PHYTOCHEMICAL ANALYSIS OF SELECTED INDIAN MEDICINAL PLANTS TO KNOW THE ANTIVIRIAL POTENTIAL AGAINST NOVEL CORONAVIRUS

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***Abstract*: Viral infections are responsible for several diseases. COVID-19 is an infectious pandemic disease, caused by the novel coronavirus. It affects the respiratory system and on severity it causes multiple organ failure which leads to death. It originated from Wuhan city, China and spread very rapidly around the world. Due to its communicable and its transforming nature we all were locked in our houses since 24 March 2020 in India. The development of a vaccine is in progress but it will take time. Ayurveda is believed to be the most ancient healthcare practice which supports a holistic tactic to healthy long life. The treatment with the use of natural medicine from plants has always been an exemplary source of medicines. Many herbal formulations have been available in the market to work against various viral infections. The possibility of a few selected Indian plants which can be good alternative for the treatment of COVID-19 disease has been discussed in this review article.**

***Index Terms*: Novel Coronavirus, Medicinal Plants, Natural Products, Anti-viral**

INTRODUCTION

The use of medicinal plants around the world is much popular in the traditional system. This is due to the safe and cheap alternative to treat all the minor to major health problems. Three-quarters of the world population is dependent on alternative medicines from natural sources. In the same relevance, the medicinal plants also showed significant potential against communicable diseases. Several Indian medicinal plants are very effective to treat infectious diseases [1] . The plants have been considered as the persistent and harmless source of effective remedies that have the potential to discover new drug entities from nature. Hence, the scientists are busy in drug development from these medicinal plants by using their conventional knowledge. There are many recent global outbreaks caused by different viruses. COVID-19 is an infectious pandemic disease, initiated by the novel corona virus[2].There are more than 100 Indian medicinal plants that have been used to cure various viral infections [3]. Many herbal formulations have also been available in the market and are very effective against various viral infections. These herbal products played their important role to the human beings. In this review, the possibility of few Indian medicinal plants that can be good alternative healing ingredients for the treatment of novel coronavirus infection have been summarized. Based on the literature and reports, the antiviral effects of these plants have been discussed.

Evaluation of Medicinal Properties of Selected Plants

Amla (*Emblica officinalis*) Gooseberry

Figure. 1: Amla (*Emblica officinalis*)Gooseberry

Amla (**Figure 1**) is a small leafy tree that grows throughout India, tropical and subtropical regions including Malaysia, Pakistan, Sri Lanka, Uzbekistan, South East Asia, China and yields an edible fruit. It is also named as Amla, Amalaki, *Phyllanthus emblica*, or Indian gooseberry and *Emblica officinalis* (EO). It is supposed to enhance immunity and defense against diseases and effective for multifarious ailments [4]. It treats drooling- the hypersalivation-condition and excess internal heat formation of the body. Amla is useful in ulcer prevention, for diabetic patients, and for memory enhancement. Amla tonic has a hematinic and lipolytic function, useful in scurvy, prevents indigestion, and controls acidity as well as it is a natural source of anti-aging.

Traditional usage: Amla plant contains vitamin C and precious oil, which is extracted from its seeds and pulp. Therefore, it can be used for the management of hair and cure scalp problems.

Parts used: Fruit, juice, oil and powder are used traditionally. Commercially it is used as Chyavanprash, oil, Amla pickle, Amla murabba, Amal juice, Amla candy and Amla chutney. The fruit has the properties of balancing all three doshas: Vata, Kapha, Pitta, and is especially effective for pitta [5].

Medicinal usage: It has its beneficial role in multifarious role in the treatment of anemia, heart problem, cancer, diabetes, ulcer and liver treatment, and various other diseases [6]. It acts as an antioxidant, antipyretic, immunomodulatory, cytoprotective, anti-inflammatory, antitussive and gastroprotective. Besides, it is useful in memory enhancement, ophthalmic disorders, and lowering cholesterol levels. It is one of the constituents of the herbal formulation Triphala, which is a combination of fruits of EO, *Terminalia chebula*, and *Terminalia belerica* in equal proportions.

