# Role of Indian Herbal Medicine in the Treatment of Pulmonary Diseases

3

M. Ovia, M. Yasasve, and L. Ansel Vishal

**Abstract**

Pulmonary diseases such as asthma, chronic obstructive pulmonary disease, lung cancer, cystic fibrosis, pulmonary hypertension, pneumonia, pleurisy, sarcoidosis, and pulmonary embolism cause severe respiratory difficulties and can even be fatal without proper treatment. Although several chemical drugs are available for the treatment of pulmonary diseases, these drugs cause severe side effects and are not completely efficient. Herbal medicine is a suitable alternative with lesser side effects and can be used for the treatment of pulmonary diseases. Several herbal plants such as *Allium sativum, Crataegus rhipidophylla, Moringa oleifera, Salvia miltiorrhiza, Terminalia arjuna, Withania somnifera* can be used for the treatment of pulmonary diseases. Apple polyphenol, ligustrazine, salidroside, Resveratrol, quercetin are some examples of phytochemicals which exhibit characteristics with the potential to modulate the symptoms of pulmonary diseases. These herbal plants and phytochemicals undergo various mechanisms such as decreasing proliferation of epithelial cells, reducing oxidative stress, anti-inflammation, inhibiting proliferation of tumor cells, vasodilation, reducing bronchial constrictions, etc., to reduce the progression of pulmonary diseases. The different types of medicinal plants and phytochemicals which can be used to treat

M. Ovia
Department of Biotechnology, Anna University, Chennai, Tamil Nadu, India

M. Yasasve
Department of Biotechnology, Sri Venkateswara College of Engineering (Autonomous – Affiliated to Anna University), Sriperumbudur, Tamil Nadu, India

L. Ansel Vishal (✉)
Department of Biotechnology, Sree Sastha Institute of Engineering and Technology (Affiliated to Anna University), Chennai, Tamil Nadu, India
e-mail: vicchuansel@gmail.com



K. Dua et al. (eds.), *Medicinal Plants for Lung Diseases*,
https://doi.org/10.1007/978-981-33-6850-7_3

pulmonary diseases along with their mechanisms will be discussed in detail in this chapter.

**Keywords**

Pulmonary diseases · Herbal medicine · Phytochemicals · Respiratory difficulties

## 3.1 Introduction

Respiratory medicine is a fast-growing field with a vital emphasis and desire for continuous technological developments. The key explanation for this may be pulmonary diseases which are the primary causes of morbidity and death worldwide [1]. World Health Organization (WHO) estimates that some 235 million people are afflicted by asthma found generally in children and about three million people die from Chronic Obstructive Pulmonary Disease (COPD) adding 6% of the world's total death rate. It is also predicted that COPD will become the third major contributor to death by 2020 [2]. Pollution and low quality of life are the main reasons for the widespread growth of pulmonary diseases. Similarly, lung cancer is now an emerging high-mortality condition. The disease has been identified with approximate mortality of 2.09 million [3]. With the latest COVID-19 pandemic, a respiratory-based disease caused more than 12,00,000 deaths and continuing to increase [4]. This type of current scenario seeks the need to obtain a higher rate of prevention and treatment for pulmonary diseases.

As a compendium of medicinal substances, traditional plants have grown to play a leading role in maintaining human health since ancient times [5, 6]. Good immunomodulatory, anti-oxidant, antibacterial, antidiabetic and anti-cancer functions are known to have been exhibited by several Indian herbal plants [7, 8]. In medicinal drugs, the method of using green extracts and phytoconstituents, each with their known properties, can be of utmost significance. In recent times, several treatment interventions have been adopted for many years in different countries to explain the efficacy and relevance of these medicinal compounds synthesized in the secondary metabolism of the medicinal herb [9]. As per the latest WHO reports, eighty percent of the world's population relies predominantly on traditional medicines [10]. In Ayurveda, a mixture of different medicinal plants is offered to a person for the treatment of the disease in a specific ratio (a polyherbal formulation). Recently, herbal formulations have gained a lot of significance and increased global interest [11]. In the treatment of asthma, malignant tumors, diabetes mellitus, obesity, etc., different formulations such as *Kanchnar guggulu*, *Chandraprabha vati,* and *Trayodashang guggulu* have been successfully used [12–14]. This chapter thus aims to review the broad classification of pulmonary diseases and the advancements in the field of traditional medicine in treating them. Furthermore, the various types of herbal plants, formulations, and phytoconstituents currently being used in the treatment of respiratory ailments would be discussed in detail.

## 3.2 Classification of Pulmonary Diseases

Pulmonary disease is a type of illness affecting the lungs and other areas of the respiratory system. Lung infections may be caused by microbes, chewing cigarettes, inhaling tobacco smoke, asbestos, or other air pollutants. Chronic obstructive pulmonary disease (COPD), lung cancer, pulmonary embolism, hypertension are some examples of pulmonary diseases [15]. Pulmonary diseases are broadly classified into three categories mainly: (1) lung airway diseases, (2) lung circulatory diseases, and (3) lung tissue diseases.

### 3.2.1 Lung Airway Diseases

These diseases affect the airway channels that hold oxygen ($O_2$) as well as other gases in and out of the lungs. They typically lead to the airway passage shortening and obstruction. Chronic obstructive pulmonary disease (COPD) is considered a widespread airway disease related to exhalation problems and breathing restriction due to alveoli defects typically caused by greater exposure to harmful particles (e.g. cigarette smoke) [16]. Important variability in symptoms, disease development, pathogenesis, lung pathology, and treatment response are mostly observed in COPD patients (Table 3.1). There are mainly three types of COPD issues which include: (1) asthma, (2) emphysema, and (3) chronic bronchitis.

#### 3.2.1.1 Asthma

Asthma is an illness in which the air sacs close and enlarge and can induce mucus in the lungs (Fig. 3.1a). This will make it extremely difficult to breathe, cause cough, wheezing (a howling noise as you exhale), and breathlessness [18]. Asthma is the mainly prevalent debilitating condition in children. It can occur at any age but is probably more frequent in children than in adults. It is important to obtain immediate treatment if the infant begins to develop asthma since it can be potentially fatal [19]. Your physician can advise you on several of the appropriate ways of treating your condition. However, it is a chronic condition lifelong for many individuals. Exposure to numerous allergens and pollutants (e.g. pollen grains, fine dust particles, smoke) that cause allergic reactions can elicit early symptoms of asthma [20].

