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Herbal remedies for prophylaxis of Covid-19: A critical review on chemistry and pharmacology of eleven domestic herbs

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Abstract
Since the outbreak of Coronavirus disease (COVID-19) caused by SARS COV-2 in early December 2019, its impact on human life throughout the world and the complications thereof has been published widely. In spite of tremendous study and research, there is no established medicine, or fully effective vaccine for COVID-19 to date. So, prevention is the key to combat COVID-19. The concept of immunity in the ancient science of life i.e., Ayurveda offers a holistic approach and a potential promise regarding immunotherapy. Depending upon the ease of availability of crude drugs in most of the Indian kitchens and in nature, eleven noble herbs are selected namely: *Cinnamon, Giloya, Haridra, Tulsi, Black pepper, Vasa, Bhumyamalaki, Kantakari, Laung, Mulethi, and Shunthi* that possess the immune-modulatory and /or antiviral effects as reported in the literature. These herbs contain a variety of phytochemicals responsible for their Pharmacological effect, and when administered in form of Kwath, may prove to be an important prophylactic therapy against COVID-19 due to Kwath's unique qualities, viz. good adaptability, better absorption, and assimilation in the body system, and retention of many of the water-soluble portions present in raw materials. Here we review the chemistry and pharmacological properties of eleven selected herbal drugs, that, if taken in form of Kwath, may act as an immunomodulator, by strengthening the immunity and provide the capacity to resist the external disease-causing agents including SARS COV-2. A glossary of important Ayurvedic terms used in this review is provided at the end to help understand the article well.

Keywords: COVID-19, domestic herbs, immunomodulation, kwath, antiviral

Introduction
On 11 February 2020, The World Health Organization (WHO) declared the name for the new corona virus disease as COVID-19. Since the first COVID-19 case reported in early December 2019, and as of 20th March, 2022, the confirmed COVID-19 cases reached over 470 million worldwide [1, 2] and the number is still increasing. The causative organism of COVID-19, severe acute respiratory syndrome coronavirus 2 (SARS CoV-2), is typically present with systemic and respiratory manifestations. Some individuals infected with SARS-CoV-2 are asymptomatic and can act as carriers. Symptoms and signs are non-specific such as fever (85-90%), cough (65-70%), fatigue (35-40%), sputum production (30-35%) and shortness of breath (15-20%) [3].
In search of therapeutics against SARS-CoV-2, researchers are using the following three broad strategies;

1. Test existing broad-spectrum anti-viral drugs,
2. *In silico* screening of molecular databases to identify the lead molecules against viral or host proteins and
3. Rational drug design based on the genomic information and pathological characteristics of COVID19.

Among these, the repurposing approach will shorten the time and reduce the cost as compared to other strategies. Apart from the above strategies, alternative approaches including traditional and herbal medicines may also have significant potential for the management of COVID-19 both as prophylaxis and therapeutic purpose [4].

Role of Immunity in combating COVID-19
1. Innate and adaptive immune system
The normal function of the immune system is recognizing, repelling, and eradicating pathogens and other foreign molecules. Specific immunity depends on the recognition of specific antigens by Cytotoxic T or B lymphocytes, and the subsequent formation of matching antibodies [5]. This requires T helper (Th) lymphocytes. The two main types are Th1, associated with T lymphocytes and Th2, associated with B lymphocytes. Regulation of the immune system depends on the balance between these two cell types. Specific immunity is acquired each time new antigens, including microorganisms, are encountered. Every time the immune system encounters a new infection, it develops or learns immunity to that infection, and an immunological memory is formed so that the next time the same infection is encountered, the individual is immune and there is no inflammatory response. Cytotoxic T cells respond to foreign cells, including tumor, transplant or virus-infected cells. They carry

receptors for recognition of intra-cellular antigens on their cell membranes [6]. B cells divide to form plasma cells that secrete antibodies into the circulation. There are five classes of antibodies and the most abundant is IgG. Antibodies are usually formed actively, but they can be transferred passively. The first exposure causes the stimulated lymphocyte clone to form memory cells. At second or subsequent exposure to the same antigen, the memory cells stimulate production of large numbers of specific, matching antibodies within hours. These rapidly bind and neutralize the pathogen, preventing the development of illness [7].

