



# Role of herbal medicines in the treatment of infectious diseases

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Received: 7 September 2022 / Revised: 9 December 2022 / Accepted: 13 December 2022  
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## Abstract

Herbal medicines have helped to cure illness because the practice has continued for generations. Multiple alkaloids/compounds that occur naturally (as against single extracts) exhibit synergistic actions such as antiviral, antibacterial, anti-protozoal, and antioxidant. The cases related to viral, protozoal, and bacterial infections were selected. Patients with amoebiasis, *E-coli*, gastrointestinal infection, skin and urinary tract infections were treated using herbal drugs. Diagnoses were confirmed with investigations. Due to their cost effectiveness, these medicines are in great demand for primary health care with cultural acceptability and minimal side effects. The aim of the reported study is to show the actual use of Indian medicinal plants used for the treatment of various types of infectious diseases. Cases varying from COVID 19 to gastrointestinal infection, viral diseases, skin and wound infections are being treated effectively with herbal drugs.

**Keywords** Herbal medicines · Infectious diseases · COVID 19 · Alkaloids · In vitro studies · Medicinal plants

## Introduction

The use of herbal medicines for the treatment of various health challenges continues to expand rapidly across the world. There is a tremendous surge in acceptance and public interest in natural therapies both in developing and developed countries, with these herbal remedies being available not only in drug stores but also in food stores. Herbal medicinal products are the primary healthcare source for the large population living in developing countries. India has a rich traditional system of medicine. Therapeutic treatments like Ayurveda, Unani, Homeopathy, Sidha, etc., mostly use herbs. Natural herbal products are being used for the development of modern drugs and dietary supplements to food and beverages. Thus, traditional medicines have provided a good level of confidence in safety and efficacy as the medicines have been used for thousands of years. There is a growing interest in natural products as a source of new chemical entities for the development of modern drugs and for the use of natural products as dietary supplements,

ingredients to food and beverages, phytocosmetics, and other herbal products.

Herbal medicine is a botanical product that can be used in extract or dilution form. The usage increases when conventional medicine is ineffective because of the growing drug resistance. Large numbers of plant species are used by the Indian herbal industry. These medicines are the synthesis of the therapeutic experiences of generations of practicing physicians. The naturally occurring combinations of compounds exhibit antiviral, antibacterial, antiprotozoal, and antioxidant actions. Since people are more worried about using conventional medicines due to their growing drug resistance, they continue to use traditional herbal medicines for good healthcare. Many hundreds of plants worldwide are used in traditional medicine for the treatment of bacterial infections being the source for the development of antimicrobial compounds. Some of these have also been subjected to in vitro screening but the efficacy of such herbal medicines has seldom been rigorously tested in controlled clinical trials. Bacterial infection is another source of problem for mankind. Though conventional medicines have effective antibiotic therapy for bacterial infection, they do have drug resistance problems. Hence, many known plants are used globally for the treatment of bacterial infections. Thus, healthcare practitioners must be aware of herbal antibiotics. The present study is undertaken to assess critically those

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antibacterial herbal medicines that have been subjected to controlled clinical trials.

## Scientific studies

### Pharmacology

Pharmacology is the therapy of the interaction of biologically active agents with living systems (Munson et al. 1995) and is further divided into two main areas pharmacodynamics and pharmacokinetics. Pharmacodynamics looks at the effects of an agent at active sites in the body. In contrast, pharmacokinetics is concerned with the medicinal effect on the body. For therapeutic study, the aim is to examine the pharmacology of key chemical groups in plants as individual herbs under phytochemistry. Nutrients such as vitamins, minerals and so on are largely responsible for the pharmacological activity of plants.

### Secondary metabolites

Primary metabolites participate in nutrition and essential metabolic processes inside the plant, whereas secondary metabolites influence ecological interactions between the plant and its environment. Based on their biosynthetic origins, plant secondary metabolites can be divided into three major groups: terpenoids, alkaloids, phenyl propanoid, and allied phenolic compounds (Croteau et al. 2000). All terpenoids, including the primary metabolites, are derived from the five-carbon precursor isopentenyl diphosphate. Alkaloids are biosynthesized principally from amino acids and phenolic compounds by either shikimic acid pathway or the malonate/acetate pathway (Croteau et al. 2000). Two large groups of secondary plant metabolites can be distinguished in terms of their biological/therapeutic activities as suggested by Efferth and Koch (2011).

