

REVIEW ARTICLE

Effect of Plant Extract Used in Ayurveda and Siddha Medicine on Asthmatics and Their Role in Maintaining Gut Microbiota Diversity – A Narrative Review

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Abstract

Objectives: This study aims to comprehend how medicinal plant extracts used in ayurveda and siddha affect the human gut microbiota in asthmatics. In this narrative review, the author attempted to summarize/incorporate the antibacterial and immunomodulatory effects of ayurveda and siddha medicinal plants and how they modulate probiotic microbial diversity and pathogenic asthmatic bacteria.

Data sources: The narrative review included all peer-reviewed papers published between 1985 and 2025. The authors did an in-depth search in four electronic databases: Google Scholar, PubMed, Web of Science and Embase, for medicinal plants, asthma, gut microbiota and antimicrobial activity.

Review methods: The author assessed the titles and abstracts before obtaining probable eligible citations for full-text analysis. To fully comprehend the subjects and their connection to the given title, references to the included articles and articles from well-known non-indexed peer-reviewed journals were sought.

Conclusion: Plant extracts used in either system of medicine to treat asthma promote the growth of probiotic anti asthmatic bacteria, including *Lachnospiraceae*, *Ruminococcus*, *Faecalibacterium*, *Akkermansia*, *Roseburia*, *Lactobacillus* and *Bifidobacterium*. The plant extracts also exhibit antimicrobial activity against several pathogenic asthmatic bacteria like *Clostridium*, *Staphylococcus*, *Pseudomonas*, *Moraxella* and *Haemophilus*. The beneficial gut bacteria population may increase by consuming plant extracts, as gut microbiome colonization improves the various metabolic functions of the host. The beneficial anti-asthmatic bacteria reduce the symptoms of asthma.

Key Words: Asthma; Ayurveda; Siddha; Gut microbiota

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1. Introduction

Asthma is a long-term inflammatory condition of the airways, mostly caused by environmental factors that interact with a person's genetic predisposition. Nearly 300 million children worldwide suffer from asthma and there are 250,000 asthma-related fatalities reported each year [1]. The bacterial, viral, fungal and even archaeal components of a healthy adult's microbiota carry out several functions, including "producing vitamins" and "synthesizing neurotransmitters and short-chain fatty acids" [2]. Many lifestyle and environmental factors might contribute to the microbial dysbiosis in the gut and lungs that characterizes asthma. Pathogenic and symbiotic bacterial strain asymmetry between the gut and lungs may influence immune maturation and induce unwanted inflammatory responses. Many disorders are treated directly or indirectly using plant-based medicine extracts. Plants are used in more than 30% of the world's pharmaceutical preparations [3]. Numerous RCTs were conducted to evaluate the effectiveness of Ayurvedic medicine on asthmatics [4]. According to one study, one hundred and fifteen patients administered phenotype-specific Ayurvedic intervention for individuals with mild to moderate asthma significantly improved lung function while lowering IgE concentration, eosinophil and cytokine levels (IL-4, IL-5 and IL-13) in the peripheral circulation. In line of treatment, Ayurveda uses a variety of plant extract formulations to treat asthma [5]. The siddha system of medicine was frequently adopted in the Southern part of India and found to be effective in treating several conditions, including asthma. There are three categories of Siddha medicine: plant goods, inorganic compounds and animal products. There are around 100 plants that are effective in treating human disorders, including respiratory diseases [6].

1.1. Objectives

The main objective of this study is to comprehend how the human gut microbiota of asthmatics is impacted by the therapeutic plant extracts used in ayurveda and siddha. The author attempted to summarize and incorporate the antibacterial and immunomodulatory effects of ayurveda and siddha medicinal plants and how they modulate probiotic microbial diversity and pathogenic asthmatic bacteria.

1.2. Data sources

All peer-reviewed publications between 1985 and 2025 were included in this narrative review. The authors conducted a thorough search in PubMed, Google Scholar, Embase and Web of Science using the keywords medicinal plants, asthma, gut microbiome, and antibiotic activity.

1.3. Review methods

Before compiling citations that were probably eligible for full-text analysis, the author first analyzed the titles and abstracts of the manuscripts. To completely comprehend the subjects and their connections to the title above, references from peer-reviewed journals and publications from renowned non-indexed peer-reviewed journals were searched very systematically.