Pharmacological properties: Amla has several pharmacological properties and can be an ingredient for various remedies like the common cold, fever, diuretic, purgative, stomach pain, ulcer prevention either alone or in combination with other ayurvedic medicine. Estari, M etal.,[7] have described free radical scavenging, analgesic and other activities of Amla.

Phytochemical present: The major phytochemical constituents present are minerals, vitamin c, tannins, alkaloids, Kaempferol, Phyllanthidine, Quercetin, Ellagic acid , phyllembein, and quercetin, are found to be biologically effective. The other class of compounds present in that plant and isolated are terpenoids, fatty acids, steroids, alkaloids, naphthoquinone, anthraquinone, coumarins and flavonoids as shown in **Figure 2**.

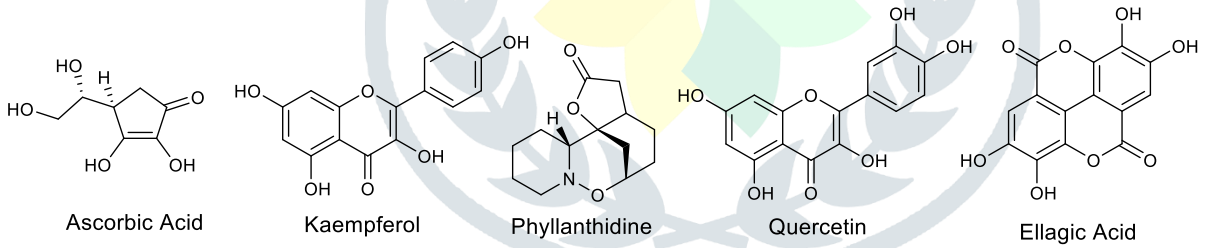

Figure 2: Potential biologically active compounds isolated from *Emblica officinalis*

Nutritive value: Percentage composition of the fruit pulp of Amla is Moisture-81.20%, Protein- 0.50, Fat - 0.10%, Minerals- 0.70%, fiber -3.40 %, Carbohydrate -14.10% and minerals -602mg/100g *Antiviral compounds*: It has a high content of Vitamin C, antioxidants, Chromium and fat burning components.

According to the Ayurvedic classifications:

1. Rasa (taste): Sour and astringent are the most dominant, but the fruit has five tastes, including sweet, bitter, and pungent
2. Veerya (nature): Cooling
3. Vipaka (taste developed through digestion): Sweet
4. Guna (qualities): Light, dry against
5. Doshas (effect on humors): Quietens tridoshas

Comparative discussion: Ayurveda experts have emphasized that several herbal combination are helpful in strengthening the immune system of human body. This is vital factor to fight against the deadly coronavirus and subsequent viral infection. Coronavirus primarily attack the respiratory system. Consuming a tablespoonful of Chyavanprash daily enhances the pulmonary immunity and it may work against the virus.

Harad (*Terminalia chebula*) Haritaki

The plant *Terminalia chebula* (**Figure 3**) is commonly known as Haritaki and belongs to the *Combretaceae* family. It is used as folk medicine in Ayurveda, Homeopathy and the Unani system of medicine. This plant is native to India and also found in other counties. The dried fruits of Haritaki are used in several home remedies [8]. Haritaki is well documented in the traditional system of medicine to treat various ailments.

Figure 3: Harad (*Terminalia chebula*)Haritaki

Folklore Medicine: According to Acharya Bahvmishra, Haritaki is mentioned in Ayurveda with its numerous properties [9]. Some are explained here - Abhya (for eye diseases), Amrta (used for the purification of body), Jivani (Able to overcome on all diseases), Putana (used as external applications), Rohini (able to heal the wound) and Vijya (it also termed to cure all human disorders). It is used for the preparation of various Ayurvedic formulations which are used to treat many diseases including leucorrhoea and pyorrhoea. The leaves and fruits bark has a major medical impact. It prevents aging and enhances the immune system to resistance against all pathogens. It increases the appetite, digestive power, stimulates the liver and a mild laxative to manage the gastrointestinal tract.