**Table 3.1** Factors responsible for causing variations in chronic obstructive pulmonary disease [17]

| S. No. | Factors contributing | Example |
|---|---|---|
| 1. | Risk factors | Smoking, pollution, genetic susceptibility |
| 2. | Inflammation patterns | Lung irritation, systematic inflammation |
| 3. | Lung pathology | Airway abnormalities, parenchymal destruction |
| 4. | Clinical manifestation | Dyspnea, exacerbation, comorbidities |
| 5. | Airflow limitation | Difficulty in breathing, exercise restriction |

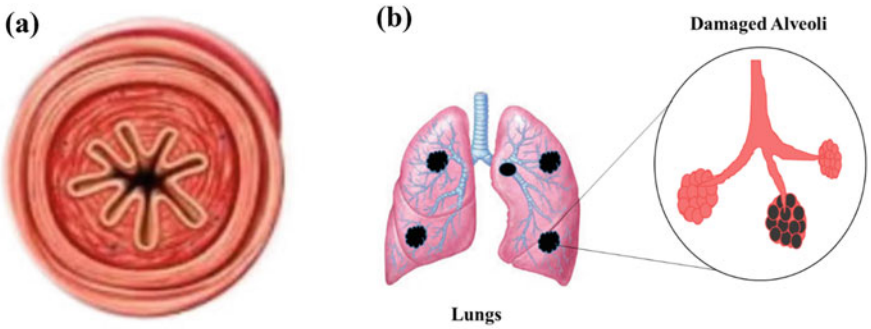


**Fig. 3.1** (**a**) Airway of asthma individual (**b**) Lungs condition during emphysema

#### 3.2.1.2 Emphysema

Emphysema is a respiratory illness that makes breathing difficult. Airbags in the lungs, i.e., alveoli sacs are impaired in people with emphysema (Fig. 3.1b). The interior walls of the airbags will deteriorate and break (creating wider air gaps instead of many smaller ones) over some time [21]. This decreases the surface area of your lungs in-turn reducing the amount of oxygen that enters your blood-stream. As you exhale, the weakened alveoli will not function properly and old air will become blocked, leaving no space for fresh, oxygen-rich air to inhale inside. Prolonged exposure to airborne allergens is the primary cause of emphysema, which includes dust, chemical smoke, tobacco smoke, and other airborne pollutants [22].

#### 3.2.1.3 Chronic Bronchitis

Chronic bronchitis is an inflammatory disease and discomfort of the bronchial channels. These channels are the airways that take air in and out of the airbags in your lungs. The inflammation of the pathways triggers the secretion of mucus. This mucus and the inflammation of the tubes make it difficult for the lungs to pump in $O_2$ and $CO_2$ out of the body (Fig. 3.2). Chronic bronchitis seems to be a more serious illness that progresses across time rather than occurs unexpectedly [23]. Cigarette smoke is a significant cause of chronic bronchitis. When tobacco smoke is inhaled into the lungs, it irritates the air passages and produces mucus. Individuals who are exposed for a long period to other factors that irritate their lungs, such as toxic fumes, pollen, and other pollutants, can also experience persistent bronchitis [24].

### 3.2.2 Lung Circulatory Diseases

Lung circulatory disease is an illness that damages the blood vessels (e.g. clotting, inflammation) in the path between the heart and the lungs. Blood flows from the heart towards the lungs and back to the heart. This mechanism constantly floods the blood with oxygen, allowing carbon dioxide to be exhaled. Any portion of the blood

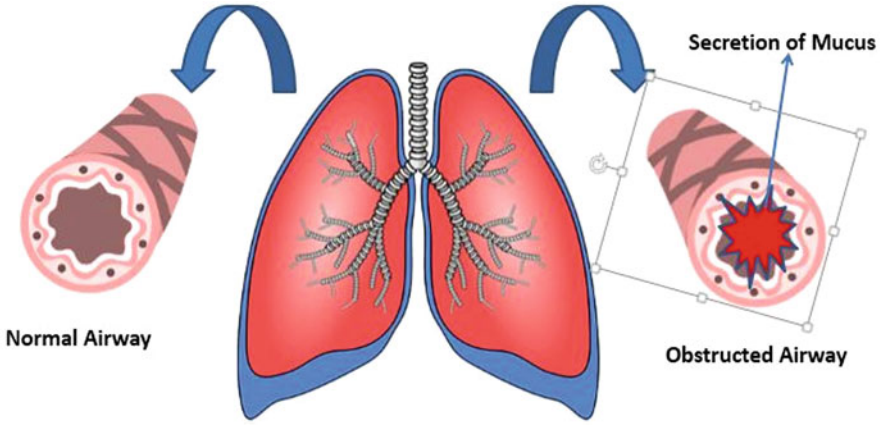


**Fig. 3.2** Diagrammatic representation of mucus secretion in bronchial channels

circulation between the lung and heart may be compromised or blocked, leading to lung circulation diseases [25].

#### 3.2.2.1 Pulmonary Hypertension

Individual sufferings from pulmonary arterial hypertension (PAH) have elevated blood pressure in the arteries that pass from your heart towards the lungs. The small arteries in your lungs are shortened or obstructed in this condition. It is difficult for the blood to flow thereby increasing the blood pressure in the lungs [26]. The heart needs to work harder to pump blood into these vessels and the heart muscle will get sluggish for a while. Eventually, this prolonged condition will lead to a heart attack in severe cases. Chest pain and tiredness are the early symptoms of PAH. Elevated levels of blood pressure in the pulmonary veins (channels carrying blood away from the lungs, to the heart) cause pulmonary venous hypertension (PVH). It is one of the most often caused due to congestive heart failure that damages heart mitral valves [27].

#### 3.2.2.2 Pulmonary Embolism (PE)

A disease in which the arteries in the lungs are impaired by a blood clot. Most of the time, pulmonary embolism is caused by blood clots that migrate from the legs or occasionally other areas of the body also known as deep vein thrombosis. PE develops as deep venous thrombi break and embolize into the circulatory system [28]. Pulmonary vascular occlusion occurs which impairs the exchange and distribution of oxygen. In the lungs, the lower lungs are more commonly affected than the upper lungs, although bilateral lung involvement is normal. Symptoms include shortness of breath, chest pain, and coughing. Prompt surgery to break up the clot dramatically or administration of blood thinners (anti-coagulants) decreases the risk of death [29].

### 3.2.3 Lung Tissue Diseases

This disease type mainly impacts the composition of the lung tissue. Bruising or inflammation of the tissue renders the lungs unable to completely expand to its full extend. This makes it impossible for the lungs to take oxygen and release carbon dioxide [30]. Examples of certain lung tissue diseases include sarcoidosis and cystic fibrosis.

#### 3.2.3.1 Cystic Fibrosis

An autosomal recessive disorder is cystic fibrosis. It is associated with mutations of the cystic fibrosis transmembrane conductance regulator gene. The most common mutation is the removal of phenylalanine at codon 508, termed as ΔF508. The cells which produce mucus, sweat, and digestive juices are affected by cystic fibrosis [31]. These fluids are induced to become thick and sticky, which blocks the various ducts passages. Symptoms vary, from cough, frequent respiratory infections, weight failure, and heavy stools. You have problems clearing mucus out of your bronchi in the particular individual suffering from this disease which leads to recurrent infection of lungs [32].