1.4. Plant extracts in treating asthma

As a result of the widespread awareness of the effects and problems related to synthetic pharmaceuticals during the past three decades, the potential therapeutic use of herbs has been studied around the world. According to numerous studies, the plant extracts used in

ayurvedic and siddha medicinal systems reduce harmful bacteria by ingesting various plant extracts, while probiotic bacteria populations are encouraged to increase.

1.5. Plant extract for reducing asthmatic symptoms

- ***Adhatoda vasica* (vasaka):** *A. vasica* is the most frequently used plant to treat allergy disorders and respiratory illnesses, including bronchial asthma. The *A. vasica* alkaloid extracts isolated from the plant leaves have a potent respiratory stimulant action on guinea pigs when the extracts are intravenously injected [7].
- ***Aegle marmelos* (bilwa):** The leaf extracts of *A. marmelos* positively relax the tracheal chain. The leaf extracts contain the anti-inflammatory phytochemicals lupeol and citral, which limit histamine-induced constriction and may also inhibit H1 receptor activity in guinea pigs [8].
- ***Alstonia scholaris* (saptaparna):** The *A. scholaris* leaf ethanol extract greatly improved bronchodilator activity and reduced prostaglandin concentration in anesthetized rats. The main mechanism by which the leaf extract's vasodilatory action operated was nitric oxide, an endothelial-derived relaxing agent, rather than adrenergic, muscarinic or prostaglandin receptors or prostaglandins [9].
- ***Andrographis paniculata* (kalamegha):** The extract of *A. paniculata* was used to treat asthma. Andrographolide is the primary chemical in *A. paniculata*, which is pharmacologically active. It has been demonstrated that andrographolide significantly reduces the inflammation induced by histamine, dimethylbenzene and adrenaline in BALB/c mice sensitized and challenged with ovalbumen, which developed airway inflammation [10].
- ***Asteracantha longifolia* (kokilaksha):** The methanolic extracts of *A. longifolia* strongly suppress the formation of leukotriene B4 in bovine polymorphonuclear leukocytes [11].
- ***Allium cepa* (palandu):** Asthma can be efficiently treated with onion oil. Histamine, acetylcholine, allergen and platelet-activating factor are all adversely affected by lyophilized onion extract experimentally proven in asthmatic mice [12].
- ***Albizia lebeck* (shirisha):** The primary use of the bark of *A. lebeck* is vital in the management of asthma. The anti-inflammatory and immunomodulatory effect is demonstrated by the alteration of cellular and molecular markers of inflammation and immunity in the asthmatic mouse model [13].
- ***Atropa belladonna* (angurshafa):** *A. belladonna* consists of atropine, scopolamine and hyoscyamine, which are anticholinergic compounds [14].
- ***Acalypha indica* (harita manjari):** This particular plant extract reduces the amount of acetylcholine-induced goat tracheal chain constriction, indicating that they contain anticholinergic and antihistaminic effects. Clonidine-containing plant extracts were shown to suppress mouse H1 receptor activity. Additionally, it promotes the suppression of mast cell degranulation that is brought on by clonidine, suggesting its capacity to maintain mast cells in rat models [15].
- ***Boswellia serrata* (shallaki):** The *Boswellia* plant's extract contains the anti-inflammatory triterpenoids known as boswellic acids. Boswellic acid and its derivatives have anti-tumor and anti-carcinogenic properties and reduce blood cholesterol levels in human models. The inhibition of pro-inflammatory 5-lipoxygenase enzymes is known and it prevents leukotriene synthase pathways [16].
- ***Benincasa hispida* (kushmanda):** The methanolic extract from *B. hispida* fruit showed active inhibitory effects on histamine and displayed mast cell stability in rat exudate cells. MEBH showed 100% fortification against the histamine that triggers asthma symptoms even at modest doses [17].

