Medicinal Plants in Targeting Asthma

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Abstract

Asthma is the inflammation of the respiratory tract, and is becoming increasingly prevalent around the globe, more so in industrialized areas than non-industrialized regions. The disease has been estimated to affect around 300 million people all over the world, as of yet, but this number has been predicted to swell by a further 100 million by 2025. The prevalence of the disease has been rising, throughout the world, especially in children, since the 1970s.

The disease causes a narrowing of the air passageway, which happens parallel to dramatic fluctuations in the levels of mast cells, lymphocytes, eosinophils, and several inflammatory cellular products like the cytokines. Asthma patients also show elevated levels of the IgE antibody that is known to bind with receptors of mast cells and assorted inflammatory cells to trigger an inflammatory response of the body. These responses include the release of biochemical such as histamines, prostaglandins, and leukotrienes, which trigger bronchoconstriction or the narrowing of the bronchi.

In the present, conventional medicinal procedures and products have proven inadequate in combatting the disease, forcing people to seek other alternatives. This pursuit has presented plants, the reservoirs of several biologically active compounds, many of which are used in plant-based medicine, as the possible counter for the spread of this disease. The Indian subcontinent, including modern-day Pakistan, India, and Bangladesh, houses 45,000 plant species that have potential medicinal properties, as perfectly reflected in the ancient Ayurveda philosophy.

Plant species commonly employed in combatting asthma have proven to have antihistaminic, antiasthmatic, and antiallergic properties. Ayurvedic

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antiasthmatic medicines must be able to counter the effects of the cellular inflammatory biochemical, one such inhibitory chemical is quercetin, a common flavonoid that inhibits the release of histamine.

Keywords

Asthma · Inflammatory cellular products · Inflammatory response · Bronchoconstriction · Plant-based medicine · Medicinal properties · Ayurveda · Quercetin

5.1 Introduction

The foremost symptoms of Asthma include the inflammation of the trachea and bronchi, dramatic changes in the levels of inflammation-related blood cells like lymphocytes, eosinophils, mast cells, cytokines, and assorted cells and cell-products. There appears to be a correlation between the elevations in the levels of IgE type antibodies which are sensitive to certain receptor sites present on the membranes of inflammatory cells including mast cells. The interaction between this antibody and the surface receptors is the key to the activation of several inflammatory reactions. These reactions include the release of biochemicals such as leukotrienes, histamines, and prostaglandins. When these chemicals are released, they contract the smooth muscles lining the wall of the respiratory tract of the patient, which is termed as bronchoconstriction [1, 2].

Asthma is becoming more and more prevalent all over the world, the density is especially high in industrialized countries that lack a decent vegetation ratio. As of writing this text, 300 million people are estimated to be infected with the said disease worldwide, which will be added upon by a further 100 million by the year 2025 [3, 4]. Asthma has increasingly caused economic and mortal losses to the global human populations, mostly in children [5].

Plants, exploited for their medicinal properties, that are used to target the symptoms of asthma, must have certain traits that counter the disease's effects. These traits include antihistaminic properties, anti-inflammatory properties, muscle-relaxing properties, immunomodulatory properties, and allergic response activities [6]. Ayurvedic medicinal plant products are loaded with anti-Kapha and anti-Vata properties which allow them to target the infected tissues and alleviate the symptoms [7]. Similarly, bronchoconstriction can be targeted by anti-oxidants which can target and inhibit the inflammatory responses that caused the problem in the first place. This is achieved by countering the effects of radical oxygen entities and nitrogen radicals, both of which are strong oxidizing agents [8].

However, at present, remedies for asthma are subpar, owing mostly to the flaws in the drugs, most notably, their adverse effects on the infected individual. This has forced people to seek alternative treatment methods, which are less adverse to the patient. In this pursuit, Quercetin has emerged as a favorable solution as it is a common flavonoid compound, found in many food-stuffs, and which can inhibit the

effects of the inflammatory response cellular machinery. Several other solutions are also being sought after [9].

Asthma makes its first impression on the patient through recurrent difficulties in breathing, episodes of chest tightening, coughing, sneezing, breathlessness, disturbances in the sleep/wake cycles, and overall discomfort [10]. These effects are the direct result of the bronchoconstriction, which have been listed beforehand. According to WHO estimates, the disease is showing increasing prevalence, and the aforementioned 300 million figure is accredited to them [11]. Among the 70 countries studied by WHO, it was concluded that Brazil was afflicted the most, whereby 12.6% of women and 11.5% of men were confirmed to be infected [12].