### Herbal medicines and conventional drugs

Though conventional drugs or their precursors are derived from plants, there is a fundamental difference between administering a pure chemical and the same chemical in a plant matrix. The homeopathic practitioner uses drugs in complex formulations whereas a conventional physician prescribes a single agent. It does seem logical that, just as our foods are chemically complex, so should be our medicines. There are, however, several phytotherapy examples and some of these are discussed below.

Synergy is an effect seen by a combination of substances that is greater than would have been expected from a consideration of individual contributions (Heinrich et al. 2004). It is an important hypothesis in herbal pharmacology in the

context of the advantage of chemical complexity. If the action of a chemical mixture is greater than the arithmetical sum of the actions of the mixture's components, the entire action is greater than the sum of the individual parts which can be considered as a cooperative or facilitating effect between the components for a specific outcome (Heinrich et al. 2004). In other words; components of plants that are not active themselves can act to improve the stability, solubility, bioavailability, or half-life of the active components. Hence a particular chemical in pure form may have only a fraction of the pharmacological activity that it has in its plant matrix. This key mechanism for synergy, therefore, has a pharmacokinetic basis.

## Infectious diseases

### Amoebiasis, giardiasis (gastrointestinal illness)

Diarrhea and dysentery are common gastrointestinal disorders in tropical countries and especially in Asian countries. They contribute enormously in terms of morbidity and mortality. Worldwide more than 1 billion people suffer from acute diarrhea. In developing countries, it amounts to over 2–3 million deaths per year. Amoebiasis has emerged as a major health problem worldwide. It is endemic in the present scenario and different in sub-tropical regions, especially in Asia. It is an infectious disease, which originated with the single-celled parasitic protozoan *Entamoeba histolytica*. The parasitic amoeba infects the liver and intestine and may cause mild diarrhea and serious dysentery with bloody and mucoid stool. Giardiasis is a common illness caused by a parasite that may result in diarrhea and stomach cramps. It is an infection in the small intestine and caused by a microscopic parasite called *Giardia lamblia*. The *Giardia* parasite can spread through contaminated water, food, and surfaces and from contact with someone who has it. Common organisms causing acute diarrhea are *E. coli*, shigella, vibrio cholera, *Staph. aureus*, giardia, salmonella, protozoa like *Entamoeba histolytica*, and viruses like rotavirus. Their average incubation period is less than 3–4 days. Pain in the abdomen, vomiting, fever are the main causes of diarrhea. Major complications arise from fluid and electrolyte imbalance due to loss of fluid and dehydration (Milleri and Murray 2018).

Herbal/homeopathic medicines discussed below have an excellent response to these conditions of diarrhea and dysentery and no other medicines are required to treat these acute diseases. The results on the patients are given in Table 1. The medicines *Holarrhena antidysenterica* and *Aegle folia* are given in tincture form which are ethanolic (90%) and drug strength of 1/10 as advised by homeopathic pharmacopeia of India. The efficacy of some of them is also tested in vitro to validate the results (Rakulini and Kalaichelvi 2019 and Boericke 1989, 1993).