#### 3.2.3.2 Sarcoidosis

Sarcoidosis is a condition characterized by the proliferation of any portion of your body with tiny colonies of inflammatory cells (granulomas), most frequently the lungs and lymph nodes. The cause of sarcoidosis is unclear, but doctors agree that it arises from reacting to an unknown material from the body's immune system [33].

Literature sources indicate that in genetically predisposed persons, infectious agents, contaminants, dust, and a possible pathological response to the body's proteins (self-proteins) may be responsible for the development of granulomas [34]. The early symptoms of sarcoidosis include fatigue, swollen lymph nodes, and weight loss [35]. The four stages of pulmonary involvement are based on the disease's radiological detection, which is beneficial for prognosis (Fig. 3.3).

### 3.2.4 Other Pulmonary Diseases

COVID-19 is a lung disease caused by a novel coronavirus (SARS CoV-2) first identified at the end of 2019. COVID-19 is mainly a lung respiratory disease leading to secretion of fluid in the air sacs restricting their ability to consume oxygen, eventually contributing to symptoms such as breathlessness, cough, etc. [36]. In pneumonia, the lungs are filled with fluid and inflamed, leading to breathing difficulty. For certain patients, respiratory issues can become bad enough to require treatment with oxygen or even a ventilator in the hospital. Although most people recover from pneumonia without significant lung injury, pneumonia associated with COVID-19 can be serious. Also after the illness has passed, lung damage may lead to respiratory problems that can take months to recover [37]. Pneumonia caused by COVID-19 continues to hold in both lungs. Airbags in the lungs are filled with fluid

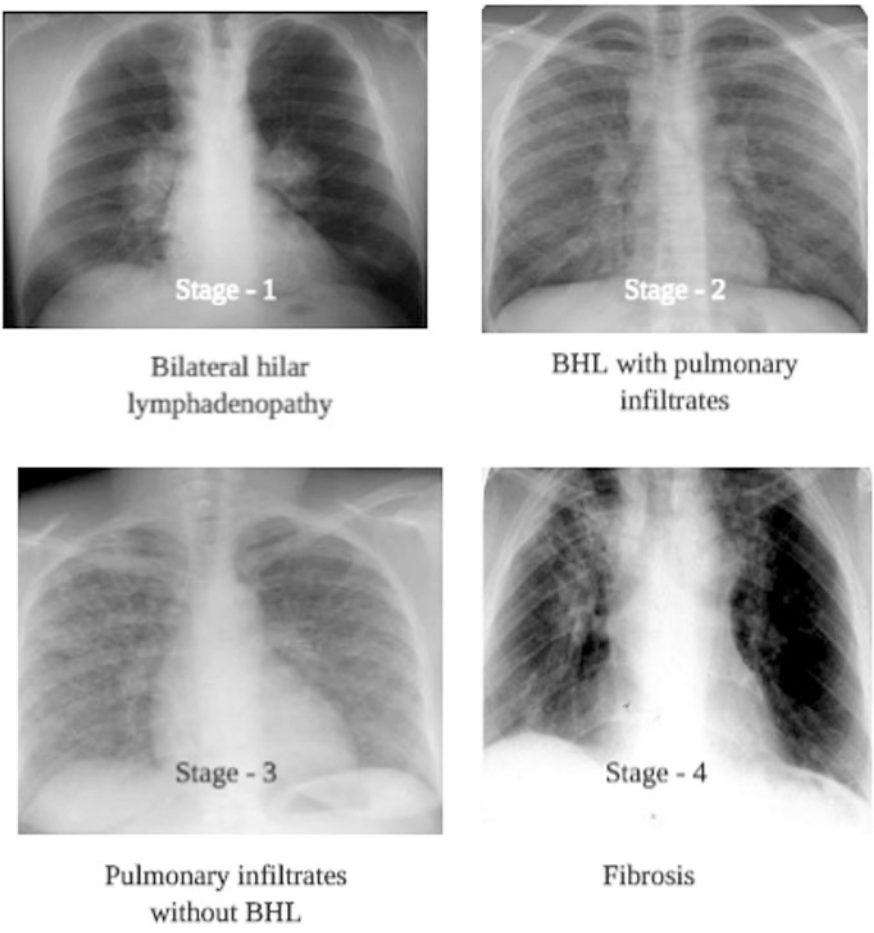


**Fig. 3.3** Different stages of sarcoidosis in radiological detection

(Fig. 3.4), restricting their capacity to take oxygen completely leading to acute respiratory distress syndrome (ARDS), a form of lung failure [38].

## 3.3 Indian Herbal Medicine Involved in Treatment of Pulmonary Diseases

### 3.3.1 Asthma

*Aleurites moluccana* also known as candlenut tree dispersed in various parts of the country has been traditionally used for the treatment of asthma, pain, fever, and headaches. This can be attributed to its various properties such as anti-nociceptive,

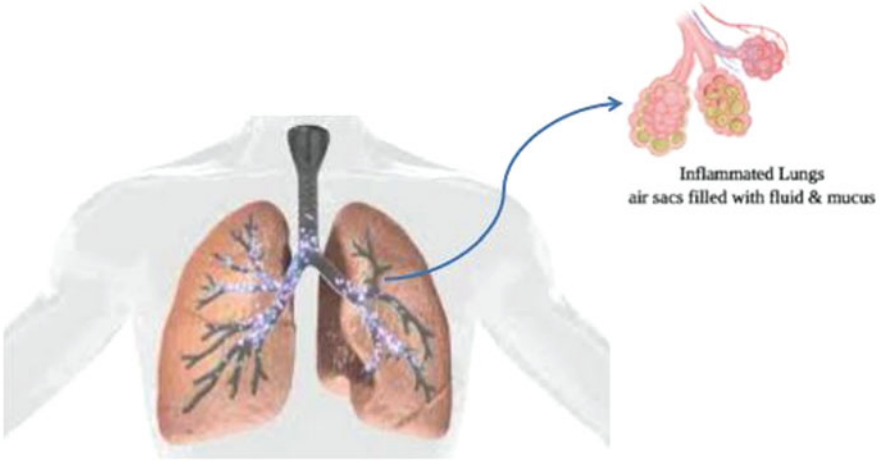


**Fig. 3.4** Pneumonia associated with COVID-19

anti-viral, anti-microbial, and anti-hypersensitivity [39]. A dried leaf extract prepared from *A.moluccana* into a semisolid herbal medicine exhibited analgesic, anti-inflammatory, and wound healing effects in the pre-clinical studies shows promise as a phytomedicine which can be used for the treatment of asthma [40]. *Nigella sativa* (Black cumin) extracts display a wide range of therapeutic properties such as anti-oxidant, anti-inflammatory, antihistaminic, anti-allergic, anti-tussive, immunomodulatory, and bronchodilatory properties. Clinical studies indicate that administration of *N. sativa* seed, boiled extract, or oil alleviated asthma symptoms in patients [41]. *Aerva lanata* (mountain knotgrass) is a common weed abundantly found in the warmer plain terrain in the country. Its ethanol extract shows anti-asthmatic potential through catalepsy and mast cell degranulation [42]. *Bacopa monnieri* (Brahmi) is another medicinal plant capable of stabilizing mast cells [43]. The extracts obtained from different parts of medicinal plants such as leaves, stem bark, and roots of *Cassia sophera* (Kasaunda), *Casuarina equisetifolia* (Whistling Pine), *Clerodendrum Serratum* (Bharangi), *Bauhinia variegate* (Rakta Kanchnar) exhibit anti-asthmatic potential against the immune responses such as histamine induced bronchial and trachea constriction, clonidine induced catalepsy, milk induced leukocytosis, and eosinophilia which plays a vital role in aggravating asthma symptoms as tested in animal models [44, 45].