In Brazil, the infection rate is much higher in children and adolescents, around 24 and 20%, respectively, making them the most vulnerable of all. Just like Brazil, other countries, worldwide, have also shown an increasing prevalence of the said disease, over the past few decades [13–15]. Conventionally, anti-inflammatory drugs, mostly inhaled versions, and relief medications are used to alleviate the symptoms [10, 16].

Preventing asthma is the most cost-effective solution to the growing spread of this disease [17]. Since the conventional options are often very expensive, in India, 79% of the patients use home remedies, instead of certified medicines, such as teas, home-made concoctions, yoga, homeopathy, herbal medicine, and so on [18]. These alternate remedies ranged between 4 and 79% in the adult populations, while this prevalence is 33–89% in children. However, it is not possible to determine the effectiveness of the said home remedies [19].

Since such remedies are used with an ever-increasing frequency, it makes sense to study them in detail, and assess their effects. There are several reasons as to why people opt for such options instead of certified medicines, the most important reason in this context is the widespread belief that conventional medicine is harmful in one way or the other, however, another factor may be affordability and accessibility. Medicinal plants, since they are natural, are seen as a better alternative, and hence endorsed by herbalists.

Since asthma is a chronic infection, requiring a prolonged, and at times, tedious treatment process. This is also one of the reasons why people seek alternative therapies and home remedies, mostly based on medicinal herbs [9]. The use of such medicinal herbs is also endorsed by the cultural values or the social makeup of communities in countries like India and Brazil.

5.2 Adverse Effects of Current Treatments Used in Asthma

Here are some adverse effects of traditional chemical-based treatments used for treating asthma [20]:

5.2.1 Isoprenaline

It can cause tachycardia.

5.2.2 Salbutamol

There can be events of dose-related muscle tremors (the more the doses, the greater the tremors), restlessness, heart palpitations, nervousness, irritation in the throat, and even edema in the ankle region.

5.2.3 Theophylline

This medication can cause dose-dependent tachypnoea, in addition to other conditions like arrhythmia, convulsions, muscle bulkiness, shock, hypotension, flushing, vomiting, heart palpitation, restlessness, dyspepsia, insomnia, tremors, and so on.

5.2.4 Anticholinergics

This medication can dry up the subject's mouth and make it difficult for you to swallow or talk. The patient may also develop a scarlet rash, may be subjected to photophobia, your near vision may become blurred, you may experience heart palpitations, hallucinations, delirium, face problems with your pulse, severe heart issues, and in case of extreme poisoning, the patient may enter a state of coma.

5.2.5 Ketotifen

It can make the patient dizzy, even sedate them. Other side effects include weight gain, feeling nauseated, and having a dry mouth.

5.2.6 Corticosteroids

These are by far the most destructive and can cause serious damage if things go wrong. The side effects include Cushing's habitus, hyperglycemia, delaying of the wound healing process, osteoporosis, vulnerability to infections, weakness in the muscles, hyperglycemia, restriction of the hypothalamo–pituitary–adrenal (HPA) axis, and so on.

The aforementioned side effects have forced researchers to come up with innovative natural solutions to combat the disease. The target solutions should be practical, applicable, available to the people, and most of all, clinically acceptable.

Alternative medicine has been under consideration for a while now, and its usage in the treatment of asthma has only increased over the years [9].

5.3 Some Traditional Plants with Antiasthmatic Potential

5.3.1 *Aerva lanata* (L.) Juss. Ex Schult

Aerva lanata, shortened as *A. lanata* is a common herbaceous weed, distinguished by its white wooly flowers which form auxiliary bunches. It is a common sight in the plains of the warmer regions in the Indian subcontinent. The plant was successfully tested for medicinal properties by a team of researchers who used its extract (mostly ethanol-soluble) at a minute concentration of 100 μg/mL mixed in preparations from the trachea of a goat, and in another experiment, prepared into oral doses of 30 and 60 mg/kg to be tested on mice, in both cases, it proved to possess effective antihistamine properties [21] (Fig. 5.1).

Fig. 5.1 *Aerva lanata* inflorescence (Source: By J.M.Garg—Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=6608619)

5.3.2 *Ageratum conyzoides* L.

Ageratum conyzoides, shortened as *A. conyzoides*, is an annual herb belonging to the family Asteraceae, formerly known as Compositae, and is indigenous to the tropical regions of the New World. However, its distribution also spreads across the tropical and sub-tropical regions of the rest of the world. The extract of its leaves is hydroalcoholic, and when prepared in oral doses of 250, 500, and 1000 mg/kg exhibit impressive antihistaminic potential and have experimentally inhibited catalepsy induced by clonidine in lab mice [22] (Fig. 5.2).