**Table 1** Gastro-intestinal infections treated with herbal tinctures

Sr no	Sex/ age	Clinical presentation	Investigations	Drug and dose	Result
1	M/45	Diabetic, history of outside food loose stools/day Pain, cramps, dysentery abdomen, flatulens++	Stool: mucus ++, watery stools, pus cells 10–15, RBC+, e. histolytica + RBC 180,	Aegle folia tincture 10 drops 4 times	Diarrhea frequency reduced in 1 day no diarrhea after 24 h
2	F/68	History of stale tin food, vomiting, pain abdomen + bloating + The next day watery diarrhea 6–8 / day. nausea, acidity +	CBC: WBC 11,000, n: 80, l 12 stool: watery, offensive, RBC+, WBC 10–12	Holarhena antidysenterica tincture 15 drops 4 times	Watery stool better in 24 h, frequency reduced to 2–3/day no diarrhea after 36 h
3	M/8	Swimming in the pool. Pain in abdomen, vomiting on day one, followed by unformed stools next day, 3–4 /day for 4 days	Stool: giardia ++, mucus ++, RBC +	Aegle folia tincture. 10 drops 3 times	The stool improved in 2 days. Stool examination after 5 days. No giardia seen
4	M/1 year	History of travel, outside water taken watery stools 12–15/day, loud, offensive poor appetite, vomiting +, fever 100f, Anal redness, excoriation min. dehydration	Stools: watery, yellowish, offensive, pus cells 15–20 Epithelial cells: 6–8 RBC + + <i>E. coli</i>	Aegle folia tincture. 5 drops + Holarhena tincture 5 drops with water 4 times	With medicine and ors stool, frequency reduced in 24 h and no diarrhea after 2 days
5	M/65	History of dm, recurrent UTI, dysuria, fever recurrent diarrhea, weight loss, uncontrolled sugar, HbA1C: 8.6	Stool culture: <i>E. coli</i> colony count 1000000 resistant to common antibiotics	Aegle folia tincture 8 drops + Holarhena tincture 8 drops 4 times	Fever and diarrhea improved in 2 days and culture-negative in 6 days

***Holarrhena antidysenterica* (H.A.) [Family name: Apocynaceae]**

*Holarrhena antidysenterica* is commonly called Kutaja in India (Fig. 1). The plant grows wild in mountains, in the tropical Himalayas, going up to an altitude of 1200 m. Also, these are found throughout many forests of India, such as Travancore, Assam, and Uttar Pradesh. It is an herb of choice for amoebic dysentery. Kutaja (root, stem, and leaf) removes the amoeba from the body, which can cause severe problems like liver abscess. It can also be used for a natural cure of chronic diarrhea and dysentery and maintains the normalcy of the digestive system. The presence of alkaloids, phenolics, tannins, and triterpenoid-related compounds are identified through preliminary phytochemical tests. Thus, this drug inhibits acetylcholinesterase conessine, iso conessine, holarrhine, kurchamide, and holarrhifin (Sinha and Sharma 2013). These observations are authenticated through pharmacognostic studies by applying the specific stains on fresh free hand cross-sections of the stem tissue.

***Aegle folia* [Family name: Rutaceae]**

It is a perennial woody tree grown in kitchen gardens, boundary plantation around mango orchards, and forest plantations in most of the states of India (Fig. 2). *Aegle* belongs to one of the three monotypic genera of orange subfamily Aurantioideae, tribe Clauseneae, and subtribe Balsamocitrinae. *Aegle marmelos* Correa is deciduous, 6–8 m in height with trifoliate aromatic leaves. The branches sometimes bear long straight spines. The bisexual flowers are nearly 2 cm wide, and form in clusters. These are greenish white in color and sweet-scented. The fruits, having globose shape, are 5–7.5 cm in diameter, are oblong pyriform, with rind gray or yellow in color. The pulp is sweet and thick yellow with orange to brown in color. Seeds are numerous and arranged in the cells surrounded by slimy transparent mucilage.

Certain biochemical constituents namely alkaloids, coumarin, and steroid are isolated from different parts of the bael tree. These are Skimmianine, aegelin, Y-sitosterol, Aegelenine,



**Fig. 2** Bael (Wood Apple)

Myrlene, p-menth-1-en-3 beta, 5 beta diol, N-2 phenylethyl cinnamate, N-hydroxy ethyl cinnamide, N-4 methoxystyryl-cinnamate, N-2-hydroxy ethyl cinnamate, lupeol, sitosterol, Alloimperatorin, Imperatorin,  $\beta$ -sitosterol, marmesin,  $\beta$ -sitosterol, dietamine, marmin, umbelliferone, lupeol, marmelosin (Nivetha et al. 2020). Inhibition of multiple sars cov2 protein by anti-viralmolecule seselin occurs from *Aegle marmelos* and decipheres using molecular docking analysis. Seselin has the inhibitory potential over multiple sars cov2 targets and holds a high potential to work effectively as a novel drug for COVID 19 (Boericke 1989; Sinha and Sharma 2013).