2. Immunopathogenesis of COVID-19

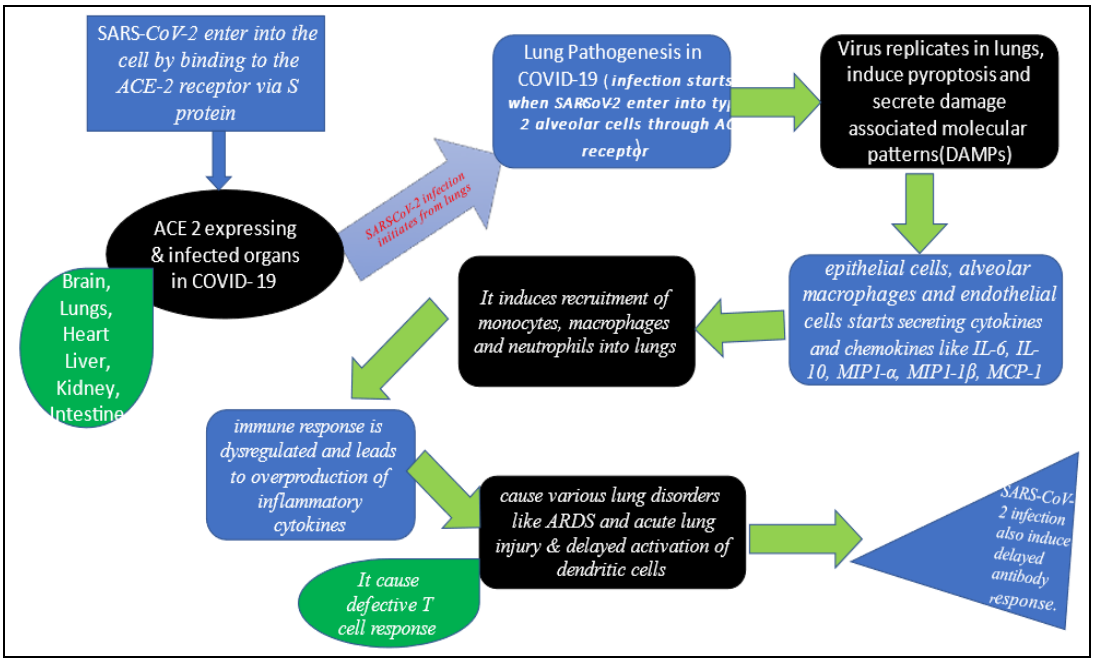


Fig 1: Immunopathogenesis of COVID-19 [8]

Fig. 1 represents the schematic diagram of SARS-CoV-2 invasion and replication into host cells in step wise manner: (1) SARS-CoV-2 gain entry into the lung cells through ACE2 receptor. ACE2 receptor is expressed by different organs of the body like brain, lungs, kidney, liver and intestine. SARS-CoV-2 frequently infects these organs but the pathogenesis of SARS-CoV-2 infection initiates from lungs and cause major damage to the lungs. Lung infection starts when SARS-CoV-2 enter into type 2 alveolar cells through ACE2 receptor. (2) Virus replicates into the lung cells and induce cells to undergo pyroptosis and secrete damage associated molecular patterns (DAMPs). (3) DAMPs are recognized by adjoining epithelial cells, alveolar macrophages and endothelial cells which stimulate the secretion of various pro-inflammatory cytokines and chemokines like IL-6, IL-10, MIP1-α, MIP1-1β, MCP-1. (4) Release of theses cytokines and chemokines induce the recruitment of monocytes, macrophages and neutrophils into lungs which further secrete the proinflammatory cytokines and form the inflammatory feedback loop. (5) During SARS-CoV-2 infection immune response is dysregulated which leads to the persistent recruitment of immune cells which promote overproduction of inflammatory cytokines which cause various lung disorders like ARDS and acute lung injury. SARS-CoV-2 infection induces delayed activation of dendritic cells that cause defective T cell response. Most of the T lymphocytes in SARS-CoV-2 infection are induced to become Th1 cells. SARS-CoV-2 infection also induce delayed antibody response [8].

3. Role of Antigens and Antibodies

The key factor for COVID-19 to occur and evolve is the interaction between the virus and an individual's immune system. As medicinal plants enhance Natural Killer (NK) cell activity, inhibit activated transcription factor 2 (ATF-2), down-regulate Th17-related cytokines including RAR Related Orphan Receptor C-transcription factor RORc, Inter lukin (IL)-17A and Th2-related cytokines including IL-5, IL-13, and IL- 6, inhibit GATA3, IL-4, IL-6, IL-1β, RORγt, IL-17A, TNF-α expression and increase the secretions of IL-10, INF-γ, etc., it shows that natural products have potent immune modulatory and immune-boosting effects that may be helpful during the infection course by increasing innate immune response to infections [9].

Ayurveda Purview

Bhaishajya Kalpana [10] (Ayurvedic Herbal Pharmaceutics) endorses the five fundamental dosage forms, namely, Swarasa (Fresh juice), Kalka (Herbal paste), Kwatha (Herbal decoction), Hima (Coldwater infusion), and Phant (Hot water infusion). Among them, Kwatha Kalpana is the most significant and widely used dosage form in Ayurvedic pharmaceutics. Decoctions also form the base of various Ayurvedic formulations such as Asava,

Arishta, Taila, Gutika, and Avaleha in various pharmaceutical processes. It is used internally for drinking purposes, medicated enemas, and externally for eyewash [11].

Pharmaceutical factors are needed to be controlled such as vessel, temperature, the proportion of water, the particle size of crude drug, duration of heating, and quantity of Prakshepa Dravyas. The renowned eleven herbs considered in this article have been used in the traditional system of medicine for the treatment of jwar, swasa, and Kasa. Every single herb is proven as the safest drug and is being used individually for their beneficial effects.