- ***Blumea lacera (kukraundha)***: Patients are recommended to inhale the odors of dried *Blumea* leaves in various parts of India in the event of a severe asthma attack [18].
- ***Cuminum cyminum (jeeraka)***: The plant extracts have an inhibitory effect on histamine H1 receptors [19].
- ***Cinnamomum cassia (tvak)***: Procyanidins, polyphenols isolated from cinnamon, significantly reduced the elevated levels of total protein, albumin, goblet cell hyperplasia and inflammatory cell infiltration in lung tissue in OVA-induced hyper-responsiveness rats [20].
- ***Clerodendrum serratum (bharngi)***: It was already documented in many studies that both high and low doses of bharngi root and stem have similar anti-inflammatory and antiallergic effects as dexamethasone. Bhrangi root appears to have promising anti-allergic and anti-inflammatory effects. The anti-allergic activity was evaluated by milk-induced leucocytosis in mice and bronchial hyperreactivity in guinea pigs sensitized with egg albumin [21].
- ***Curcuma longa (haridra)***: Demethoxycurcumin and curcumin are both found in *C. longa*. Administration of *C. longa* or curcumin shows anti-inflammatory and antioxidant effects in an animal model of asthma. Through inhibition of cyclooxygenase-2 (COX-2), lipoxygenase and nitric oxide inducible synthase (iNOS), curcumin reduces allergic airway inflammation and hyperresponsiveness. It lowers levels of inflammatory cytokines [22]. Nuclear factor-E2-related factor 2 and Heme Oxygenase (HO)-1 signaling pathways are activated, CD4⁺ and CD25⁺ are regulated and the Notch-1-GATA 3 signaling pathway is also inhibited [23].
- ***Camellia sinensis (caha syamaparni)***: Saponin is a phytochemical found in tea leaves. In the pig lung sample, Tea Leaf Saponin (TLS) reduced the release of antigen-induced leukotriene [24].
- ***Moringa oleifera (shigru)***: It was already reported in many studies that *M. oleifera* seed significantly enhanced the FVC and FEV1 readings, as well as the PEF, FEV and MVV measurements in the asthmatic human model [25].
- ***Ocimum sanctum (tulasi)***: A dried and fresh leaf ethanol extract of *O. sanctum* has anti-asthmatic properties. *O. Sanctum* has anti-asthmatic benefits because of its smooth muscle relaxant property, which is connected to an increase in cAMP in bronchial smooth muscle cells and to the suppression of smooth muscle cell growth. *O. sanctum* consists of eugenol, which causes the relaxation of bronchial smooth muscle [26].
- ***Plantago major (ashvagola)***: *P. major* inhibits mast cell degranulation, promotes mucus formation and has anti-allergic properties. It mostly reduces edema and inflammation due to its astringent tannins [27].
- ***Piper longum (pippali)***: *P. longum* is mostly used to treat cough and asthma in Ayurveda. When milk and *P. longum* fruit powder are mixed, asthma incidence and severity are significantly reduced. The Petroleum Ether (PE), Alcoholic and Decoction extracts of the *P. longum* plant demonstrate the presence of alkaloids, steroids, glycosides, flavonoids and carbohydrates. The three extracts can all be used to treat asthma [28].
- ***Tamarindus indica (amalika)***: *T. indica* is used to treat and prevent asthma since it has anti-asthmatic properties, including bronchodilation, antihistamine and anti-inflammatory effects observed in rat models [29].
- ***Borassus flabellifer (tada)***: Cough and lung disorders are also treated using the plant's seed. The oral administration of *B. flabellifer* to mice causes the development of T suppressor cells, which block the delayed type of serum-hypersensitive receptor [30].
- ***Crocus sativus (kumkum)***: Asthma and cough are treated with the dead stigma of the plant. It provides mild relaxation when used to treat bronchitis, whooping cough and dry cough [5].

- ***Euphorbia hirta* (dugdhika bheda):** *E. hirta* is also known as an asthma weed. The entire plant is used to treat bronchitis and asthma. Anti-allergic and anti-anaphylactic properties are demonstrated by the plant's ethanolic extract.
- ***Solanum nigrum* (kakamachi):** *S. nigrum* L's fruits and leaves are used for the treatment of asthma and bronchitis. The DNA-binding activation of NF-kB and AP-1 is inhibited by a glycoprotein isolated from the plant [31].
- ***Solanum trilobatum* (alarkapapatramu):** The whole plant is used for the treatment of asthma, bronchitis and eosinophilia [32].
- ***Solanum xanthocarpum* (kantakari):** The plant may decrease the histamine from bronchial and lung tissue [5].
- ***Strychnos potatorum* (ambuprasada):** The plant's fruits and seeds are used to treat bronchial asthma, eosinophilia and cough [5].
- ***Tylophora indica* (arkaparni):** The leaves of the plant show effectiveness against asthma (Table 1) [33].