Clinical results carried out on patients who suffered gastrointestinal infections are shown in Table 1. Patients were treated with different herbal tinctures. Stool culture was taken from the patients having gastrointestinal infections. *S. aureus* was isolated as a causative organism. Sensitivity studies were done with a homeopathic herbal solution (0.1 ml) with a 5 mm sterile culture disc. 90% alcohol was kept as a standard as tinctures are hydro-alcoholic. Zone of inhibition was studied in comparison with alcohol disc. Disc with the combination of *Aegle folia* and H.A. showed maximum zone of inhibition. This experiment is shown in Fig. 3. A similar in vitro experiment was performed using *E. coli* culture and depicted as shown in Fig. 4.

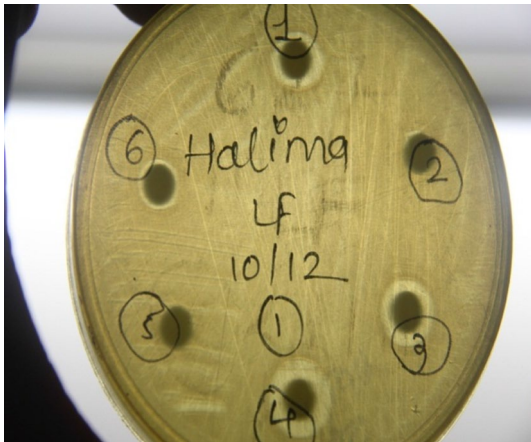
**Fig. 1** Kutaja







**Fig. 3** *Staph. aureus* culture: (1) *Cynodon* tincture, (2) *Echinesia* tincture, (3) *Gambogia* tincture, (4) *Podophyllum* tincture, (5) Ethanol control, (6) *Aegle folia* tincture (7) *Holarrhena* tincture (8) *Aegle folia* + *Holarrhena* tincture



**Fig. 4** *E. coli* culture (1) *Aegle folia* tincture, (2) *Azardichata* tincture, (3) *Holarrhena* tincture, (4) *Aegle folia* + *Holarrhena* tincture, (5) *Cynodon* tincture, (6) Ethanol control

## Wound healing

The wound is an anatomical and functional disruption of the skin following an injury. In response to the injury, wound healing is a complex process of tissue repair or remodeling. Wound care is constantly evolving with the advances in medicine. Platelets with fibrin help in clot formation at the injury site. Mediators of inflammation are released along with the cellular response primarily at neutrophils and granular sites which help in wound healing. Herbal medicines are used by Ayurvedic practitioners and folk medicine practitioners for thousands of years.

In the current times, different types of biopolymers are being researched for developing economical, sustainable, stable, and effective delivery systems for the treatment of wounds. Recent scientific evidence and clinical trials conducted using traditional and alternative medicine in wound therapy hold good promise in the future.

### *Calendula Calendula officinalis* [Family name: *Asteraceae*]

*Calendula* (*Calendula officinalis*) is a plant known as pot marigold (Park 1995). It is a genus of about 15–20 species of annual and perennial herbaceous plants in the daisy family *Asteraceae* often known as marigolds (Stace 2010). They are native to southwestern Asia, Western Europe, Macaronesia, and the Mediterranean. The flowers of *C. officinalis* contain flavonol glycosides, triterpene oligoglycosides, oleanane type triterpene glycosides, saponins, and a sesquiterpene glucoside (Ukiya et al. 2006 and Yoshika et al. 2001).

*Calendula officinalis* oil is still used medicinally as an anti-inflammatory and a remedy for healing wounds in homeopathic and herbal literature (Okoh et al. 2008). *Calendula* ointments are skin products available for use on minor cuts, burns, and skin irritation (Leach 2008).