1. The importance of Ayurveda in boosting the immunity

Ayurveda, a traditional system of medicine, was originated in India more than 3000 years ago. The term *Ayurveda* is derived from the Sanskrit words ayur (life) and veda (science or knowledge). The classic Ayurveda text Charaka Samhita [12], mentioned about epidemic management and defines immunity as the ability to preventing and arresting the progression of disease for maintaining. The Ayurveda pays larger emphasis on building strength of mind and body to cope with various stressors, including infection. Similar to innate and acquired immunity, the Ayurveda concept of immunity (Bala or strength) is classified as natural (Sahaja), chronobiologic (Kalaja), and acquired (Yuktikrut). In Ayurveda several treatment options are available for enhancing immunity against respiratory illnesses, these include certain immune modulators (known as Rasayana), local and systemic intervention. Local prophylaxis measures such as herbal decoctions, consumptions of hot water, gargling with medicated water, and steam inhalation described in Ayurveda for respiratory illnesses. These interventions can be quickly implemented on large scale with the advantages of simplicity, affordability, and acceptability. This is clearly evident that such traditional measures can positively influence mental health and immune function through modulating psycho neuro immune pathways. Ayurveda has enough potential and possibilities to be employed both for the prevention and an adjunct treatment option for COVID-19.

2. Concept of Ayurveda

Ayurveda emphasizes the promotion of health through the strengthening of host defences, to act as a resistive force against day-to-day physiological extremes as well as opportunistic maladies. This force to reckon with, as regards everyday wellness is termed as “Vyadhiksamatwa” [13] in Ayurveda. The concept expounds both preventive medicine aspects along with curative aspects of treatment as the self-explanatory terms “Vyadhibalavirodhitvam” and “Vyadyutpadapratibandhakatvam”.

Vyadhiksamatwa has tremendous importance in the daily wellness of human beings for prevention and recovery from diseases. When etiological factors come in contact with body they try to produce disease. At the same time, body tries to resist the disease. Vyadhiksamatwa in Ayurveda is not merely immunity against a specific infectious agent or disease. Rather, it implies resistance against the loss of the integrity, proportion, and interrelationship amongst the individual’s Dosas and Dhatus. Ayurveda classics described countless useful dravya, formulations, mode of conducts to enhance immunity (Bala or Vyadhiksamatwa), and they are used in combination with each other [14].

Kwath: A simple and effective Ayurvedic dosage form

Kwath/Kashaya means decoctions, it is prepared by boiling herbs in water for specific time and temperature [15]. Kwath, as immunity boosting health drink recommended by AYUSH ministry, contains *Tulsi (Ocimum sanctum), Dalchini (Cinnamomum zeylanicum), Sunthi (Zingiberofficinale)* and *Krishna Marich (Piper nigrum)* [16]. An attempt has been made to add and review some more commonly available herbal ingredients in form of a Kwath, pertaining to its Anti-viral, Immunomodulator, Anti- inflammatory and other pharmacological effects which are involved in the prevention of covid infection from literatures and scientific publications. There is a very well-developed sub-discipline entirely devoted to drug formulations known as “Rasa-shastra and Bhaishajya Kalpana”. Kwatha Kalpana is having the upper hand because of its many unique qualities, namely, easy availability of raw materials, single drug-herb decoction, good adaptability, better absorption, and assimilation in the body system, and retains many of the water-soluble portions present in raw materials.

1. Probable mode of action of *Kwaths*

Rasayanas are those that bring about proper uptake, growth, and improvement of essential seven vital tissues, which ultimately increases Oja. Thus, there is a regeneration of cells and body tissues leading to increased immunity [17].

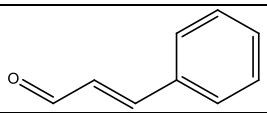
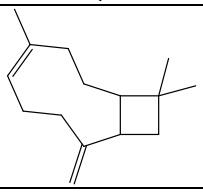
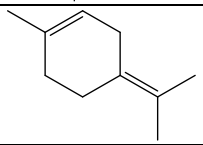
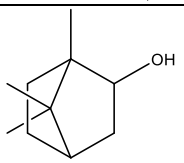
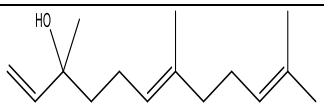
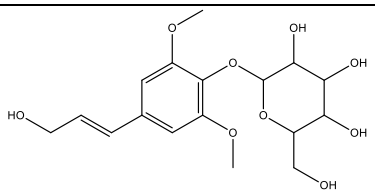
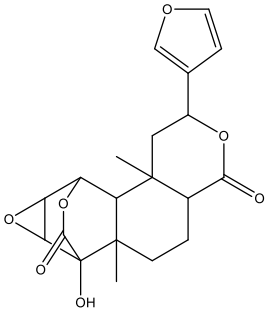
When Rasayana (drugs of different Rasas) are taken, they are digested by Jatharagni followed by Bhutagni. During this phase Vata, Pitta and Kapha were produced along with Sara part i.e. Ahaara Rasa. This qualitative Ahaara Rasa produces pure Rasa Dhatu, which then continues the chain of production of other RaktadiDhatus with the help of respective Dhatavagni up to Oja's formation. Therefore, well-formed Dhatus keep on nourishing the body till they are taken. Rasayana drugs act at the level of Rasa by improving the nutritional value of the Poshak Rasa which helps to obtain the best quality of Dhatu and some Rasayana drugs act at the level of Agni and Stratos by improving digestion and metabolism. The Rasayana drugs possessing the Ushna, Laghu, Ruksha, and Katu, Tikta, Kashaya Rasa acts at the level of Agni, vitalizing the organic metabolism leading to an improved structural and functional pattern of Dhatus [18].

