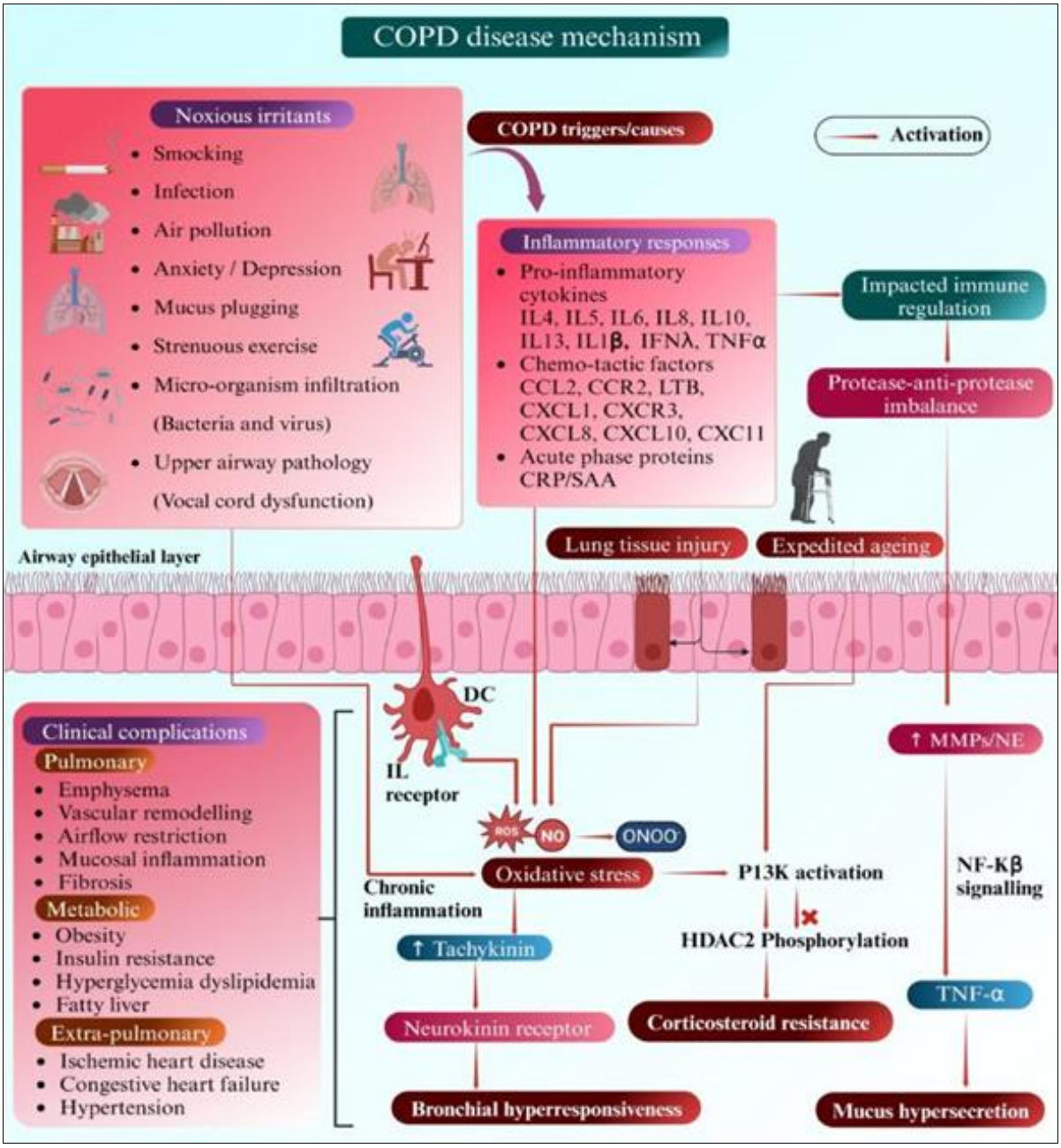

Fig 7: Mechanism of COPD disease [35].

4.3 Bronchodilators

Because they improve airflow and relieve bronchoconstriction, bronchodilators are a crucial component of COPD treatment. The two main bronchodilator kinds used to treat COPD are β-agonists and anticholinergics. Formoterol and salbutamol are examples of β-agonists that relax the smooth muscles around the airways to produce Broncho dilation [39]. While long-acting bronchodilators may have a longer beginning of action and may not be suitable for immediate relief during acute exacerbations, short-acting bronchodilators only provide relief for a short period of time and require repeated administration, beta-agonists can also cause tremors, an increase in heart rate, and palpitations, and anticholinergics can cause dry mouth, constipation, and urine retention [40].

5. Safety of medicinal plants and herbal medicines used in traditional medicine

Because of their extensive history of use in the treatment of disease and the information that has been gathered over many generations, plants used in traditional medicines have generally been regarded as safe. Because therapeutic plants are carefully chosen for use, poisonous fatalities have been uncommon in many cultural contexts [41]. Despite the fact that thousands of people die every year from even ostensibly "safe" over-the-counter medications, deaths or hospitalizations brought on by herbs are extremely uncommon; not even the US National Poison Control Centers have a section in their database dedicated to adverse herb responses [42]. Traditional medicines are typically considered safe when taken as food supplements, nutritional supplements, or medications. Nonetheless, there have been cases where both humans and animals have had negative side effects linked to the use of herbal remedies [43].

6. Conclusion

Plant-based remedies offer a promising avenue for managing COPD symptoms and slowing disease progression. The reviewed compounds, including *curcumin*, *ginger*, *garlic*, and *thyme*, demonstrate therapeutic potential through their anti-

inflammatory, antioxidant, and bronchodilatory effects. These natural compounds can target multiple pathways, providing multi-targeted benefits. While traditional medicines are generally considered safe, it is essential to acknowledge potential side effects and interactions. Further research is needed to fully understand the mechanisms and safety profiles of these plant-based remedies. However, their therapeutic potential makes them an attractive adjunctive treatment option for COPD patients. By exploring these natural compounds, we can develop more effective and comprehensive treatment strategies for this debilitating disease.

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