Table 1: Effects of plant extracts on microbial population.

Sl. N o.	Name of the plant	Phytochemicals present in the plant	Study type	Design/method/doses	Gut microbial alteration/anti-microbial properties	Reference
1	<i>Adhatoda vasica</i> (vasaka)	Phenol, tanin, alkaloids, saponins, flavonoids	Experimental/ <i>in vitro</i>	Antimicrobial activity by the disk diffusion method.	Shows antimicrobial effects against <i>Proteus mirabilis</i> , <i>Bacillus subtilis</i> , <i>Pseudomonas aeruginosa</i> and <i>Staphylococcus aureus</i> .	[34]
2	<i>A. marmelos</i> (bilwa)	Lupeol, citral	Experimental/ <i>in vitro</i>	Growth inhibition method/methyl plant extracts.	Shows inhibition against <i>Clostridium perfringens</i> .	[35]
3	<i>A. Scholaris</i> (chitvan)	Tannins, phenols and steroids	Experimental/ <i>in vitro</i>	Antimicrobial activity by disk diffusion method/the meoh soxhlet extracts of dried plant material (leaves, stem bark, root bark).	Plant extracts inhibits <i>Bacillus subtilis</i> , <i>Escherichia coli</i> and <i>Staphylococcus aureus</i> .	[36]
4	<i>A. paniculate</i> (kalamegha)	Andrographolide	Experimental/ <i>in vitro</i>	Cell cultured/ELISA.	Significant increases of <i>Lachnospiraceae</i> and <i>Ruminococcus</i> .	[37]
5	<i>A. cepa</i> (palandu)	Organosulfur derivatives, flavonoids, polyphenols, quercetin and glycosides.	Experimental/ <i>in vivo</i>	RCTs/45mg of PTS-0/kg of mice model.	Increases the population of <i>Coriobacteriaceae</i> , <i>Lachnospiraceae</i> , <i>Acidaminococcaceae</i> . Shows antimicrobial activity against <i>E. coli</i> , <i>Salmonella</i> , <i>Bacteroidetes</i> , <i>Klebsiella</i> .	[38]

6	<i>A. belladonna</i> (angurshafa)	Tropane alkaloids	Experimental/ <i>in vitro</i>	Antimicrobial activity by disk diffusion method/ethanolic extract of plant leaf.	Plant ethanolic extract exhibits antibacterial action against <i>Staphylococcus aureus</i> and <i>Escherichia coli</i> .	[39]
7	<i>A. Indica</i> (harita manjari)	Clonidine	Experimental/ <i>in vitro</i>	Antimicrobial activity by disk diffusion method/hexane, chloroform, ethyl acetate, methanol extracts from the leaves.	Hexane, chloroform, ethyl acetate and methanol extracts of <i>Acalypha indica</i> leaves showed antimicrobial activity against <i>Staphylococcus aureus</i> , <i>Staphylococcus epidermidis</i> , <i>Bacillus cereus</i> , <i>Streptococcus faecalis</i> and <i>Pseudomonas aeruginosa</i> .	[41]
8	<i>B. serrata</i> (saptaparni)	Boswellic acid	Experimental/ <i>in vivo</i>	RCTs/100mg/Kg/Asthmatic mice.	The consumption of plant extracts causes the growth of <i>Firmicutes</i> and <i>Lactobacillus</i> bacteria.	[40]
9	<i>B. hispida</i> (kushmani)	Triterpenoids, flavonoids, benzoic acid	Experimental/ <i>in vitro</i>	Antimicrobial activity by the disk diffusion method.	<i>Benincasa hispida</i> fruit extracts show antimicrobial activity against microbial and <i>Salmonella typhimurium</i> , <i>Pseudomonas aeruginosa</i> , <i>Proteus vulgaris</i> , <i>Serratia liquefaciens</i> and <i>Shigella marcescens</i> .	[42]
10	<i>B. lacera</i> (kukurandru)	Acyclic diterpene	Experimental/ <i>in vitro</i>	Antimicrobial activity by disk diffusion method/plant extracted with 95% ethanol.	Shows antimicrobial activity against <i>E. coli</i> .	[43]
11	<i>C. cyminum</i> (jeeraka)	Volatile oils, alcohols and aldehydes	Experimental/ <i>in vivo</i> /human model	RCT/16S sequencing and Phylogenetic investigations.	There is an increase in <i>Clostridium</i> , <i>Bacteroides</i> , <i>Citrobacter</i> , <i>Enterobacter</i> and <i>Enterococcus</i> .	[44]
12	<i>C. cassia</i> (tvak)	Phenolic compound, tannin	Experimental/ <i>in vivo</i> /Human model	RCT/16S sequencing and phylogenetic investigations.	It has inhibitory effects on <i>C. perfringens</i> , <i>B. fragilis</i> , <i>B. longum</i> and <i>L. acidophilus</i> .	[45]
13	<i>C. serratum</i> (bharngi)	Steroids, saponin and alkaloids	Experimental/ <i>in vitro</i>	Antimicrobial activity by the disk diffusion method, root of the plant extracted with 70% ethanol.	The leaf extracts of the plant show the maximum zone of inhibition against <i>Enterobacter aerogenes</i> and a moderate zone of inhibition against <i>Pseudomonas aeruginosa</i> .	[46]
14	<i>C. sinensis</i> (chasyamaparni)	Saponin	Experimental/ <i>in vivo</i>	RCT/16S sequencing and phylogenetic	Plant extracts increase the population of <i>Lachnospiraceae</i> , <i>Ruminococcaceae</i> , <i>Faecalibacterium</i> , <i>Roseburia</i> and <i>Blautia</i> .	[47]