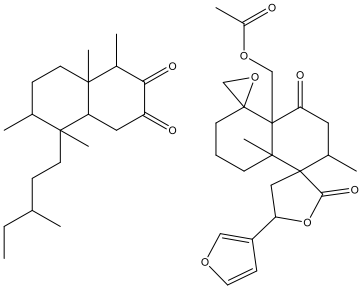
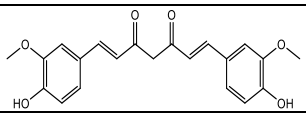
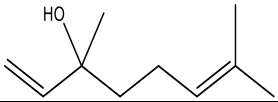
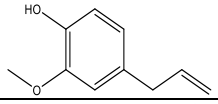
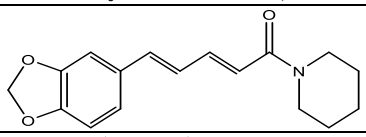
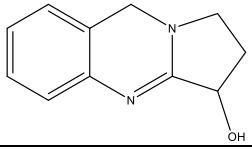
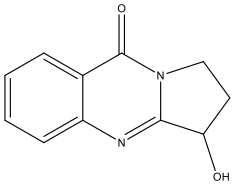
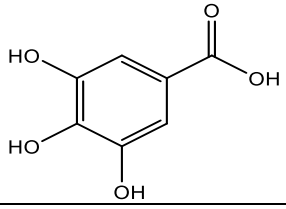
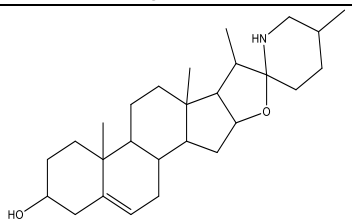
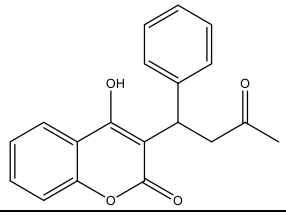
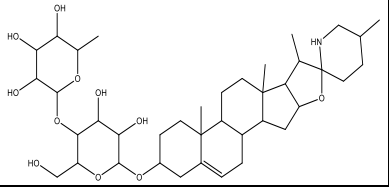
According to Acharya Charaka, a person undergoing Rasayana or rejuvenation therapy attains longevity, memory, intellect, freedom from diseases. Rasayana Chikitsa boosts the Ojas (immune system). Rasayana is the one that is concerned with the immunity enhancer. Rasayana is a treatment in which the body constituents are prepared to adapt to a selective tissue endowment program. This concept in modern scientific understanding would mean the enhancement of immune responsiveness of an organism against pathogens by non-specifically activating the immune system with immunomodulatory agents of plant origin. Rasayana improves the host resistance of an individual, helping to prevent aging and diseases. Rasayana Chikitsa or rejuvenation therapy helps to promote and preserve health and longevity in the healthy and to cure disease in sick. Rasayana is helpful to increase the immunity of the person to keep him away from opportunistic diseases. The possible mechanisms by which the action of Rasayana can be interpreted with modern aspects are as follows: nutritive function, immune modulatory action, antioxidant action, anti-aging action, neuroprotective action, hemopoietic effect, etc. [19].

Chemistry and Pharmacology of Eleven Domestic Herbs

Depending upon the ease of availability of crude drugs in most of the Indian kitchens and in nature, eleven noble herbs are selected that possess the immunomodulatory and /or antiviral effects as reported in the literature cited below**.** These herbs contain a variety of phytochemicals responsible for their Pharmacological effect as mentioned in Table 1. A relevant description of selected herbs is presented in following paragraphs following the table.

Table 1: Important Chemical Constituents of selected herbal drugs

S. No	Name of Herb	Major Chemical Constituents	Chemical Structure	Reported Activity
01.	Cinnamon	Cinnamaldehyde		antioxidant, anti-inflammatory, antidiabetic, antimicrobial, anticancer, lipid-lowering, and cardiovascular-disease-lowering
		B-Caryophyllene		
		Terpinolene		
		L-borneol		
		E-nerolidol		
02.	Giloya	Glycosides Syringin		Immunomodulator, Vasorelaxant
		Diterpenoid Lactone (Tinosporides,		

		Clerodane derivatives)		
03.	Haridra	Curcumin		Anti-viral
04.	Tulsi	Linalool		Antiviral, Antibacterial, Antioxidant
		eugenol		
05.	Black pepper	Piperine		Immunomodulator Antipyretic, anti cancer, Antioxidant
06.	Vasa	Vasicine		Bronchitis, anti-tussive,Bronchodialator
		Vasicinone		
07.	Bhumyamalaki	Gallic acid		Antioxidant, Immunomodulator, Anticancer, Antiviral(ellagic acid), Antibacterial
08.	Kantakari	Steroidal alkaloid Solasodine		Antipyretic, Antiasthmatic, Anti-inflammatory, Anthelmintic
		Coumarins		
		Flavonoids, Glycoalkaloid(Khasianine)		