5.3.3 *Argemone mexicana* L.

It is quite common to encounter *Argemone mexicana*, shortened as *A. mexicana*, in the fields and even the roadsides of India. This plant is known to possess antiallergic properties. Its aqueous extracts, when prepared as an oral dose of 50 mg/kg can be effective in combatting leukocytosis and eosinophilia [23] (Fig. 5.3).

Fig. 5.2 *Ageratum conyzoides* (Source: By Minghong—Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=4030608)

Fig. 5.3 *Argemone mexicana* (Source: By B. Navez—Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=4732240)

5.3.4 *Asystasia gangetica* (L.) T. Anderson

Asystasia gangetica, shortened as *A. gangetica*, is a common remedy option for asthma throughout various parts of Nigeria. The extract of its leaves, concurrent with hexane, ethyl acetate, and methanol, was proven to be quite effective in their antihistaminic activity (countering allergic reactions and inflammations). It did not inhibit the contractions and relaxations in the target tissues, however, it did stop spasmodic contractions [24] (Fig. 5.4).

5.3.5 *Bacopa monnieri* (L.) Pennell

The extracts of *Bacopa monnieri*, shortened as *B. monnieri*, contain compounds soluble in petroleum ether, methanol, chloroform, and water, which at doses of 10 μg/mL can effectively stabilize mast cells in lab rats. The extract proved to be quite effective at stopping mast cell degranulation [25] (Fig. 5.5).

5.3.6 *Senna sophera* (L.) Roxb

Senna sophera, formerly known as, *Cassia sophera*, is a part of traditional asthma treatments, and that of assorted diseases too. The leaf extracts of this plant contain

Fig. 5.4 *Asystasia gangetica* (Source: CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=70915)

fractions soluble in ethyl acetate, ethanol, and chloroform, which have a proven antihistaminic potential at concentrations of 250, 500, and 750 mg/kg, researchers believe that the underlying cause of this potential may be the presence of flavonoids [26] (Fig. 5.6).

5.3.7 *Casuarina equisetifolia* L.

Casuarina equisetifolia, shortened as *C. equisetifolia*, is an evergreen tree, measuring as high as a whopping 50 meters in some cases. It is cultivated in the coastal areas of stretch of land in India between Gujrat and Orissa, in some regions of West Bengal (also part of India), and the Andamans. The wood and bark extracts of this tree possess methanol-soluble fractions which have appreciable antihistaminic potential, which has been experimentally proven by Ahel et al., [27] (Fig. 5.7).

5.3.8 *Rotheca serrata* (L.) Steane & Mabb

Rotheca serrata, formerly known as *Clerodendrum serratum*, is known by its common name "bharangi" by the practitioners of Ayurveda. Traditionally, this

Fig. 5.5 *Bacopa monnieri* (Source: By Forest and Kim Starr, CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=6109556)

plant has been used to cure several diseases and conditions like inflammation, pain, rheumatism, malaria, and respiratory diseases. The root extract of this plant contains a major fraction of ethanol-soluble compounds which exhibit antihistaminic potential, as was noted by researchers who tested it on goat tracheal tissues, and via doses to mice at 50, 100, and 200 mg/kg [28, 29].

5.3.9 *Cnidium monnieri* (L.) Cusson

Cnidium monnieri, shortened as *C. monnieri*, is a common part of traditional Chinese medical treatments, such as for alleviating pain in the vagina, treating impotence, curing suppurative dermatitis, and so on. However, researchers also discovered that its antiallergic properties, owing to its ethanol and osthol (a chromame) soluble extracts can tackle cutaneous anaphylaxis in lab rats [30].

5.3.10 *Crinum glaucum* A. Chev

Crinum glaucum, shortened as *C. glaucum*, is popularly used in traditional remedies in South-Western Nigeria. It is believed to be effective in countering cough,

Fig. 5.6 *Senna sophera* seeds (Source: By Tracey Slotta—http://plants.usda.gov/java/largeImage?imageID=seso2_001_ahp.tif, Public Domain, https://commons.wikimedia.org/w/index.php?curid=12236440)

convulsions, and asthma. Researchers isolated aqueous extracts of this plant, prepared doses of 100–400 mg/kg, and tested it on guinea pigs, where it showed great effectiveness in antihistaminic activities [31].