15	<i>M. oleifera</i> (shigru)	Alkaloids, saponins, tannins, steroids, flavonoids	Experimental/ <i>in vitro</i>	investigation/ mice model. <i>In vitro</i> fermentation experiment.	Increases the population of <i>Bacteroidetes</i> and decreases the population of <i>Proteobacteria</i> .	[48]
16	<i>O.sanctum</i> (Tulasi)	Eugenol	Experimental/ <i>in vitro</i>	Disk methods for antimicrobial test/dried leaf powder mixed with boiled water.	Prevents microbial dysbiosis.	[49]
17	<i>P. Kurroa</i> (kutaki)	Androsin and apocynin	Experimental/ <i>in vitro</i>	The antimicrobial activity was evaluated by the cup-plate method/the dried rhizomes of the plant were extracted with methanol.	<i>Picrorhiza kurroa</i> shows antimicrobial activity against <i>S. aureus</i> , <i>E. coli</i> and <i>Bacillus subtilis</i> .	[50]
18	<i>P.majora</i> (ashvogola)	Tannins	Experimental/ <i>in vitro</i>	High-pressure anion exchange chromatography coupled with a multi- angle laser light scattering detector and fourier- transform infrared spectroscopy.	Enhances the growth of prebiotic bacteria like <i>Lactobacillus</i> .	[51]
19	<i>P. longum</i> (pippali)	Alkaloids, steroids, glycosides, flavonoids	Experimental/ <i>in vivo</i>	RCT/16S rRNA sequencing/ Mice model.	Promotes the growth of beneficial probiotics like <i>Lactobacillus</i> and <i>Bifidobacteria</i> . It also inhibits the growth of <i>Bacteroides</i> .	[52]
20	<i>T.indica</i> (amalika)	Beta - amyirin, campesterol, beta - sitosterol	Experimental/ <i>in vitro</i>	High- throughput sequencing.	It inhibits <i>Escherichia</i> , <i>Shigella</i> and <i>Dorea</i> and promotes the growth of <i>Lactobacillus</i> , <i>Prevotella</i> and <i>Faecalibacterium</i> .	[53]
21	<i>A.graveolens</i> (ajmoda)	Polyphenol, flavonoids	Experimental/ <i>in vivo</i>	RCT/16S rRNA sequencing /mice model.	Increases the abundances of <i>Lactobacillus</i> , <i>Ruminococcaceae</i> , <i>Faecalibaculum</i> and <i>Blautia</i> and decreases the abundances of harmful bacteria <i>Alloprevotella</i> and <i>Helicobacter</i> .	[54]