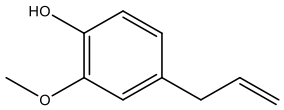
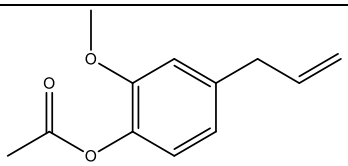
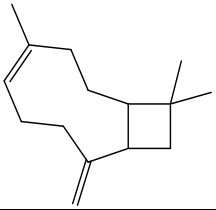
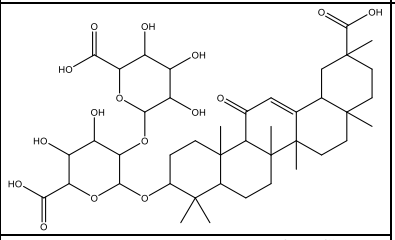
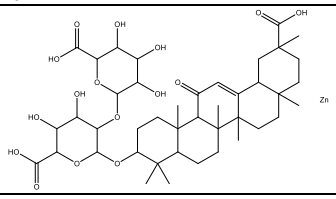
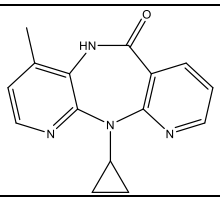
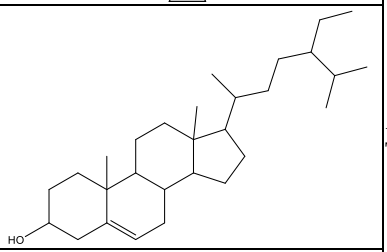
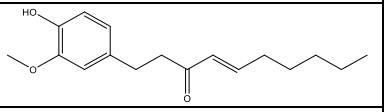
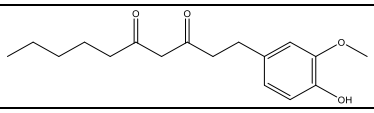
09.	Laung	Volatile oil Eugenol		Antioxidant, Antiviral, Antimicrobial, Anti inflammatory
		eugenyl acetate		
		beta Caryophyllene		
10.	Mulethi	Glycyrrhizin,		Antiviral, Immunomodulator
		Liquoritin		
11.	Shunthi	Nevirapine		Anti-inflammatory, Anti - Thrombotic, Antibacterial
		Beta sitosterol		
		6-shogaol		
		Gingerdione		

Fig 2

1. Cinnamon

Cinnamon or *Cinnamomum verum* belongs to the family of *Lauraceae* (Domestic name: Dalchini) Cinnamon is dried inner bark, is brown in colour and has a delicately fragrant aroma and a warm sweet flavour. The colour of cinnamon is a uniform light brown to pale tan. Cinnamon quills are ground to an aromatic powder [20].

Immunomodulatory effect: It is a potent immune system booster and is used in various ailments like flu, indigestion, edema, cough, etc. [21]. Cinnamon at high dose (100 mg/kg) showed immune-stimulant activity as it significantly increased the phagocytic index, serum immunoglobulin levels and antibody titer and decreased the percentage reductions in neutrophil count [22]. The studies also suggest that cinnamaldehyde can act as a strong regulator of monocyte/macrophage-mediated immune responses by inhibition of PI3K, PDK1 and NF-κB activation of signaling components [19, 20]

Anti-viral properties: Another prominent health benefit ofcinnamon is its ability to relieve cold and soothe sore throat. It is rich in antioxidant polyphenols and pro-anthocyanidins that boost your immunity naturally. It is also packed with antiviral, antibacterial and antifungal properties [23].

2. Giloya

Giloya or *Tinospora Cordifolia* belongs to the family of *Menispermaceae* (Domestic name: *guduchi*). Giloya is a herbaceous vine with heart-shaped leaves and red fruit. A variety of active components derived from the plant like alkaloids, steroids, di-terpenoid lactones, aliphatic, and glycosides have been isolated from the different parts of the plant body, including root, stem, and whole plant [24].

Immunomodulatory effect: *T. cordifolia* is well known for its immunomodulatory response. A large variety of compounds which are responsible for immunomodulatory and cytotoxic effects are 11- hydroxymuskatone, N-methyle-2-pyrrolidone, N-formylannonain, cordifolioside A, magnoflorine, tinocordioside and syringing. These natural compounds have been reported to improve the phagocytic activity of macrophages, enhancement in nitric acid production by stimulation of splenocyte, and production of reactive oxygen species (ROS) in human neutrophil cells [25].

Antiviral properties: *T cordifolia* provided significant relief from sneezing, nasal discharge, nasal obstruction, and nasal pruritus compared with placebo with compatible improvements on assesment of the nasal smears and nasal mucosa [26].

3. Haridra

Haridra (turmeric) or *Curcuma longa* belongs to the family *Zingiberaceae* (Domestic name: *haldi*) Turmeric is perennial rhizomatous herbaceous plant, yellow to orange cylindrical, aromatic rhizomes are used for various purposes. Haridra has antioxidant, anti-inflammatory, antiviral, and antifungal actions. The active constituents of Haridra are the flavonoid (diferuloylmethane), diarylheptanoid (curcumin), and various volatile oils, including turmerone, atlantone, and zingiberene. Other constituents include sugars, proteins, and resins [27].

Immunomodulatory effect: Curcumin could greatly affect both the innate and adaptive arms of immunity through modulating immune cells' function including neutrophils, macrophages, monocytes, natural killer cells (NK cells), dendritic cells (DCs), T cells, and B cells. The inhibitory effect of curcumin on other immune cells

proliferation has also become evident. Studies have shown that curcumin has suppressive effects on the proliferation of B-cell lymphoma cells. This function of curcumin followed a dose- and time-dependent pattern. A pathway through which curcumin may exert its suppressive effects on macrophages has been suggested to be NF-κB signaling pathway as it has been observed that this compound diminishes macrophage activation and influenza virus induced-lung inflammation by inhibiting NF-κB pathway [28].