Plant pharmacological studies have suggested that *Calendula* extracts have antiviral, antigenotoxic, and anti-inflammatory properties in vitro (Jimenez-Medina et al. 2006). In herbalism, *Calendula* in suspension or in tincture is used topically for treating acne, reducing inflammation, controlling bleeding, and soothing irritated tissue. Topical application of *C. officinalis* ointment has helped to prevent dermatitis and pain (Pommier et al. 2004). *Calendula* is being used traditionally for abdominal cramps and constipation. *Calendula ethanolic* tincture is used locally as an anti-inflammatory and septic agent. The aqueous-ethanol extract of *C. officinalis* flowers shows both spasmolytic and spasmogenic effects, thus providing a scientific rationale for this traditional use (Bashir et al. 2006).

### Echinacea

Echinacea, also known as the purple coneflower, is a herbal medicine that has been used for centuries, customarily as a treatment for the common cold, coughs, bronchitis, upper respiratory infections (David and Cunningham 2019), and some inflammatory conditions. Echinacea is promoted as a dietary supplement for the common cold and other infections, based on the idea that it might stimulate the immune system to more effectively fight infection. Echinacea preparations have been promoted for topical use (application to the skin) for wounds and skin problems. Current evidence

indicates that the risk of interactions between *echinacea* supplements and most medications is low.

The antibacterial activity of marigold (*Calendula officinalis*) extract and *echinacea* on two reference strains namely *Staphylococcus aureus*, and *Pseudomonas aeruginosa* were investigated (Fig. 5). From the present study, it is seen that there is the most antibacterial activity of marigold methanolic extract and essential oil on gram-positive bacteria. For *Pseudomonas* and *Staph. aureus*, the most active medicine is tincture (1:10) with 90% alcohol for the exhibition of highest activity. *Pseudomonas* and *S. aureus* is common pyogenic bacteria associated with wound infections which can cause delayed healing. Calendula and echinacea effectively treat these infections and help wound healing.

## Epidemics

### A. Dengue

Dengue is a mosquito-borne viral infection. Dengue virus is transmitted by female mosquitoes mainly of the species *Aedes aegypti* and, to a lesser extent, *Aedes albopictus*. The mosquitoes are vectors of chikungunya, yellow fever and Zika viruses. It is found in tropical and sub-tropical climates worldwide, mostly in urban and semi-urban areas. About half of the world's population is now at risk. The global incidence of dengue has grown dramatically in recent decades. Dengue is prevalent in Asian and African countries where climate is humid and poor sanitation. The patient

generally suffers severe head ache, pain behind the eyes, muscle and joint pains, nausea, vomiting, rash etc.

Dengue is a viral fever. Viruses such as Arbo virus, RNA virus are transmitted by *Aedes aegypti* mosquito, in tropical countries, typically in monsoon season. After incubation period of 2–7 days, patient gets symptoms of fever, head ache, body and muscle pains and retro orbital pains called as break-bone fever. A macular rash appears after 3–4 days. Illness typically lasts for 7–8 days. The illness can cause complications like thrombocytopenia, epistaxis, dengue hemorrhagic, and dengue shock syndrome. The fatality rate can be up to 8% (Clarence 2011).

A few dengue cases were treated effectively at the clinic in Mumbai in dengue epidemic of 2014. Commonest herbal medicines in the tincture form used were (1) *Eupatorium perfoliatum* and (2) *Bryonia alba*.

### *Eupatorium perfoliatum* tincture [Family name: Asteraceae]

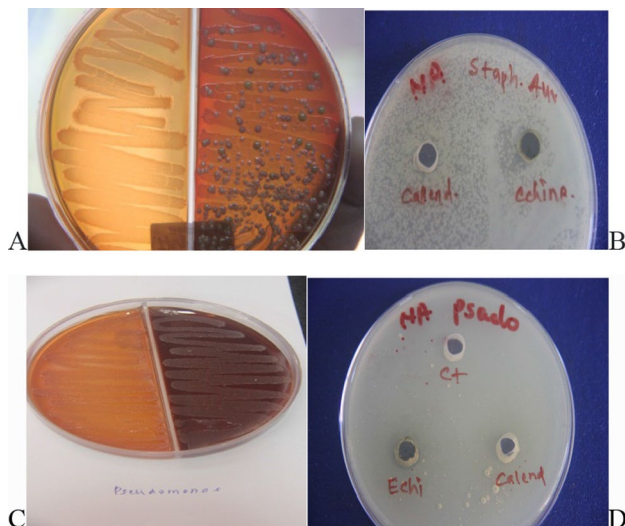
The tree (Fig. 6) commonly called snakeroot or boneset, is a genus of flowering plants in the aster family, containing about 30 to 60 species depending on the classification system. The perennial plant is native of US and Canada growing to almost 4 m. Stem and flowers contain plant chemicals such as eupafolin, curcumin, cutin, kaempferol, quercetin, gurgunen and are generally used for dengue, viral fever, and flu (Saeed-ul-Hassan et al. 2013; Jatoliya and John 2020; Phatak 1972; Hensel and Mass 2011).