22	<i>B.flabellifer</i> (tada)	Flavonoids, phenols, alkaloids, saponins, tannins and terpenoids	Experimen tal/ <i>in vitro</i>	16S rRNA sequencing/ phylogenetic investigations.	Promotes the growth of <i>L. plantarum</i> , <i>E. faecium</i> , <i>P. acidilactici</i> and <i>P. pentosaceus</i> .	[55]
23	<i>B.diffusa</i> (punarnava)	Rotenoids and alkaloids	Experimen tal/ <i>in vitro</i>	Antimicrobial activity by agar disc diffusion method.	Gram-positive bacteria, including <i>S. aureus</i> , <i>B. subtilis</i> , <i>S. faecalis</i> and <i>M. luteus</i> , as well as gram-negative bacteria like <i>E. coli</i> , <i>S. typhi</i> , <i>K. pneumoniae</i> and <i>S. flexneri</i> , were all susceptible to the antibacterial activity of <i>B. diffusa</i> 's aqueous extracts.	[56]
24	<i>C.bonduc L</i> (latakaranja)	Terpenoids and phenolics, alkaloids	Experimen tal/ <i>in vitro</i>	Antimicrobial activity by agar disc diffusion method.	<i>Caesalpinia ponduc L</i> shows antimicrobial activity against <i>Staphylococcus aureus</i> , <i>Escherichia coli</i> and <i>Pseudomonas aeruginosa</i> .	[57]
25	<i>C.gigantea L</i> (arka)	Alkaloids, steroids, cardiac glycosides	Experimen tal/ <i>in vitro</i>	Antimicrobial well diffusion method.	Antibacterial activity against <i>K. Pneumoniae</i> and <i>E. coli</i> .	[58]
26	<i>C.Sativus L</i> (kumkum)	Crocin	Experimen tal/ <i>in vivo</i>	16s r DNA sequencing analysis/mice model/10mg/ kg.	Inhibits the growth of <i>Cyanobacteria</i> and <i>Proteobacteria</i> .	[59]
27	<i>E.hirta</i> (dugdhika bheda)	Kaempferol, luteolin, quercetin	Experimen tal/ <i>in vitro</i>	Antimicrobial activity/agar well diffusion.	Methanolic leaf extract exhibits antibacterial activity against <i>Escherichia coli</i> , <i>Bacillus subtilis</i> , <i>Staphylococcus aureus</i> and <i>Saccharomyces cerevisiae</i> .	[60]
28	<i>S.nigrum L</i> (kakamachi)	Tannins, alkaloids, flavonoids, and saponins	Experimen tal/ <i>in vitro</i>	Antimicrobial activity/agar well diffusion.	<i>S.nigrum L</i> leaves show <i>P.aeruginosa</i> .	[61]
29	<i>S.xanthocarpum</i> (kantakari)	-	Experimen tal/ <i>in vitro</i>	Antimicrobial activity/agar well diffusion/met hanolic extracts of the plant.	The methanolic extracts of <i>S.xanthocarpum</i> show antibiotic activity against <i>S. aureus</i> .	[62]
30	<i>T.indica</i> (arkaparni)	Alkaloids, flavonoids, terpenoids	Experimen tal/ <i>in vitro</i>	Antimicrobial activity/agar well diffusion/Met hanolic extracts of the plant.	Shows antimicrobial activity against <i>B. subtilis</i> , <i>S. aureus</i> , <i>M. luteus</i> and <i>Pseudomonas aeruginosa</i> .	[63]

31	<i>Curcuma longa</i> (haldi)	Curcumin	Experimental/ <i>in vivo</i>	RCT/16S sequencing and phylogenetic investigation/ Mice model.	Significant increase of <i>Prevotellaceae</i> , <i>Bacteroidaceae</i> , <i>Akkermansia</i> and <i>Rikenellaceae</i> .
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2. Discussion