Antiviral properties: Curcumin's antiviral activities can also be evidenced by its ability to regulate various molecular targets that contribute to various cellular events, such as transcription regulation, and the activation of cellular signaling pathways. Curcumin's role in targeting various cellular pathways, further inhibiting the growth, and replication of viruses makes it an ideal candidate as an anti-viral drug. Curcumin binds and inhibits the target receptors including SARS-CoV-2 protease, spike glycoprotein-RBD, and PD-ACE2, which are involved in virus infection [29].

4. Tulsi

Tulsi or *Ocimum tenuiflorum* belongs to the family *Lamiacea*. (Domestic name: *Tulsi).*

It is small, perennial shrub. The leaves of green or purple and the fruit is nutlet and produces several seeds. The herb is beneficial within the treatment of system disorder. A decoction of the leaves, with honey and ginger is a good remedy for respiratory disease, asthma, influenza, cough and cold [30].

Immunomodulatory effect: Consumption of Tulsi leaf on empty stomach increases immunity. Tulsi is used for immune-based therapies mainly for treating diseases, control of ecto-and endo-parasites, fertility enhancement, bone setting, and poor mothering management [31]. It also shows immune-modulatory effects such as modulation of cytokine secretion, histamine release, immunoglobulin secretion, class switching, cellular co-receptor expression, lymphocyte expression, and phagocytosis [32]. Tulsi, by enhancing immune response boost the defense mechanism against the infection.

Antiviral properties: Tulsi is highly useful in treatment of respiratory disorders. This aromatic plant supports the removal of phlegm and catarrhal matter from the bronchial tube. The essential oils extracted from Tulsi leaves also possess anti-fungal and anti-viral activity [33]. Extracts and selected purified components of tulsi showed a broad spectrum of anti-DNA and RNA virus activities also. Three phytochemical compounds of tulsi, namely, vicenin, sorientin 4'-O-glucoside 2”-O-p-hydroxy-benzoagte, and ursolic acid showed inhibition of main protease of SARS-CoV-2 in a molecular docking study [34].

5. Black pepper

Black pepper or *Piper nigrum* belongs to the family *Piperaceae*. (Domestic name: kali mirchi or marich). Black pepper is a flowering vine grown for its fruits which are small round hardened black berries.

Immunomodulatory effects: The effect of piperine to B cell functioning and on the humoral immune response to T-un/dependent antigens, it was found that, in vitro, it inhibits proliferative response induced by lipopolysaccharide (LPS) and immunoglobulin α-IgM antibody. Also, piperine resulted in inhibition of IgM antibody secretion [35].

The extract and its constituents like piperine, regulate the balance of the cytokines production of Th1, Th2, Th17, and Treg cells, reduce the accumulation of inflammatory cells, inhibit the expressions of GATA3, IL-4, IL-6, IL-1b, RORgt, IL-17A and TNF-a, increase INF-g and IL-10 secretions in BALF (Broncho-alveolar lavage fluid) and increase macrophage activation and T and B cell proliferation [19].

Antiviral properties: *Piper nigrum* also possess anti-viral activity due to the presence of alkaloids. According to molecular docking based study, it has been found that piperine could inhibit methyltransferase of Dengue virus and VP35 interferon inhibitory domain of Ebola virus comparative to commercial antiviral [28].

In Ayurvedic practices, pepper is added to tonics for treating cold and cough. Pepper also provides relief from sinusitis and nasal congestion. It has an expectorant property that helps break up the mucus and phlegm depositions in the respiratory tract [36]. Its natural irritant quality helps you expel these loosened materials through the act of sneezing or coughing, which eliminates the material from the body and helps you recover from infection or illness that caused the deposition in the first place. Pepper is a good treatment for respiratory conditions due to its properties as an expectorant, as well as its strong anti-inflammatory properties [37].

6. Bhumyamalaki

Bhumyamalaki or *Phyllanthus amarus* belongs to the family *Euphorbiaceae*. (Domestic name: *bhuiamla* or *jungle amla).*

The plant appears to be miniature amla tree, It’s a perennial herb with small leaflets and yellow flower. It has many tiny mustard –seed-sized fruits on its stem. Recently, the plant is gaining momentum because of its novel antiviral activity against Hepatitis-B, Hepatitis-A, jaundic, intestinal infection, diabetes, astringent, stomachic, diuretic, febrifugal and antiseptic properties etc. [38].

7. Kantakari

Kantakari or *Solanum xanthocarpum* belongs to the family *Solanaceae.* (Domestic name: chotikateri, rigni).

It is prickly diffused, bright green perennial herb with bluish –violet colour flowers and yellowish or white berry fruit. Whole herbs including roots and berries are medicinally useful.

The fruit of *Solanum xanthocarpum* is known for several medicinal uses such as anthelmintic, antipyretic, anti-inflammatory, antitumor, cytotoxic activities**,** antiasthmatic, antispasmodic and hypotensive [39]. Juice of fruit of *Solanum xanthocarpum* is used in sore throats and rheumatism. Kantakari is mainly known for its shwasahara, kasahara, jwarahara property in different dosage form virginianum L. herb is useful in cough, chest pain, against vomiting, hair fall, leprosy, itching scabies, skin diseases and cardiac diseases associated with edema [40].