### 3.3.2 Chronic Obstructive Pulmonary Disease

*Solanum nigrum* (Manathakkali) has been traditionally used as a Siddha medicine and its leaves and fruits have also been widely consumed as a food ingredient in India. Its leaf extracts can inhibit swelling caused by an inflammatory response. A

glycoprotein isolated from *S. nigrum* was found to inhibit the synthesis of pro-inflammatory compounds by interfering with the DNA binding of NF-kB and AP-1. The ethanolic extract of *Boerhavia diffusa* (Punarnava) was found to reduce the levels of nitric oxide and superoxide which have a major role in the pathogenesis of COPD. It also exhibits spasmolytic, anti-microbial, and cytoprotective activities [46]. Clinical trials involving the administration of two Indian herbal medicine Vasadi syrup and Shwasaghna dhuma to patients diagnosed with COPD as two trial groups showed vast improvements in their COPD symptoms as well as $FEV_1$%. The constituents of Vasadi syrup are *Justicia adhatoda* (Vasa), *Curcuma longa* (Haridra), *Coriandrum Sativum* (Dhanyaka), *Clerodendrum Serratum* (Bharangi), *Tinospora cordifolia* (Guduchi), *Zingiber officinale* (Shunthi), *Solanum virginianum* (Kantakari), *Piper longum* (Pippali) in equal parts. Contents of Shwasaghna dhuma are powder of seeds of *Solanum virginianum* (Kantakari), dry leaves of *Datura stramonium* (Dhatura), *Trachyspermum ammi* (Ajwain), seeds of *Hyoscyamus niger* (Khurasani ajwain), Potassium Nitrate (Kalmi shora), *Curcuma longa* (Haridra), *and Cannabis sativa* (Bhanga) in equal parts [47].

#### 3.3.2.1 Chronic Bronchitis

*Ocimum sanctum* (Tulsi) traditionally used as a medicine can be used for the treatment of bronchitis as well as bronchial asthma. It displays several therapeutic properties such as anti-microbial, analgesic, antispasmodic, adaptogenic which can be attributed to Eugenol, the active compound present in Tulsi [48]. Clinical studies carried out in bronchitis patients in a double-blind, randomized, placebo-controlled manner by the administration of a mix of thyme fluid extract and primrose root tincture resulted in a decrease in bronchitis symptoms as well as the duration of bronchitis [49]. *Hedera helix* (Ivy) leaf extract was also found to alleviate the symptoms of chronic bronchitis in some studies [50]. Nigellone, a phytochemical isolated from *Nigella sativa* (Black cumin) was found to exhibit antispasmodic and facilitating respiratory clearance while thymoquinone another phytochemical did not show the same effect [51].

#### 3.3.2.2 Emphysema

Curcumin isolated from *Curcuma longa* (Turmeric) was found to alleviate the symptoms of pulmonary inflammation and emphysema induced by cigarette smoking and porcine pancreatic elastase activity in a mice model [52]. Epigallocatechin-3-gallate, a phytochemical which is abundantly found in *Camellia sinensis* (Green tea) was found to reduce the progression of emphysema by inhibiting the leukocyte elastase activity in a dose-dependent manner [53]. Quercetin, a flavonoid compound was found to attenuate the progression of emphysema by decreasing the level of oxidative stress, pulmonary inflammation and reducing the expression of MMP9 and MMP12 in mice model [54].

### 3.3.3 Lung Cancer

*Curcuma longa* (Turmeric) is a commonly used food ingredient throughout India. *C. longa* extract was found to exhibit cytotoxic property and inhibition of telomerase activity in a dose-dependent manner in an in vitro study carried out in the A549 lung cancer cell line [55]. Conferone, a phytochemical isolated from *Ferula* species exhibited mild cytotoxic effects against A549 lung cancer cell line [56, 57]. *Annona muricata (Mamaphal)* also shows the cytotoxicity effect in the A549 lung carcinoma cell line which can be attributed to its constituent compounds annomuricin A and B [58]. *Andrographis paniculata (*Kiryat) alcoholic extracts were found to show chemopreventive effects by enhancing the levels of DT-diaphorase (DTD), superoxide dismutase (SOD), and catalase in the lungs in a mouse model [59]. *Phyllanthus urinaria (*Jaramla) extract showed anti-angiogenic potential by inhibiting neovascularization in the tumor cells and also inhibiting the migration of HUVEC in a mice model implanted with Lewis lung carcinoma cells [60]. Other medicinal plants that can be used to alleviate the symptoms of lung cancer include *Zingiber officinale* (Ginger), *Glycyrrhiza glabra* (Liquorice), *Terminalia chebula* (Myrobalan), *Ocimum sanctum* (Tulsi), and *Adhatoda vasica* (Malabar nut) [61].

### 3.3.4 Cystic Fibrosis

Herbal extracts from *Phyllanthus acidus* (Star gooseberry) play a vital role in epithelial transport by enhancing the levels of cAMP, activating $Ca^{2+}$, $K^{+}$ channels, and subsequent cellular signaling pathways as well as activating CFTR thus preventing the progression of cystic fibrosis [62]. Genistein is a phytochemical compound found in several medicinal plants that are capable of regulating various ions channels in CFTR, activates ΔF508 CFTR mutant and enhances the expression of mutant CFTR proteins [63, 64]. Curcumin, a phytochemical isolated from *Curcuma longa* (Turmeric) responsible for its characteristic yellow color can inhibit the calcium pump in the endoplasmic or sarcoplasmic membrane facilitating the removal of ΔF508 CFTR from the endoplasmic reticulum [65]. Resveratrol, a polyphenolic phytochemical commonly found in grapes and peanuts is capable of significantly elevating the cellular cAMP concentrations by activating adenylate cyclase and inhibition of cAMP phosphodiesterases which in turn leads to an increase in CFTR activity [66].