As mentioned, the Ayurveda and Siddha herbs enhanced the growth of probiotic beneficial bacteria like *Lactobacillus*, *Bifidobacterium*, *Faecalibacterium*, *Akkermansia*, *Roseburia*, *Lachnospiraceae* and reduced the symptoms of asthma (Figure 1). *Lactobacillus* showed anti-inflammatory and anti-asthmatic effects by producing SCFA [64]. However, asthma symptoms improved after taking *L. gasseri* A5 orally, as evidenced by greater lung function and lower clinical symptom scores [65]. *Bifidobacterium* showed immunomodulatory effects and reduced the symptoms of asthma. The *Bifidobacterium breve* strain decreased the HDM-induced inflammation and the number of eosinophils and neutrophils [66]. Consumption of *Bifidobacterium* strain enhanced the number of regulatory T cells (T regs), CD⁴⁺ T cells that inhibited immune response hyperactivation and production of the cytokine IL-10 [67]. *Lachnospira* is an important producer of SCFAs such as acetate, propionate and butyrate. The SCFAs attach to the GPR43 on the surface of inexperienced CD⁴⁺ T cells [68]. The T regulatory transcription factors are thus encouraged to be acetylated by the SCFA-GPR 43 complex. Fox P3 is inhibited in naive CD⁴⁺ T lymphocytes by histone deacetylase suppression [69]. The *Akkermansia* genus prevents the onset of asthma by encouraging T-reg cell differentiation [70]. However, an attempt was made by Kuczma et al., an antigenic peptide from *Akkermansia*, which anergized T cells and boosted the population of peripheral T regulatory cells [71]. Asthma severity and fecal *A. muciniphilia* concentration were adversely correlated. Additionally, *Veillonella*, *Faecalibacterium* and *Rothia* are bacteria that prevent the onset of asthma [72].

The medicinal herbs significantly reduced the populations of harmful bacteria, including *Clostridium*, *Staphylococcus*, *Pseudomonas*, *Moraxella* and *Haemophilus*, which aggravate asthmatic symptoms (Figure 2). In addition, if *Clostridium difficile* colonization occurs within one month of birth, children are more likely to develop asthma [73]. In a child with asthma, fecal IgE levels were positively correlated with colonization by *Clostridium* species [74]. *Staphylococcus* bacteria cause eosinophilic asthma. Serine-protease-like proteins (SPLs), extracellular proteases released by *Staphylococcus aureus*, have been shown to aggravate eosinophilic asthma, as reported by Stentzel et al. [75]. SPLs and other proteases connected to the protease-activated receptors-2 on epithelial cells release alarmins such as IL-33 and TSLP that activate IL-4 and cause a Th2 response [76]. As an opportunistic pathogen, *Pseudomonas* is a gram-negative bacterium that causes bronchiectasis, COPD and other respiratory conditions. However, as per Tuli et al., the mucosal barrier is damaged by the planktonin exo-proteins isolated from *P. aeruginosa* [77]. When flagellin is obtained from *P. aeruginosa*, the powerful neutrophil chemoattractant IL-6 and IL-8 are secreted in greater amounts by human epithelial cells [78]. An increased risk of childhood asthma is linked to nasopharyngeal colonization by *Streptococcus*, *Moraxella* and *Haemophilus* species within the first year of life [79]. Asthmatics generally have lower bacterial diversity and more *Haemophilus* and *Neisseria*, associated with higher levels of Th2-related lung inflammation. *Moraxella catarrhalis* increased, epithelial injury was induced and inflammatory cytokines (IL-8, IL-33) were expressed [80]. A high population of *Moraxella* and *Haemophilus* is linked to a higher risk of wheezing at age 5. Histamine (Bronchoconstrictor) is secreted by *E. coli*, *Lactobacillus vaginalis* and *Morganella morganii*, which might increase the number of asthmatic attacks [81].