8. Laung

Laung or *Syzygium arometicum* belongs to the family *Myrtaceae* (Domestic name: laung).

These are aromatic flower buds. They are brownish, rough, and irregularly wrinkled longitudinally with short fracture and dry, woody texture. The oil extracted from clove, has numerous medicinal properties. It is essential in the manufacturing of Indian Ayurvedic medicine and Chinese medicine. It is also used in dentistry when the clove oil is used for dental emergencies as anodyne. In addition, cloves also possess certain other medicinal properties such as anti-mutagenic, anti-inflammatory, antioxidant etc. Clove oils are also used in the production of antibiotics for its antimicrobial properties [41].

Antioxidant property: Eugenol present in clove possesses strong antioxidant activity, which is comparable to the activities of the synthetic antioxidant, BHA (butylated hydroxyl anisole) and Pyrogallol**.** Clove has the highest capacity to give off hydrogen and reduce lipid peroxidation. With respect to the lipid peroxidation, the inhibitory activity of clove oil determined using a linolenic acid emulsion system indicated a higher antioxidant activity than the standard BHT (Butylated hydroxyl toluene) [42].

Antiviral properties: The main bioactive component of clove is Eugenol. The inhibitory action of eugenin is on the viral DNA synthesis by acting as a selective inhibitor of the HSV-1 DNA polymerase and eugenol on viral replication and reducing infection [28].

9. Mulethi (Liquorice)

Liquorice or *Glycyrrhiza glabra* belongs to the family *Leguminosae* (Domestic name: Mulethi). Liquorice consists of peeled and unpeeled roots, stolons, stem of *Glycyrrhi zaglabra.* Unpeeled liquorice is externally yellowish brown or dark brown & internally yellowish colour with Faint odour and sweet taste.

Immunomodulatory effects: In vitro studies proved that Glycyrrhiza glabra at 100µg/ml concentration, showed immune stimulatory effects. It increases production of TCD69 lymphocytes and macrophages from human granulocytes. According to *in vivo* studies, liquorice root extract was found to prevent the rise in the amount of immune-complexes related to autoimmune diseases like systemic lupus erythematosus [43]. Liquorice has been shown to work as efficiently as codeine in sore throat. It decreases irritation and produces expectorant effects. Liquorice extract may also be able to stimulate tracheal mucus secretions producing demulcent and expectorant effects. Glycyrrhizin is responsible for demulcent action of liquorice [44]. Licorice and glycyrrhizate compounds have long been used as a potential therapeutic agent for several virus diseases including chronic hepatitis B and C, as well as human acquired immunodeficiency syndrome [45]. In vitro antiviral effects for viruses causing respiratory tract infections like influenza virus and the severe acute respiratory syndrome (SARS) corona virus [46].

Anti-viral effects: It is reported that liquorice extract inhibits the growth of viruses, including herpes simplex, Varicella zoster**,** and of Japanese encephalitis, influenza virus**,** vesicular stomatitis virus, and type A influenza virus [47]. Recent study on two clinical isolates of SARS virus (severe acute respiratory syndrome virus) [FFM-1 and FFM-2] gave valuable insight about anti-viral activity of glycyrrhizin. The study was carried out on patients with SARS, admitted to clinical center of Frankfurt University, Germany. This study on antiviral activities of ribavirin, 6-azauridine, pyrazofurinmycophenolic acid and glycyrrhizin proved that glycyrrhizin was the most efficient in controlling viral replication. Thus, it can be a good prophylactic measure [43].

Glycyrrhizic acid can terminate latent infection of KSHV when all current drugs are found to be ineffective against latent infection. Glycyrrihizic acid down-regulates the expression of latency associated nuclear antigen (LANA) in B lymphocytes. This causes natural cell death (apoptosis) of the KSHV virus [48].

10. Shunthi

Shunthi or *Zingiber officinale* belongs to the family *Zingiberaceae* (Domestic name: adrak).

It is a flowering plant whose rhizome is widely used as medicine. Mature ginger rhizomes are fibrous and dry.

In Ayurveda, ginger is reported to be useful in treating inflammation and rheumatism [77]. Now its anti-inflammatory action has been proved, it is particularly useful in treating chronic inflammation because it partially inhibits two important enzymes that play a role in inflammation cyclooxygenase (COX) and 5-lipoxygenase (LOX). Anti-inflammatory drugs can cause side effects, such as ulcers. Examined that ginger

administered orally (500 mg/kg) caused significant changes in the serum PGE2 and suggest that ginger could be used as an anti-thrombotic and anti-inflammatory agent [49].