5.3.11 *Curculigo orchioides* Gaertn

Curculigo orchioides, shortened as *C. orchioides*, is a small herb spread widely across regions in India, China, and the islands to the east and south-east: Japan and the Malayan archipelago. *C. orchioides* rhizome extract contains fractions of alcohol-soluble compounds, which at doses of 100–400 mg/kg were proven to be effective in stabilizing mast cells. The extract's antihistaminic properties are worth praising [32].

It was also proven effective in tackling and even reversing histamine-induced contractions of the respiratory tract, bronchoconstriction, leukocytosis, eosinophilia, and assorted conditions. These experiments proved effective on goat, pig, and mice tissues [33] (Fig. 5.8).

Fig. 5.7 *Casuarina equisetifolia* (Source: By Ethel Aardvark—Own work, CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=4989854)

5.3.12 *Eclipta alba* L.

The extract of *Eclipta alba*, shortened as *E. alba*, contains a 50% fraction of ethanol which has proven antihistaminic and anti-anaphylactic potentials which become significant at doses of 250 and 500 mg/kg. These doses proved to be effective in countering mast cell degranulation, anaphylaxis, tracheal issues, and assorted respiratory problems [34] (Fig. 5.9).

5.3.13 *Euphorbia hirta* L.

Euphorbia hirta, shortened as *E. hirta*, is a wild herb that is found in the warmer regions of India. The extracts of this plant are ethanol-soluble, which, at doses of 100–1000 mg/kg exhibit effective antihistaminic and antiallergic potentials. These extracts have been proven to inhibit degranulation of mast cells, and assorted medical issues [35] (Fig. 5.10).

Fig. 5.8 *Curculigo orchioides* (Source: By Viren Vaz (self)—at CEC, Mumbai, CC BY-SA 2.5, https://commons.wikimedia.org/w/index.php?curid=863216)

5.3.14 *Ficus benghalensis* L.

Ficus benghalensis, shortened as *F. benghalensis*, is a huge tree, growing as high as 30 meters, forming an expansive canopy which has inspired its local name: banynan tree (banyan meaning small residence). The aqueous extracts of this plant contain ethanol and ethyl acetate soluble compounds, the tree's bark has proven antihistaminic potential which becomes noticeable at a dose of 50 mg/kg. This potential is accredited to the presence of flavonoid compounds [36, 37] (Fig. 5.11).

5.3.15 Gakani

The said herbal mixture is a polyherbal traditional drug that contains extracts of *Cenchrus biflorus*, *Olax subscorpioidea*, *Piper guineense*, *Psorospermum guineense*, *Securidaca longipedunculata*, and *Syzygium aromaticum*. Gakani has been honed, traditionally, for its antiasthmatic power, this potential has been tried and tested by researchers. It was tested on the tracheal tissues of guinea pigs, their ileum tissues, rat stomach tissues, and on a hind paw edema caused by albumin. In all cases, the extract proved to be effective at inhibiting the histamine-induced contraction of affected tissues. The extract was proven to be effective [38].

Fig. 5.9 *Eclipta alba* (Source: By J.M.Garg—Own work, CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=7606450)

5.3.16 *Hemidesmus indicus* (L.) R.Br

Hemidesmus indicus, shortened as *H. indicus*, is a shrub widely distributed in regions of Indian. The extracts of this plant, which are ethanol-soluble, have proven to possess antihistaminic activity which becomes prominent at doses of 25, 50, and 100 mg/kg which was tested on tracheal extracts of goat, anaphylaxis-infested paw, and catalepsy, and proven effective [28, 29] (Fig. 5.12).

5.3.17 *Amburana cearensis* (Allemão) A.C.Sm

Amburana cearensis, shortened as *A. cearensis*, is a plant endowed with medicinal properties, used in traditional herbal medicine, commonly found in Northeast Brazil savannah. It is used to treat respiratory distresses, mostly asthma. The trunk extracts are endowed with flavonoids which may be the causative factor behind its effectiveness [39] (Fig. 5.13).

Fig. 5.10 *Euphorbia hirta* (Source: By Forest and Kim Starr, CC BY 3.0, https://commons.wikimedia.org/w/index.php?curid=6160393)

5.3.18 Members of Family Zingiberaceae

Some members of the Zingiberaceae family have been proven to possess antiallergic potentials, as noted by [40].

5.3.19 *Lepidium sativum* L.