Pharmacological Properties: *T. chebula* is listed at top of Ayurvedic Materia Medica and in Tibet called as 'King of Medicine' because of its extra ordinary medical impact. It has mainly astringent, mild laxative, purgative and stomatic properties. It has ability to cure many ailments which include anorexia, asthma, constipation, cough, diarrhea, dyspepsia, gastroenteritis, hepatomegaly, ulcer, renal calculi, skin disease, tumors, and urinary discharge. It is considered a broad-spectrum medicinal plant due to its diverse pharmacological properties. It showed Antiallergic, Antiarthritic, Antibacterial, Anticaries, Anticarcinogenic, Antidiabetic, Antifungal, Anti-inflammatory, Antimutagenic, Antioxidant, Antiprotozoal, Hypolipidemic, Antiulcer, Antiviral, Cardioprotective, Gastrointestinal motility, Hepatoprotective, Immunomodulatory, Purgative, Radioprotective and Wound healing activity [10] .

Phytochemical Identified: The phytochemical investigation of this plant led to the identification of several natural products. The class of compounds found in this plant are revealed as alkaloids, carbohydrates, fatty oil, flavonoids, glycosides, polyphenols, saponins, steroids, tannins and terpenes. The main components are listed as ascorbic acid (vitamin C), chebulic acid, chebulagic acid, corilagin, ellagic acid, ethyl gallate, gallic acid, mannitol and tannic acid. It also displayed antiproliferative action against various cancer cell lines. The chebulagic acid has been found to show anticancer potential against cell line membranes marker numbers like colon (COLO-205), colon (HCT-15), breast (MDA-231), prostate (DU-145), chronic myeloid leukemia (K562) and stomach cancers. It has 5- lipoxygenase, (5-LOX) inhibitory action with an IC_{50} value of 2.1 μM.

Antiviral Potential: The tannins derivative, Chebulagic acid (CHLA) and punicalagin (PUG) were isolated from the fruits of *Terminalia chebula* displayed significant antiviral activity (**Figure 4**). These two compounds exhibited good antiviral activity against hepatitis C virus (HCV), herpes simplex virus type 1 (HSV-1), and other viruses in previous studies. The antiviral potential shown by the compounds were ranged with the EC_{50} values from 0.38 to 198 μM concentrations. The mechanism of action showed the inhibition of viral attachment, penetration and spread inside human cells at different level for each virus. Precisely, these natural products can block all the infective steps for selected viruses. Hence, these natural entities have been termed as Broad-spectrum antiviral efficiency compounds[11].These natural products also displayed

significant action against the dengue virus (DENV-2). They inhibit the entry and penetration of the virus, but unable to affect cell to cell transmission [12].

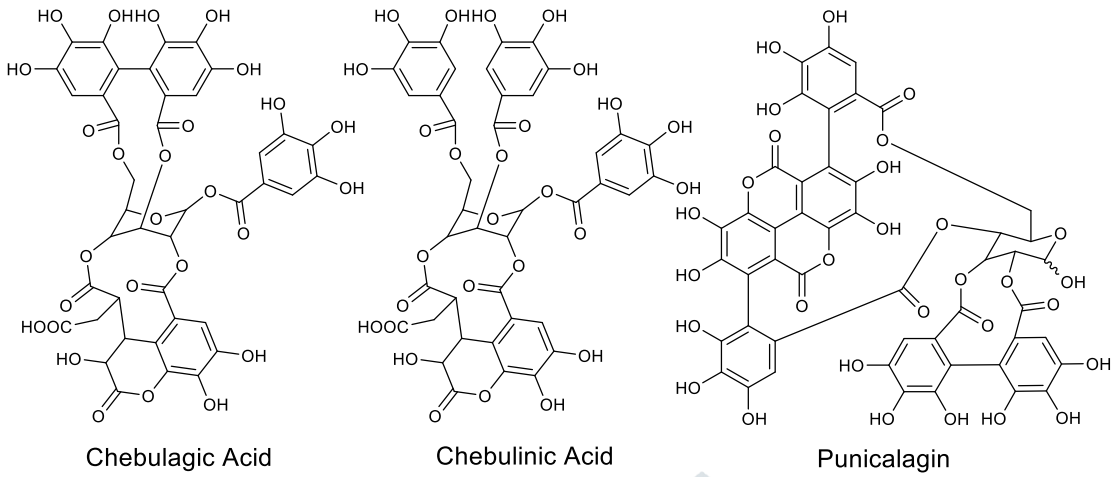

Figure 4: Structure of potent antiviral compounds isolated from *Terminalia chebula* plant