Immunomodulatory effect: The bioactive compounds of ginger such as nevirapine, β-sitosterol, 6-gingediol, germacrene, methyl-6- shogaol, 6-gingerol, a-linalool, 6-shogaol, gingerdion, zingiberene, etc., are known to inhibit viral replication; among these the most potent inhibitors of reverse transcriptase (RT) enzyme is β-sitosterol, which is predicted to be used as non-nucleoside reverse transcriptase (NNRTIs) HIV-1 inhibitors [50]. The rhizome of Ginger and its main components like gingerols, shogaols, etc inhibit prostaglandin and leukotriene biosynthesis, inhibit cyclooxygenase and lipoxygenase activities [51], inhibits the synthesis of pro-inflammatory cytokines such as IL-1, TNF-a, and IL-8 without any significant effect in IL-6 levels; inhibit the excessive production of NO, PGE (2), TNF-a, and IL1beta, reduce the elevated expression of NFkB and TNF-a, down regulate inflammatory iNOS and COX-2 gene expression, inhibit thromboxane synthetase, raise levels of prostacyclin without a concomitant rise in PGE 2 or PGE 2 alpha, inhibit platelet aggregation, decrease age-related oxidative stress markers and enhance fibrinolysis [19].

Antiviral properties: It has been proven by many studies that the ginger and its bioactive compounds showed effective antiviral activity against SARS-CoV-2, Influenza virus, Herpes simplex virus, Human respiratory syncytial virus, Chikungunya virus [52]. Ginger acts as anti-SARS-CoV-2 due to their interaction with spike and main protease (Mpro) protein as proved by molecular docking study [53]. The S protein is responsible for SARS-CoV-2 entry during the infection which binds with angiotensin-converting enzyme 2 (ACE2) receptor from the host cell to generate an appropriate environment for viral replication [28].

11. Vasa

Vasa or *Adhatoda vasica* belongs to the family *Acanthaceae*. (Domestic name: Arusha).

It is evergreen shrub with smooth edge short petiole which is bitter in taste with white flowers and yellowish bark. The root, leaves and flower are part used. It is a potent ayurvedic plant that enhances the respiratory system.

Antiviral properties: Adhatoda has been used in traditional medicine to treat respiratory disorders. Both vasicine and vasicinone the primary alkaloid constituents of Adhatoda are well established as therapeutical respiratory agents [54]. Extracts of Adhatoda leaves and roots are useful in treating bronchitis, and other lung and bronchiole disorders, as well as common coughs and colds [49].

Conclusion

In the current pandemic scenario, precautions and boosting immunity are one of the best choices to get away from COVID-19 infection. As per our study on reported literature, we conclude that the uses of spices and herbs may play a significant role against viral infections. We have analysed that common domestic herb *viz. Cinnamon, Giloya, Haridra, Tulsi, Black pepper, Vasa, Bhumyamalaki, Kantakari, Laung, Mulethi, and Shunthi* play a vital role against SARSCoV-2 (COVID-19) as well as other viral infections, which was also supported by some other recent studies, These Ayurveda herbs are seen to have rich sources to fight against the immuno-pathogenesis process of viral diseases, which may prove their effectiveness against COVID-19. The result of this review is to provide supportive scientific evidences towards the antiviral, immune-modulator, and Anti-inflammatory properties of these herbs. It is recommended that the consumption kwath made up of a combination of the eleven domestic herbs considered above may prove to be a prophylactic or preventive health drink for COVID-19.

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Glossary

1. *Agni* - Fire; the force residing within the body that creates digestion; responsible for the transformation of one substance into another; metabolism. Agni is contained within pitta.
2. *Ajna* – Command
3. *Asava*- Medicated wine made with freshly pressed herbal juice. A popular example is Kumari Asava, which is useful for reproductive and digestive complaints and liver tonification.
4. *Arishta*- Medicated wine made with a decoction

5. *Avaleha*- Sweet candy, jam or jelly.
6. *Bala*-The strength or force of the pulse.
7. *Balya*- Herbs which increase strength and are tonifying.
8. *CharakaSamhita* - Considered the greatest of all the classical texts on Äyurveda. Written by Charaka, it contains the teachings of the sage Agnivesa, who was one of the six students of the great sage Atreya. It is Agnivesa's teachings which makes up the bulk of what is known about classical Äyurveda. Caraka was himself a great physician.
9. *Chit* - Consciousness absolute; the ocean within which we all are connected.
10. *Dosha* - Three main forces which govern the body (väta, pitta and kapha; literally means faulty or to cause harm, although they only do so when they are functioning abnormally. When functioning normally, they maintain the good health of the body and guide all of the normal bodily functions.
11. *Dhatu* -Tissue
12. *Guti (gutika)* - Tablet or pill.
13. *Hima* - Cold infusion
14. *Jwara*– Fever
15. *Kalka* - Herbal paste.
16. *Kapha* - The force behind the structure and stability of the body; the elements are water and earth; its qualities are heavy, cold, moist, static, smooth and soft; its root is in the upper stomach. Also a term for mucous.
17. *Kasa* – Cough
18. *Kwatha (kwath)* - Decoction (made by boiling the hard parts of herbs).
19. *Ojas* - The subtle immune system; the essence that gives the tissue and the mind strength and endurance; the force that keeps the tissues healthy. Composed primarily of earth and water (qualities similar to kapha). Produced from the essence of shukra. When strong, no disease can affect the body. The energetic template of kalpha.
20. *Rasayana* - Rejuvenative tonic; nourishes all dhätus and builds ojas. A specialized form of tonification that follows purification such as pancha karma; a special term meaning "that which promotes longevity by preventing aging and by making the body young again". Also called pashat karma.
21. *Taila* – Oil
22. *Vyadhikshamatva* - Forgiveness, literally forgiveness of disease; immunity.

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