### 3.3.5 Pulmonary Hypertension

*Allium ursinum* (Wild garlic) and its compounds were found to alleviate the symptoms of pulmonary hypertension by decreasing the blood pressure, inhibiting of ACE activity and enhancing right ventricle function in animal models [67]. Administration of *Crataegus rhipidophylla* (Hawthorn) extract in broiler chickens with pulmonary hypertension induced by high altitude showed an increase

in expression of proteins such as albumin and globulin with a simultaneous decrease in the level of enzymes responsible for liver damage such as ALT and AST which occurs as a consequence of pulmonary hypertension progression [68]. *Moringa oleifera* (Drumstick tree) is abundantly found in the country and its various plant parts are commonly consumed as food ingredients. The alcoholic leaf extract of *Moringa oleifera* was administered to Wistar rats after inducing induced pulmonary hypertension by treatment with monocrotaline. It was found that the extract inhibited pulmonary hypertension by enhancing vasodilation and through its anti-oxidant properties [69].

### 3.3.6 Pneumonia

Various medicinal plants from the *Verbascum* species also known as Mullein have been used for the treatment of pneumonia as part of traditional herbal medicine due to its antibacterial activity. The extract isolated from *Verbascum fruticulosum* exhibited a high level of antibacterial activity against the multidrug-resistant strain of *Streptococcus pneumoniae* and can be used for the treatment of pneumonia. Similarly in the same study the extract obtained from *Urtica urens* (Dwarf nettle) also showed anti-microbial activity against *S. pneumoniae* although lesser than that of *V. fruticulosum* [70]. *Beta vulgaris* (Beetroot) is a commonly consumed vegetable. The alcoholic leaf extracts of *B. vulgaris* fractionated by n-hexane and chloroform displayed antibacterial activity by an increase in zone of inhibition in a concentration-dependent manner against *Klebsiella pneumonia* [71]. Other medicinal plants that have been used for the treatment of pneumonia include *Ficus racemosa* (Gular fig), *Nepeta glutinosa (Benth)*, *Ricinus communis* (Castor bean), *Terminalia chebula* (Myrobalan), and *Vitex negundo* (Chaste tree) [72].

### 3.3.7 Pleurisy

Ayurvedic medicines such as Praanrakshak can be used for the treatment of pleurisy. It consists of various medicinal plants such as *Cinnamomum zeylanicum* (Cinnamon), *Albizia lebbeck* (Shirish), *Adhatoda vasica* (Malabar nut), *Tylophora asthmatica* (Anantmool), and *Clerodendrum serratum* (Bharangi). *Cinnamomum zeylanicum* was found to exhibit anti-microbial, anti-oxidant, anti-inflammatory, and anti-nociceptive properties [73]. The stem bark extract of *Albizia lebbeck* exhibits various therapeutic properties such as anti-inflammatory, anti-anaphylactic, and analgesic which can alleviate the symptoms of pleurisy [74]. Vasicine, a phytochemical isolated from *Adhatoda vasica* showed antibacterial, anti-fungal, and anti-inflammatory activities in an in vitro study [75]. The plant extracts of *Tylophora asthmatica* exhibited immunosuppressive, anti-inflammatory, inhibition of delayed hypersensitivity response, and expectorant abilities in various clinical studies [76]. *Clerodendrum serratum* (Bharangi) extracts obtained from its roots and leaves display anti-asthmatic, anti-allergic, anti-inflammatory, anti-cancer, mast cell

stabilization effects according to various scientific investigations [77]. All these studies indicate that ayurvedic medicine such as Praanrakshak can be used for the treatment of pleurisy.

### 3.3.8 COVID-19

The extract of medicinal plants such as *Agastache rugosa* (Indian mint), *Astragalus membranaceus* (Katira), *Cassia alata* (Candlebush), *Cullen corylifolium* (Scurfy Pea), *Gymnema sylvestre* (Gurmar), *Mollugo cerviana* (Carpetweed), *Quercus infectoria* (Manjakani), *Tinospora cordifolia* (Gurjo) is capable of inhibiting the action of coronavirus [78]. Various phytochemicals isolated from medicinal plants such as quercetin, curcumin, withaferin A, luteolin, amaranthin, apigenin, gallic acid can also be used as potential drug candidates due to their ability to inhibit the mechanism of action of SARS-CoV-2 by targeting spike protein, the main protease, ACE-2 and its receptor [79]. In a case study, a 43-year-old male with COVID-19 symptoms was treated solely with Ayurvedic medicine and recovered completely. The treatment regimen involved the administration of Sudarsana Churna (for alleviating fever), Talisadi Churna (for loss of taste), and Dhanwantara Gutika (aids in overcoming breathing problems) [80, 81].

### 3.3.9 Sarcoidosis

Medicinal plants such as *Ocimum tenuiflorum* (Tulsi), *Curcuma longa* (Haridra), *Phyllanthus emblica* (Amalaki), *Tribulus terrestris* (Gokshura), *Asparagus racemosus* (Shatavari), *Withania somnifera* (Ashwagandha), and *Commiphora wightii* (Guggul) can be used for the treatment of sarcoidosis since they exhibit a wide range of therapeutic potential such as anti-oxidant, anti-inflammatory, anti-angiogenic, anti-microbial, immunomodulatory properties. Ayurvedic medicines that can be used for sarcoidosis treatment include Punarnava mandur and Kanchnar guggul which are capable of boosting the immune system as well as reducing the pain, inflammation, and other symptoms of the disease [82]. A clinical study involving the administration of herbal medicine called Reumaherb made up of three medicinal plants, namely *Echinacea purpurea, Harpagophytum procumbens,* and *Filipendula ulmaria* was found to exhibit anti-angiogenic and anti-inflammatory activity in a mice model transplanted with bronchoalveolar lavage (BAL) cells obtained from sarcoidosis patients. This anti-angiogenic potential could play a vital role in preventing the progression of sarcoidosis [83].

### 3.3.10 Pulmonary Embolism

*Selaginella bryopteris* (Sanjeevini) plant extract possesses anti-microbial, anti-coagulant, and anti-platelet properties which shows promise as a medicinal plant that can