### *Bryonia* tincture [Botanical name: *Bryonia alba*]

*Bryonia* is a plant in the gourd family (Fig. 7). This perennial climbing vine has white flowers, red berries, and a thick, fleshy root with a strong, bitter odor. Its root is used as a medicine to prevent infection and to treat several diseases like intestinal diseases, lung diseases, arthritis, liver disease, and metabolic disorders. The appropriate dose of bryonia depends on several factors such as patient's age, health, and several other conditions. As a Homeopathic medicine it is used for the treatment of dengue and relieves muscle and joint pain in the body with no side effects and no known drug interactions.

### B. COVID 19

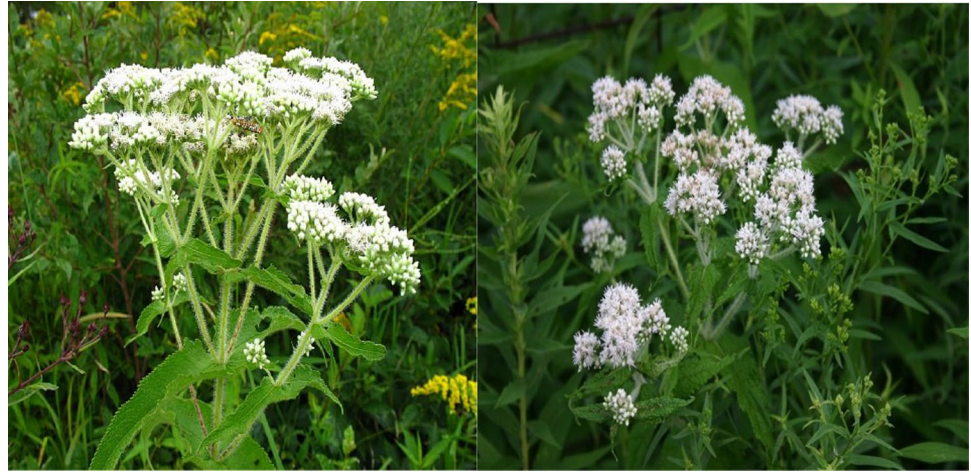
COVID 19 is the most devastating pandemic mankind has seen in last hundreds of years. This viral pandemic is caused by RNA virus and human to human transmission by droplet infection. Primary target is respiratory system, leading to symptoms ranging from coryza, cough, sore throat, hoarseness, bronchitis, pneumonia to ARDS and pulmonary fibrosis.



**Fig. 5** *Pseudomonas* and *S. aureus* are common pyogenic bacteria associated with wound infections which can cause delayed healing. Calendula and Echinacea effectively treat these infections and help wound healing. **A** *S. aureus* culture plate. **B** *S. aureus* sensitivity for Calendula and Echinacea. **C** *Pseudomonas* culture. **D** *Pseudomonas* sensitivity to Calendula and Echinacea



**Fig. 6** *Eupatorium perfoliatum* plant



**Fig. 7** *Bryonia* plant



Inflammation and uncontrolled immune response are the pathological events leading to all the complications. Lower respiratory tract is most affected. ACE 2 is the target receptor of COV 2. ACE 2 expressions is seen in lung epithelium as inflammation and endothelial injury. Increase in cytokines like IL6, IL 10 which trigger violent inflammatory response in lung and other organs. Cytokine storm to lung is common cause of death. There are a very few effective drugs to control this pathology except steroids. Most of other drugs used for treatment are found ineffective.