Lepidium sativum, shortened as *L. sativum*, is commonly termed as Asaliyo, is an annual herb with a glabrous appearance, commonly used in salads in several regions of India. The extracts of this plant are soluble in ethyl acetate, ethanol, n-butanol, and methanol which inhibit the activity of histamine and other allergens [41] (Fig. 5.14).

5.3.20 *Mentha spicata* L.

Mentha spicata, shortened as *M. spicata*, is endowed with unique flavonoids and glycosides, soluble in ethyl acetate, which shows antihistaminic properties [42] (Fig. 5.15).

Fig. 5.11 *Ficus benghalensis* (Source: By McKay Savage—originally posted to Flickr as India—Kolkata—10—Great Banyan Tree, CC BY 2.0, https://commons.wikimedia.org/w/index.php?curid=6028234)

Fig. 5.12 *Hemidesmus indicus* (Source: By No machine-readable author provided. Shyamal assumed (based on copyright claims)—No machine-readable source provided. Own work assumed (based on copyright claims), CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=801456)

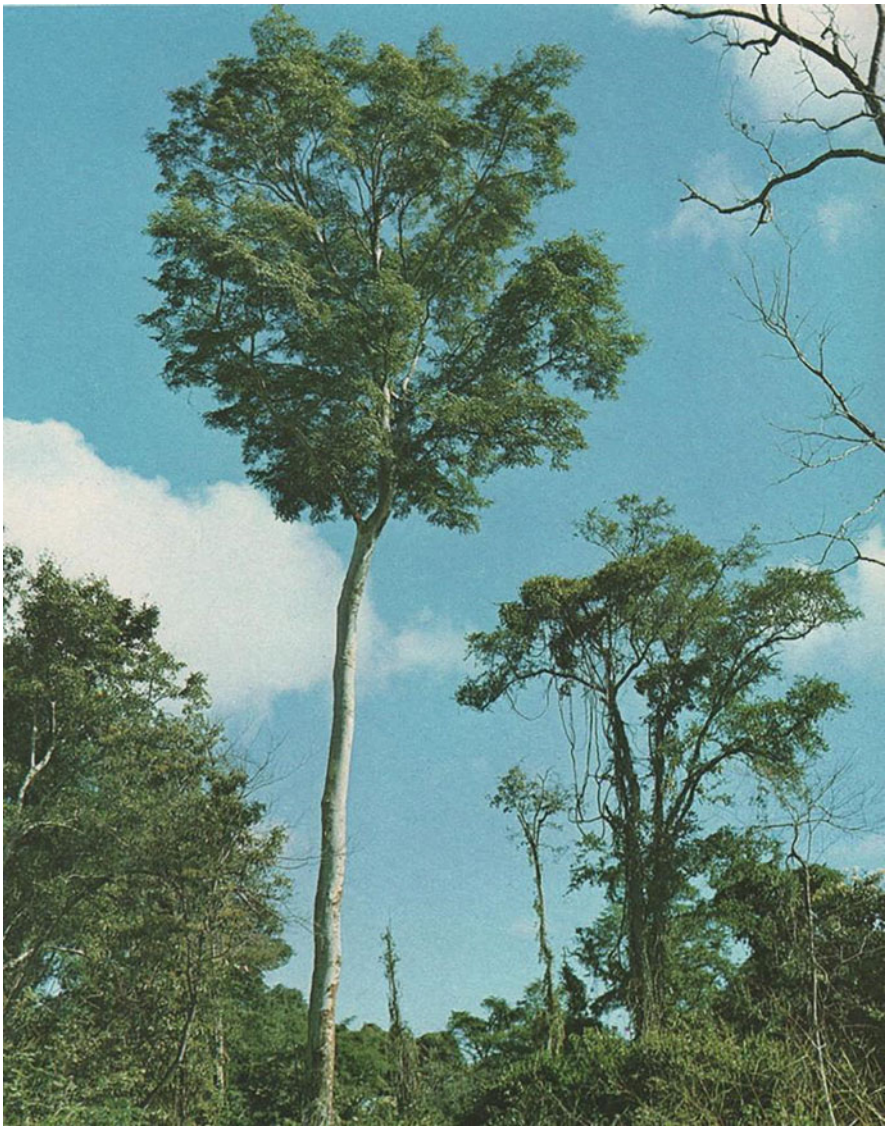

Fig. 5.13 *Amburana cearensis* (Source: By Jorge Vallmitjana - Libro del Árbol, Tome II, edited by Celulosa Argentina S. A., Buenos Aires, Argentina, October 1975. The visual material is not explicitly copyrighted, but the editors thank Mr. Jorge Vallmitjana for his photographic contribution; Public Domain, https://commons.wikimedia.org/w/index.php?curid=4473843)

5.3.21 *Momordica dioica* Roxb. Ex Willd

Momordica dioica, shortened as *M. dioica*, is a creeper with medicinal properties. The leaves and fruits are used for medicinal purposes, to cure several diseases such

Fig. 5.14 *Lepidium sativum* (Source: CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=116773)

as fever, bronchitis, asthma, and even severe conditions like leprosy. Extracts dissolved in water and methanol from its pulp are endowed with antihistaminic properties which have been experimentally verified with lab mice, using doses of 50 mg/kg [43] (Fig. 5.16).