In another study, the fruits were tested against the infection of sexually transmitted herpes simplex virus-2 (HSV-2). The 50% ethanolic fruit extract and two isolated compounds namely chebulinic acid and chebulagic acid have significant antiviral potential However, the cytotoxicity on Vero cells showed CC_{50} value of 409.71 µg/mL for crude extract. The two compounds exhibited a cell viability of more than 95% at a concentration of 200 µg/mL. The mechanistic pathway showed that the compounds efficiently banned the penetration and attachment of the HSV-2 to the Vero cell [13].

Potential to overcome novel coronavirus: The plant *T. Chebula* is a rich source of vitamin C (Ascorbic Acid). Vitamin C is the most significant component to enhance the immune system. It has been proved in previous studies that Ascorbic Acid helps to protect from SARS viruses. An ayurvedic formulation, *NyagrodhadiKashayam* (□□□□□□□□□□□

□) made from the mixture of three plants namely, Giloy, Ginger and Harad (*T. Chebula*) is very effective in the treatment of COVID-19 patients. Recently, this formulation has been successfully trialed on coronavirus infected patients. So, this plant could be the most significant medicine for coronavirus patients in the future.

Sahajan (*Moringa oleifera*) Drumstick tree

Figure 5: Sahajan (*Moringa oleifera*) Drumstick tree

Moringa oleifera (**Figure No.5**) is a fast-growing, drought resistance tree of the *Moringaceae* family, native to the Indian subcontinent mainly to the southern foothills of the Himalayas in north western India. Moringa can withstand both severe drought and mild frost conditions and hence widely cultivated across the world. It is an indigenous tree from the north of India, Pakistan, and Nepal, of which all its components (leaves, seeds, flowers, and barks) are considered medicinal. *Moringa* derives its name from a Tamil word, murungai, meaning "twisted pod", signify to the young fruit. The species name is speculated from the Latin word's oleum 'oil' and ferre 'to bear'.

Traditional Uses: Moringa is a genus of medicinal plants that have been used traditionally to cure wounds and various diseases. Different parts of the plant have different traditional uses [14]. The leaves of this plant were used as antibacterial and antimalarial agents. The oil of this plant in Oman was used to treat stomach disorders. The oil was also used in perfume and hair oil. The gum of the plant was used for curing fevers, asthma, and dental decay. The flowers of this plant were used to cure the tumor, inflammation, etc. Moringa seed cake was used for water purification.

Medicinal Usage: It has massive medicinal potential, which has also been recognized in the Ayurvedic and Unani system. Almost every part of the plant including bark, root, gum, leaf, flowers, seed and oil has been used for treating various diseases. The eye diseases are treated with the juice of the leaves with honey. The alcoholic extracts of the leaves show analgesic activity and aqueous root extract showed an antifertility profile [15].

Pharmacological properties: The diverse activities have listed in **Table 1**.

Table 1. Activities Shown by Moringa.