**Table 3.2** Medicinal plants used in the treatment of pulmonary diseases

| Medicinal plant | Disease condition | Reference |
|---|---|---|
| *Acalypha indica* | Bronchitis and asthma | Ram et al. [90] |
| *Brassica nigra* | Chronic bronchitis | |
| *Glycyrrhiza glabra* | COPD and asthma | |
| *Pimpinella anisum* | Emphysema, bronchitis, asthma | |
| *Trachyspermum ammi* | Emphysema, asthma, bronchitis | |
| *Semecarpus anacardium* | Lung cancer | de Monteiro et al. [91] |
| *Ervatamia heyneana* | | |
| *Calamus rotang* | | |
| *Sida rhombifolia* | Pneumonia | Adnan et al. [92] |
| *Cajanus cajan* | | |
| *Vitex negundo* | | |
| *Allium sativum* | Pulmonary hypertension | Jasemi et al. [93] |
| *Crataegus rhipidophylla* | | |
| *Moringa oleifera* | | |
| *Salvia miltiorrhiza* | | |
| *Terminalia arjuna* | | |
| *Withania somnifera* | | |

be used for the treatment of pulmonary embolism [84]. The aqueous and ethanolic extracts of the fruit of *Terminalia bellirica* (Behada) one of the constituent medicinal plants of Triphala churna displayed anti-thrombotic and thrombolytic activity in an in vitro study [85]. The aqueous leaf extract of *Leucas indica* (Guma) was found to exhibit fibrinolytic, anti-platelet, and anti-coagulant activity by inhibition of thrombin and factor Xa [86]. The polyphenolic extract of *Vitis vinifera* (Grapeseed) commonly consumed as fruit also showed anti-coagulant and anti-platelet activities in an in vitro model [87]. *Fagonia arabica* (Dhamasa) is widely distributed throughout the Indian subcontinent and its aqueous extract and fractions displayed thrombolytic, anti-coagulant, and anti-oxidative properties in an in vitro study [88, 89]. The various medicinal plants used currently in the treatment of pulmonary disease ailments have been summarized in Table 3.2.

## 3.4 Phytoconstituents Involved in Treatment of Pulmonary Diseases

Phytochemicals are biologically active compounds present in plants with defensive and disease-preventive properties. Important clinical effects against cardiovascular and respiratory disorders have been shown by various phytochemical components like quercetin, resveratrol, triterpenoids, etc., [93]. A few examples of plant-derived compounds that have medicinal value in treating pulmonary diseases are been listed in Table 3.3.

**Table 3.3** Phytochemicals used for the treatment of pulmonary diseases

| Phytochemicals | Disease condition | References |
|---|---|---|
| Androsin | Bronchial asthma | Sharafkhaneh et al. [76] |
| Apple polyphenol | Pulmonary hypertension | Jasemi et al. [93] |
| Curcumin | Bronchitis, emphysema, cystic fibrosis | Sharafkhaneh et al. [76] |
| Ligustrazine | Pulmonary hypertension | Jasemi et al. [93] |
| Quercetin | Asthma, COPD, pulmonary hypertension | Jasemi et al. [93] |
| Resveratrol | Asthma, COPD, pneumonia, Sarcoidosis, pulmonary hypertension | Sharafkhaneh et al. [76] |
| Salidroside | Pulmonary hypertension | Jasemi et al. [93] |
| Triterpenoids | Chronic bronchitis, pulmonary hypertension | Ram et al. [90] |

## 3.5 Conclusion

This chapter provides a comprehensive review about various Indian herbal medicinal plants and their therapeutic potential in the treatment of several pulmonary diseases. These medicinal plants and their phytochemical constituents exhibit a diverse range of therapeutic properties such as anti-oxidant, anti-inflammatory, anti-angiogenic, anti-coagulant, anti-microbial and immunomodulatory properties. So herbal medicine can be used as a viable alternative for treatment of respiratory ailments due to their efficacy as well as to avoid the side effects caused by various chemical drugs. Although various herbal formulations have been traditionally used in Ayurveda and Siddha for treatment of pulmonary diseases more clinical studies are required to elucidate the mechanisms behind the pharmacological effects of these herbal medicine.

## References

1. Donnelly JP, Baddley JW, Wang HE (2014) Antibiotic utilization for acute respiratory tract infections in U.S. emergency departments. Antimicrob Agents Chemother 58:1451–1457
2. WHO (2007) Global surveillance, prevention and control of chronic respiratory diseases: a comprehensive approach. https://www.who.int/gard/publications/GARD_Manual/en/. Accessed 30 Oct 2020
3. WHO (2018) Cancer fact sheet. https://www.who.int/news-room/fact-sheets/detail/cancer. Accessed 30 Oct 2020
4. Hu Y, Sun J, Dai Z et al (2020) Prevalence and severity of corona virus disease 2019 (COVID-19): a systematic review and meta-analysis. J Clin Virol 127:104371
5. Petrovska BB (2012) Historical review of medicinal plants usage. Pharmacogn Rev 6:1–5
6. Sofowora A, Ogunbodede E, Onayade A (2013) The role and place of medicinal plants in the strategies for disease prevention. Afr J Tradit Complement Altern Med 10:210–229

7. Farzaei F, Morovati MR, Farjadmand F et al (2017) A mechanistic review on medicinal plants used for diabetes mellitus in traditional persian medicine. J Evid Based Complement Altern Med 22:944–955
8. Yuan H, Ma Q, Ye L et al (2016) The traditional medicine and modern medicine from natural products. Molecules 21:559
9. Ekor M (2014) The growing use of herbal medicines: issues relating to adverse reactions and challenges in monitoring safety. Front Pharmacol 4:177
10. WHO (2019) WHO global report on traditional and complementary medicine 2019. https://www.who.int/traditional-complementary-integrative-medicine/. Accessed 30 Oct 2020
11. Mathew L, Babu S (2011) Phytotherapy in India: transition of tradition to technology. Curr Bot 2:17–22
12. Dadoriya P, Dey YN, Sharma D et al (2020) In-vitro anti-inflammatory and antioxidant activities of an Ayurvedic formulation – Trayodashang guggulu. J Herb Med. https://doi.org/10.1016/j.hermed.2020.100366
13. Tomar P, Dey YN, Sharma D et al (2018) Cytotoxic and antiproliferative activity of kanchnar guggulu, an Ayurvedic formulation. J Integr Med 16:411–417
14. Wanjari MM, Mishra S, Dey YN et al (2016) Antidiabetic activity of Chandraprabha vati - a classical Ayurvedic formulation. J Ayurveda Integr Med 7:144–150
15. Liao SX, Sun PP, Gu YH et al (2019) Autophagy and pulmonary disease. Ther Adv Respir Dis 13:1753466619890538
16. Rabe KF, Watz H (2017) Chronic obstructive pulmonary disease. Lancet 389:1931–1940
17. Manian P (2019) Chronic obstructive pulmonary disease classification, phenotypes and risk assessment. J Thorac Dis 11:S1761–S1766
18. Mims JW (2015) Asthma: definitions and pathophysiology. Int Forum Allergy Rhinol 1:S2–S6
19. Chung KF (2017) Clinical management of severe therapy-resistant asthma. Expert Rev Respir Med 11:395–402
20. Wu TD, Brigham EP, McCormack MC (2019) Asthma in the primary care setting. Med Clin North Am 103:435–452
21. Janssen R, Piscaer I, Franssen FME et al (2019) Emphysema: looking beyond alpha-1 antitrypsin deficiency. Expert Rev Respir Med 13:381–397
22. Kurashima K, Takaku Y, Ohta C et al (2017) Smoking history and emphysema in asthma-COPD overlap. Int J Chron Obstruct Pulmon Dis 12:3523–3532
23. Kim V, Criner GJ (2013) Chronic bronchitis and chronic obstructive pulmonary disease. Am J Respir Crit Care Med 187:228–237
24. Guillien A, Soumagne T, Dalphin JC et al (2019) COPD, airflow limitation and chronic bronchitis in farmers: a systematic review and meta-analysis. Occup Environ Med 76:58–68
25. Naeije R (2013) Physiology of the pulmonary circulation and the right heart. Curr Hypertens Rep 15:623–631
26. Vonk Noordegraaf A, Groeneveldt JA, Bogaard HJ (2016) Pulmonary hypertension. Eur Respir Rev 25:4–11
27. Humbert M, Montani D, Evgenov OV et al (2013) Definition and classification of pulmonary hypertension. Handb Exp Pharmacol 218:3–29
28. Essien EO, Rali P, Mathai SC (2019) Pulmonary embolism. Med Clin North Am 103:549–564
29. Ramiz S, Rajpurkar M (2018) Pulmonary embolism in children. Pediatr Clin N Am 65:495–507
30. Fischer A, du Bois R (2012) Interstitial lung disease in connective tissue disorders. Lancet 380:689–698
31. Rafeeq MM, Murad HAS (2017) Cystic fibrosis: current therapeutic targets and future approaches. J Transl Med 15:84
32. Paranjape SM, Mogayzel PJ Jr (2014) Cystic fibrosis. Pediatr Rev 35:194–205
33. Llanos O, Hamzeh N (2019) Sarcoidosis. Med Clin North Am 103:527–534
34. Soto-Gomez N, Peters JI, Nambiar AM (2016) Diagnosis and management of sarcoidosis. Am Fam Phys 93:840–848