COVID cases which are mild to moderate and few severe cases were treated with indicated homeopathic medicines along with a few herbal extracts at Dr. Barve's Clinic in Mumbai as indicated in Table 2. The drug strength of these hydro alcoholic extracts was 1/10 and was prepared as directed by Homeopathic Pharmacopeia of India. Following drugs were effectively used:

**Aspidosperma Quebracho Blanco tincture [Family name: Apocynaceae]**

This is an evergreen tree that grows in Argentina (Fig. 8). Tincture is prepared from stem bark. It helps in improving oxygenation which is effective remedy for asthma. The tincture given 10–15 drops three to four times a day stimulates respiratory center. Drug strength is 1/10 in ethanolic extract

(Verma 2006). Aspidosperma contains alkaloid. Yohibine and tannins can be used in bronchitis also since it has anti-inflammatory properties (Fern 2021). The lung capacity is increased as it contains alkaloids, aspidospermine, aspidosamin, and quebrachine (Horatio 1908). Aspidosperma reduces edema, infiltration of cells, and vasodilatation in the lung, and thus has anti-inflammatory properties (De Souza et al. 2017). Aspidosperma is found effective in trials conducted in asthmatic patients (Sukriti et al. 2020). Aspidosperma alkaloids antagonize the spasmodic action of ACTH and histamine on smooth muscle (Banerjee et al. 1954).

***Justicia adhathoda* tincture**

*Justicia adhathoda* plant and leaves are used for the preparation of tincture (Fig. 9). The plant is a rich source of vitamin C. The active alkaloids are vasicine, adhatodine and vasicinone (Dhankar and Kaur 2011). The tincture is used for respiratory tract illness, asthma, bronchitis, and cough. It has anti-inflammatory, anti-tussive and mucolytic properties and thus clears mucus secretions. Vasicoline shows good inhibitory activity on replicase RdRP and protease (Bag and Bag 2020). Vasicine, vasicol, vasicinone, adhatonine all have anti-cholinesterase activity, anti-tussive, and anti-inflammatory activity (Ahmad et al. 2009). *Justicia* shows anti-bacterial activities against bacteria like *S. aureus*, *Klebsiella*,

**Table 2** COVID 19 patients treated with herbal medicines

Sr. no	Drug used	Drug strength of ethanolic extract	Indications	Dose and repetition	No. of patients	Results
1	Aspidosperma quebracho	1/10	COVID 19 with breathlessness with bilateral pneumonia or ground glass opacities, known asthmatic, emphysema, O <sub>2</sub> saturation less than 94%	Min. 10 drops with water twice a day to max: 15 drops 4 times	15	Oxygenation and breathlessness improved in 2 days in 70% patients out of which 4 cases were on positive pressure O <sub>2</sub>
2	Senega Polygala	1/10	Old patients with COVID 19, dry cough, rattling mucus, difficult expectoration, dry cough with dyspnoea, viscid mucus, hoarseness, pleural effusion,	Min: 15 drops 3 times with water to max: 20 drops 3 times	18	Senega helped as mucolytic. Reduced cough paroxysms in old people esp. with h/o chronic bronchitis, aphonia and hoarseness. Improved in 3–4 days. Helped to clear opacities in lung faster
3	Justicia adhatoda	1/10	Early stages of Covid to prevent further cytokine storm, cough, coryza, sore throat, acute catarrhal stage	Min. 10 drops 3 times a day with water, Max: 15 drops 4 times a day (excess dose can cause nausea)	24	Reduces catarrhal phase effectively, given in mild cases early in disease phase. Prevents cough leading to breathlessness. Out of 24 only one patient had developed breathlessness

*Pseudomonas* which can cause secondary infections of lung. Vasicine and vasicinone combined together produce broncho dilatory effect in alcoholic extract (Baral et al. 2018).