5.3.22 *Mucuna pruriens* (L.) DC

The methanol-soluble fractions, extracted from seeds, are rich with L-DOPA which has endowed with impressive antihistaminic properties that were tried, tested, and proven at doses of 50, 100, and 200 mg/kg with lab mice [44] (Fig. 5.17).

5.3.23 *Myrica esculenta* Buch.-Ham. Ex D.Don

Myrica esculenta, shortened as *M. esculenta*, is famous by its vernacular name Kaiphal. It is traditionally used in herbal medicines for treating diseases like asthma and bronchitis in the Ayurvedic medical philosophy—which has been thoroughly scrutinized scientifically and has been most proven to be effective. Researchers tested the antiallergic and anti-inflammatory potentials of ethanol-soluble compounds extracted from the plant. Using doses of 75 and 150 mg/kg of its extract, researchers verified its potential [45]. The bark of the plant also contains extracts

Fig. 5.15 *Mentha spicata* (Source: By Simon Eugster—Simon 13:07, 2 July 2006 (UTC)—Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=913901)

with proven medical properties, which the researchers put to test using doses of 75 mg/kg which tackled the effects of histamine and acetylcholine in guinea pigs [46].

5.3.24 *Nyctanthes arbortristis* L.

Nyctanthes arbortristis, shortened as *N. arbortristis*, is a traditional herbal option for treating asthma. The extract of this plant, soluble in petroleum ether, is effective against histamine-induced distress, which it can alleviate at doses of 50 mg/kg [47].

5.3.25 *Olea europaea* L.

Olea europaea, shortened as *O. europaea*, needs no introduction. It has been revered and honed throughout history not only for its medicinal properties but even due to spiritual involvement. This small tree, which remains evergreen, can grow anywhere between 12 and 20 ft, with rigid branches and a grey-colored bark. The aqueous extract of this plant has impressive antihistaminic potential which inhibited mast cell

Fig. 5.16 *Momordica dioica* (Source: By Sivahari—Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=16283137)

degranulation at doses of 4 and 8 mg/kg in mice, and at a dose of 100 μg/mL for goat and guinea pig [48] (Fig. 5.18).

5.3.26 *Microsorum scolopendria* (Burm.F.) Copel

The ethanol extracts of *Microsorum scolopendria*, formerly known as *Phymatosorus scolopendria*, have been proven to show histamine inhibiting potential [49].

5.3.27 *Piper betle* L.

Its aqueous and ethanol-soluble extracts were tested and proven to be effective against asthma for guinea pigs at doses of 100 and 200 mg/kg [50].

5.3.28 Striga Orobanchioides

The ethanol-soluble and aqueous extracts of this plant proved effective in countering the effects of histamine in guinea pigs [51].

Fig. 5.17 *Mucuna pruriens* (Source: By Agong1—Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=13865651)

5.3.29 *Sphaeranthus indicus* L.

Its ethanol based and ethyl acetate-based extracts showed great effectiveness in countering the degranulation of mast cells [52].

5.3.30 *Cynodon dactylon* (L.) Pers.

This is among the most predominant grasses of the Indian subcontinent, its extracts in petroleum ether, methanol, and chloroform show great medicinal potential in counter mast cell degeneration and so on [53].

Fig. 5.18 *Olea europaea* (Source: By en:User:Nickfraser—en:Image:Olivesfromjordan.jpg, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=2208405)

5.4 Conclusion

Many non-prescription drugs are plant-based or based on compounds derived from plants. The use of such medications for the treatment of asthma not only opens up a new avenue in the approach towards this disease but also promises to safeguard patients from the side effects of conventional options. While herbal medicine cannot be endorsed as a solution because of its non-standardization, standardized plant-based medicines appear to be the way forward as their effectiveness is proven by a heap of studies. The only thing that remains to be ascertained is their effect on human beings for which further experimentation is required.

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