35. Bargagli E, Prasse A (2018) Sarcoidosis: a review for the internist. Intern Emerg Med 13:325–331
36. Ahn DG, Shin HJ, Kim MH et al (2020) Current status of epidemiology, diagnosis, therapeutics, and vaccines for novel coronavirus disease 2019 (COVID-19). J Microbiol Biotechnol 30:313–324
37. Hani C, Trieu NH, Saab I et al (2020) COVID-19 pneumonia: a review of typical CT findings and differential diagnosis. Diagn Interv Imaging 101:263–268
38. Wang F, Nie J, Wang H et al (2020) Characteristics of peripheral lymphocyte subset alteration in COVID-19 pneumonia. J Infect Dis 221:1762–1769
39. Clarke R, Lundy FT, McGarvey L (2015) Herbal treatment in asthma and COPD – current evidence. Clin Phytosci 1:4
40. Cesca TG, Faqueti LG, Rocha LW et al (2012) Antinociceptive, anti-inflammatory and wound healing features in animal models treated with a semisolid herbal medicine based on Aleurites moluccana L. Willd. Euforbiaceae standardized leaf extract: semisolid herbal. J Ethnopharmacol 143:355–362
41. Gholamnezhad Z, Shakeri F, Saadat S et al (2019) Clinical and experimental effects of Nigella sativa and its constituents on respiratory and allergic disorders. Avicenna J Phytomed 9:195–212
42. Kumar D, Prasad D, Parkash J et al (2009) Antiasthmatic activity of ethanolic extract of Aerva lanata Linn. Pharmacologyonline 2:1075–1081
43. Samiulla DS, Prashanth D, Amit A (2001) Mast cell stabilising activity of Bacopa monnieri. Fitoterapia 72:284–285
44. Mali RG, Dhake AS (2011) Evaluation of effects of Bauhinia variegata stem bark extracts against milk-induced eosinophilia in mice. J Adv Pharm Technol Res 2:132–134
45. Taur DJ, Patil RY (2011) Some medicinal plants with antiasthmatic potential: a current status. Asian Pac J Trop Biomed 1:413–418
46. Ram A, Duraisamy A, Selvakumar B et al (2009) Medicinal plants from siddha system of medicine useful for treating respiratory diseases. Int J Pharm Anal 1:975–3079
47. Sharma PK, Johri S, Mehra BL (2010) Efficacy of Vasadi syrup and Shwasaghna Dhuma in the patients of COPD (Shwasa Roga). Ayu 31:48–52
48. Prakash P, Gupta N (2005) Therapeutic uses of Ocimum sanctum Linn (Tulsi) with a note on eugenol and its pharmacological actions: a short review. Indian J Physiol Pharmacol 49:125–131
49. Gruenwald J, Graubaum H-J, Busch R (2005) Efficacy and tolerability of a fixed combination of thyme and primrose root in patients with acute bronchitis. A double-blind, randomized, placebo-controlled clinical trial. Arzneimittelforschung 55:669–676
50. Guo R, Pittler MH, Ernst E (2006) Herbal medicines for the treatment of COPD: a systematic review. Eur Respir J 28:330–338
51. Wienkötter N, Höpner D, Schütte U et al (2008) The effect of nigellone and thymoquinone on inhibiting trachea contraction and mucociliary clearance. Planta Med 74:105–108
52. Suzuki M, Betsuyaku T, Ito Y et al (2009) Curcumin attenuates elastase- and cigarette smoke-induced pulmonary emphysema in mice. Am J Physiol Lung Cell Mol Physiol 296:L614–L623
53. Sartor L, Pezzato E, Garbisa S (2002) (−)Epigallocatechin-3-gallate inhibits leukocyte elastase: potential of the phyto-factor in hindering inflammation, emphysema, and invasion. J Leukoc Biol 71:73–79
54. Ganesan S, Faris AN, Comstock AT et al (2010) Quercetin prevents progression of disease in elastase/LPS-exposed mice by negatively regulating MMP expression. Respir Res 11:131
55. Mohammad P, Nosratollah Z, Mohammad R et al (2010) The inhibitory effect of Curcuma longa extract on telomerase activity in A549 lung cancer cell line. Afr J Biotechnol 9:912–919
56. Kooti W, Servatyari K, Behzadifar M et al (2017) Effective medicinal plant in cancer treatment, part 2: review study. J Evid Based Complement Altern Med 22:982–995
57. Valiahdi SM, Iranshahi M, Sahebkar A (2013) Cytotoxic activities of phytochemicals from Ferula species. Daru 21:39