Recent study on Vasicine concludes that Vasicine could be a potential target for treatment of COVID 19. Vasicine efficacy against corona virus infection symptoms evaluated by silica screening studies on virus protein ACE 2 receptors, 3CL protease and spike protein SARS HRI motif using PyRx tool and Auto DOC1.5.6 based on PyRx results, vaccine with ACE2 receptors show higher docking affinity score (– 7.1 K/cal). These were repeatedly compared with other virus proteins (Thangaraju et al. 2021 and Ghosh and Chakraborty 2021). It can be useful in dry cough, hoarseness, suffocative feeling dyspnoea, vomiting, yellowish expectoration, bronchitis, pneumonia (Ghosh 1984).

The flowering plant is perennial and grows in North America and South Canada (Fig. 10). The common name is snakeroot. The root is used for medicine, as it contains saponins, senegin, sorbitol, sterol and phenolic acid. The senega tincture (from roots) is used for dry cough, wheezing, chest congestion, rattling mucus and cough, dyspnoea, aphonia, bronchitis and emphysema (Verma and Yadav 2013; Boericke 1989) 0.80% ethanolic extract inhibits inflammatory cytokines IL1B, IL6 when tested in RAW264.7 macrophage cell system (Van Qet et al. 2009). Segega acts as expectorant and expels phelgm, mucololytic action due to saponins in senega which reduces viscosity of cough (Kalra and Khatak 2011). Senega has anti-tussive and expectorant activity (Gairola et al. 2010).

## Discussion

Detailed studies on Gastro-Intestinal Infections patients and COVID 19 patients were conducted with their food habits, clinical investigations and the quantity of drugs given. The cases related to viral, protozoal, and bacterial infections were selected. Patients with amoebiasis, *E-coli*, and gastro-intestinal infection, skin and urinary tract infections were treated using herbal drugs. Diagnoses were confirmed with investigations. Repeated investigations were carried out to confirm the improvement. Drug and plant review of herbal medicines used is also described in the text.

## Concluding remarks and future perspectives

Herbal medicines and plant extracts are widely used in the treatment of various infectious diseases due to their effectiveness, safety and affordability. Antimicrobial resistance being the major concern in today's modern medicine, the researchers are convinced to go for selecting and standardizing plant treatments since they heal or prevent infectious



**Fig. 8** *Aspidosperma* Quebracho Blanco plant



**Fig. 9** *Justicia adhatoda* Senega Plant [Family name: Polygonaceae]



**Fig. 10** *Senega polygala* plant



diseases. There is a need for precisely conducting in vitro and in vivo studies to target antimicrobial efficacy of plants. The quality of available plant species is limited to a particular geographical area. Because of environmental conditions and pollution, therefore scientific cultivation of medicinal plants is very necessary for the reproducibility of the

composition of plant products. On the basis of increasing resistance of bacteria for the standard therapies, the current role of plants could be summarized as treating acute infections, skin or wound infections, and viral diseases including COVID 19. Rather than using a single extracted alkaloid from the plant, if we use the plant as a whole, as available

in nature, the naturally occurring group of alkaloids in the plants have better synergistic action without side effects. Average particle size of homeopathic herbal tinctures used, ranged between 2 to 34 microns which helped to deliver medicine to the patients very effectively. The above study shows the effectiveness of plant extracts of *Aegle folia* and *Holarrhena antidysenterica* in the treatment of gastroenteritis, *Aspidosperma*, Senega, and *Justicia* in the treatment of viral bronchitis and cough. Also, for the treatment of viral diseases like dengue, *Eupatorium perfoliatum*, and *Bryonia alba* have shown excellent results. Skin and wound infections with pyogenic bacteria show excellent results (in vitro and in vivo) using herbal drugs like calendula and echinacea. Thus the knowledge of medicinal plants reveals the foundation to pharmacological research.

**Acknowledgements** The author (RSC) acknowledges the constant support from Dr. Anushree Lokur, Principal, Ramnarain Ruia Autonomous College, Mumbai, India and also expresses his gratitude to Dr. Barve's Clinic, Mumbai for the clinical results. RSC thanks Navjeet Kaur for arranging the whole manuscript as per standard of the journal. RSB thanks AIMIL Vadodara Laboratory, Vadodara, India and Dr. Pusalkar's laboratory, Sewree, Mumbai, India.

## Declarations

**Conflict of interest** The authors declare that they have no conflict of interest.

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