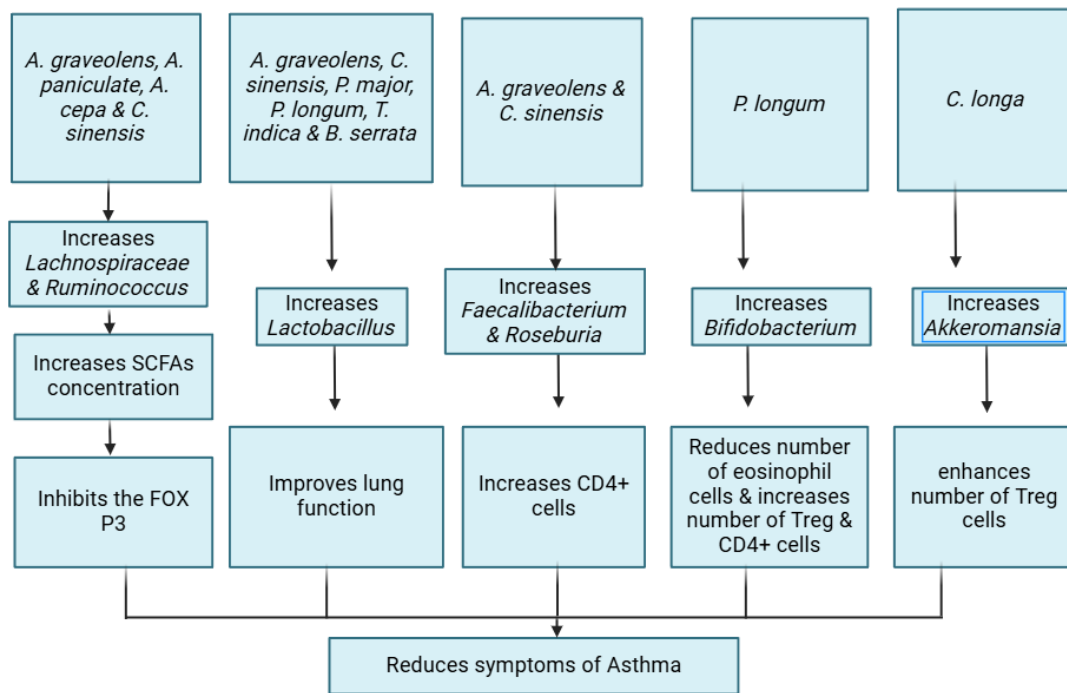


Figure 1: Medicinal herbs modulating probiotics anti-asthmatic bacteria.

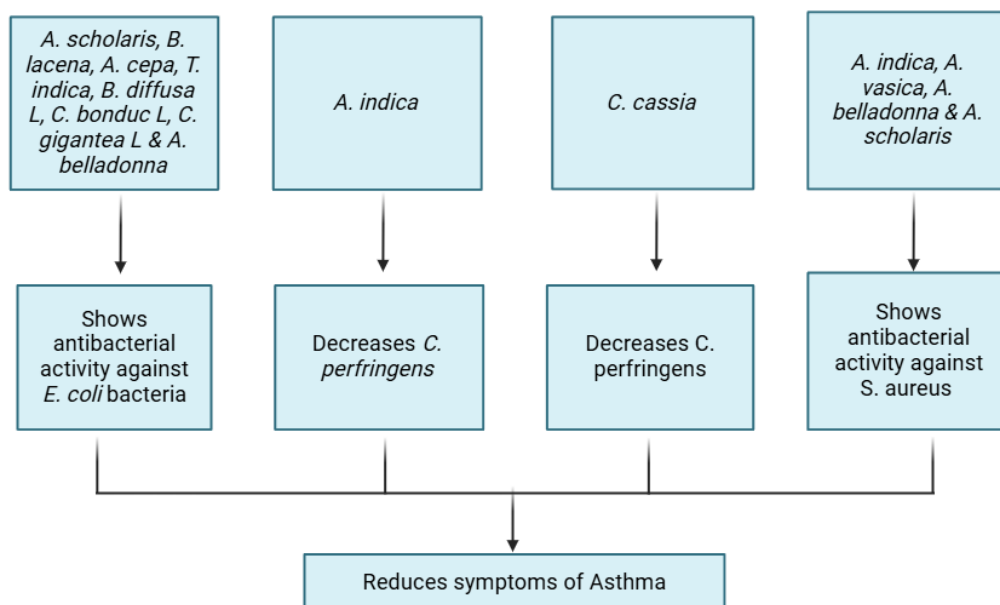


Figure 2: Medicinal herbs decrease the pathogenic asthmatic bacteria.

3. Conclusion

It could be comprehended that plant extracts are widely used to treat asthma in Ayurveda and Siddha systems and have the potential to promote the growth of probiotic anti asthmatic bacteria and antimicrobial activity against several pathogenic asthmatic bacteria. The

beneficial gut bacteria population might increase by consuming plant extracts, as gut microbiome colonization improves the various metabolic functions of the host. It had previously been proven that plant extracts rich in phytochemicals reduce the symptoms of asthma. The plant extracts are rich in phytochemicals, which may interfere with the growth of pathogenic microbiota populations and diversity. An increase in probiotic bacteria and a reduction of pathogenic opportunistic bacteria causes a reduction in the symptoms of asthma. It is challenging to comprehend how plant extracts affect the microbiota in the human gut, as limited experimental studies have been reported for drugs used in ayurvedic and siddha medicine. More studies need to be carried out in this direction to understand the mechanism better.

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