58. Desai AG, Qazi GN, Ganju RK et al (2008) Medicinal plants and cancer chemoprevention. Curr Drug Metab 9:581–591
59. Singh RP, Banerjee S, Rao AR (2001) Modulatory influence of Andrographis paniculata on mouse hepatic and extrahepatic carcinogen metabolizing enzymes and antioxidant status. Phytother Res 15:382–390
60. Huang S-T, Yang R-C, Lee P-N et al (2006) Anti-tumor and anti-angiogenic effects of Phyllanthus urinaria in mice bearing Lewis lung carcinoma. Int Immunopharmacol 6:870–879
61. Garodia P, Ichikawa H, Malani N et al (2007) From ancient medicine to modern medicine: ayurvedic concepts of health and their role in inflammation and cancer. J Soc Integr Oncol 5:25–37
62. Sousa M, Ousingsawat J, Seitz R et al (2007) An extract from the medicinal plant Phyllanthus acidus and its isolated compounds induce airway chloride secretion: a potential treatment for cystic fibrosis. Mol Pharmacol 71:366–376
63. Dey I, Shah K, Bradbury NA (2016) Natural compounds as therapeutic agents in the treatment cystic fibrosis. J Genet Syndr Gene Ther 7:284
64. Hwang TC, Wang F, Yang IC et al (1997) Genistein potentiates wild-type and delta F508-CFTR channel activity. Am J Phys 273:C988–C998
65. Sumbilla C, Lewis D, Hammerschmidt T et al (2002) The slippage of the Ca2+ pump and its control by anions and curcumin in skeletal and cardiac sarcoplasmic reticulum. J Biol Chem 277:13900–13906. https://doi.org/10.1074/jbc.M111155200
66. El-Mowafy AM, Alkhalaf M (2003) Resveratrol activates adenylyl-cyclase in human breast cancer cells: a novel, estrogen receptor-independent cytostatic mechanism. Carcinogenesis 24:869–873
67. Bombicz M, Priksz D, Varga B et al (2017) A novel therapeutic approach in the treatment of pulmonary arterial hypertension: allium ursinum liophylisate alleviates symptoms comparably to sildenafil. Int J Mol Sci 18:1436
68. Ahmadipour B, Kalantar M, Hosseini SM et al (2017) Hawthorn (Crataegus Oxyacantha) extract in the drinking water of broilers on growth and incidence of pulmonary hypertension syndrome (PHS). Rev Bras Cienc Avic 19:639–644
69. Chen K-H, Chen Y-J, Yang C-H et al (2012) Attenuation of the extract from Moringa oleifera on monocrotaline-induced pulmonary hypertension in rats. Chin J Physiol 55:22–30
70. Gupta VK, Kaushik A, Chauhan DS et al (2018) Anti-mycobacterial activity of some medicinal plants used traditionally by tribes from Madhya Pradesh, India for treating tuberculosis related symptoms. J Ethnopharmacol 227:113–120
71. Hussain Z, Muhammad P, Sadozai S et al (2011) Extraction of anti-pneumonia fractions from the leaves of sugar beets Beta vulgaris. J Pharm Res 4:4783–4785
72. Asadbeigi M, Mohammadi T, Rafieian-Kopaei M et al (2014) Traditional effects of medicinal plants in the treatment of respiratory diseases and disorders: an ethnobotanical study in the Urmia. Asian Pac J Trop Med 7S1:S364–S368
73. Ranasinghe P, Pigera S, Premakumara GS et al (2013) Medicinal properties of 'true' cinnamon (Cinnamomum zeylanicum): a systematic review. BMC Complement Altern Med 13:275
74. Desai TH, Joshi SV (2019) Anticancer activity of saponin isolated from Albizia lebbeck using various in vitro models. J Ethnopharmacol 231:494–502
75. Singh B, Sharma RA (2013) Anti-inflammatory and antimicrobial properties of pyrroloquinazoline alkaloids from Adhatoda vasica Nees. Phytomedicine 20:441–445. https://doi.org/10.1016/j.phymed.2012.12.015
76. Sharafkhaneh A, Velamuri S, Badmaev V et al (2007) The potential role of natural agents in treatment of airway inflammation. Ther Adv Respir Dis 1:105–120
77. Patel JJ, Acharya SR, Acharya NS (2014) Clerodendrum serratum (L.) moon. - a review on traditional uses, phytochemistry and pharmacological activities. J Ethnopharmacol 154:268–285
78. Benarba B, Pandiella A (2020) Medicinal plants as sources of active molecules against COVID-19. Front Pharmacol 11:1189

79. Bhuiyan FR, Howlader S, Raihan T et al (2020) Plants metabolites: possibility of natural therapeutics against the COVID-19 pandemic. Front Med 7:444
80. Adhikari B, Marasini BP, Rayamajhee B et al (2020) Potential roles of medicinal plants for the treatment of viral diseases focusing on COVID-19: a review. Phytother Res. https://doi.org/10.1002/ptr.6893
81. Girija PLT, Sivan N (2020) Ayurvedic treatment of COVID-19/SARS-CoV-2: a case report. J Ayurveda Integr Med. https://doi.org/10.1016/j.jaim.2020.06.001
82. Parasuraman S, Thing GS, Dhanaraj SA (2014) Polyherbal formulation: concept of ayurveda. Pharmacogn Rev 8:73–80
83. Radomska-Leśniewska DM, Skopińska-Różewska E, Demkow U et al (2016) A natural herbal remedy modulates angiogenic activity of bronchoalveolar lavage cells from sarcoidosis patients. Cent Eur J Immunol 41:25–34
84. Mahmud S, Akhter S, Rahman MA et al (2015) Antithrombotic effects of five organic extracts of bangladeshi plants in vitro and mechanisms in in silico models. Evid Based Complement Alternat Med:782742
85. Ansari V, Siddiqui H, Singh SP (2012) Antithrombotic and thrombolytic activity of terminalia belerica fruit extracts. Res J Pharm Biol Chem Sci 3:471–478
86. Gogoi D, Arora N, Kalita B et al (2018) Anticoagulant mechanism, pharmacological activity, and assessment of preclinical safety of a novel fibrin(ogen)olytic serine protease from leaves of Leucas indica. Sci Rep 8:6210
87. Bijak M, Sut A, Kosiorek A et al (2019) Dual anticoagulant/antiplatelet activity of polyphenolic grape seeds extract. Nutrients 11:93
88. Chourasia SR, Kashyap RS, Deopujari JY et al (2014) Effect of aqueous extract and fractions of Fagonia arabica on in vitro anticoagulant activity. Clin Appl Thromb Hemost 20:844–850
89. Gholkar AA, Nikam YP, Zambare KK et al (2020) Potential anticoagulant herbal plants: a review. Asian J Res Pharm Sci 10:51–55
90. Ram A, Balachandar S, Vijayananth P et al (2011) Medicinal plants useful for treating chronic obstructive pulmonary disease (COPD): current status and future perspectives. Fitoterapia 82:141–151
91. de Monteiro LS, Bastos KX, Barbosa-Filho JM et al (2014) Medicinal plants and other living organisms with antitumor potential against lung cancer. Evid Based Complement Alternat Med:604152
92. Adnan M, Ali S, Sheikh K et al (2019) Review on antibacterial activity of Himalayan medicinal plants traditionally used to treat pneumonia and tuberculosis. J Pharm Pharmacol 71:1599–1625
93. Jasemi SV, Khazaei H, Aneva IY et al (2020) Medicinal plants and phytochemicals for the treatment of pulmonary hypertension. Front Pharmacol 11:145