Activity	**Plant Part**	**Short description**
Antimicrobial	Leaves, seeds, flowers	*Staphylococcus aureus, Baciliussubtilis* *Escherichia coli, Pseudomonas aeruginosa*
Anti-inflammatory	Root, seeds	Showed this activity in Carrageenan induced paw edema model
Anti-asthmatic	Alcoholic seeds extract	Showed spasmolytic in acetylcholine, $BaCl_2$ and 5HT induced bronchospasm
Analgesic	Fruits, leaves, seeds	This activity was shown in the acetic acid writhing model in mice
Antipyretic	EtOH/EtOAc seeds extract	Significant antipyretic activity in rats
Antihypertensive	Leaves, roots, gums	To regulate blood pressure and chlolestrol level.
Antidiabetic	Leaf	Therapeutic agent for diabetes.
Antioxidant	Leaf, fruit, seed	Methanloic and ethanolic extracts have the highest antioxidant activity with 65.1 and 66.8% respectively.
Hepatoprotective	Ethanolic extracts from leaves, roots, flowers	Showed good protection against liver damage induced by anti-TB drugs in rats
Antitumor	Leaves	The plant extract was analyzed for cytotoxicity
Antifertility	Roots, bark	Post-coital antifertility activity in mice
Antispasmodic	Leaves	In various animal models on adult Holtzman albino rats of either sex
Cardiac stimulant	Leaves, root, bark	Root bark contained alkaloid moringinine which acts as a cardiac stimulant

Nutritional properties: Moringa is an excellent indigenous source of highly digestible protein, calcium, iron, potassium, vitamins, trace metal ions, antioxidants and essential amino acids. It is a good source of fiber, proteins, lipids, carbohydrates.

Antiviral activity of Moringa against foot and mouth diseases: *Moringa* has proved its antiviral activity against many diseases. FMD (Foot and Mouth Disease) is a highly infectious disease of cloven-foot animals. This plant possesses antiviral activity against DNA and RNA viruses. The alcoholic extract has significant antiviral activity. FMD is a devastating and transmissible viral infection. This disease causes the loss of cattles and buffaloes.

Curry leaf plant (*Murraya koenigii*)

Figure 6: Curry leaf plant (*Murraya koenigii*)

India is well rich in the biodiversity of medicinal plants. *Murraya koenigii* (**Figure 6**) is one of them but usually scientists focus less. *Murraya koenigii* has been proven as a natural medicinal plant. *Murraya koenigii* is found as a useful plant that is present in many parts of the country with different names.

Traditional and Medicinal usage: It is used in traditional medicine to treat diarrhea, dysentery, inflammation of gums, drunk as antihypertensive skin eruptions and bites of poisonous animals, to stop vomiting, diabetes, fever, herpes, post-partum pain, strengthen gums and teeth, enhance blood circulation, digestion and metabolism.

Pharmacological properties: Sindhu et al[16]. have reported cell related immune response, and the cellular destruction of harmful cells by *Murraya koenigii* leaves

Phytochemicals present: The many class of compounds identified from this plant which includes phenolics, flavonoid, saponins, terpenoids, tannin and alkaloids.

Antimicrobial activity: According to a literature survey, the methanolic extract of *Murraya koenigii* showed antibacterial activity against Gram-positive and Gram-negative species. The three bioactive carbazole alkaloids compounds possess essential antimicrobial and topoisomerase and inhibition activities.

Antibacterial activity: It is effective against *Escherichia coli*, *staphylococcus*, *streptococcus* and *Proteus*. It can be used as a useful remedy in everyday food to prevent many bacterial infections. Pyrano-carbazoles isolated from *M. koenigii* exhibited antibacterial activity on bacterial strains of *staphylococcus* and *Klebsiella pneumonia*. Green synthesized silver nanoparticles (SNPs) from Murraya koenigii exhibited therapeutic efficacy against multidrug-resistant MDR bacteria *M. koenigii*, essential oil showed antibiofilm activity against *Psusdomoasaeruginosa*.

Antioxidant activity: Extracts of *M. koenigii* shows antioxidant properties. It colonizes the formation of oxygen-derived free radicals such as superoxide, hydroxyl radicals, lipid peroxidation and nitric oxide.

Antifungal activity: The existence of phytochemical constituents of molecular structures and their diverse mechanisms of action, like alkaloids, terpenoids, flavonoids, phenolics, tannins and saponins are responsible for the antimicrobial properties. It can inhibit the mycelial growth and enhance antifungal action against *Penicillium notatum*, *Aspergillus flavus*, *Aspergillus niger*, *Fusarium moniliforme*, *Mucor mucedo*, *Penicillium funiculosm*.

Neem (*Azadirachta indica*)

Figure 7: Neem (*Azadirachta indica*)

Neem Tree (**Figure 7**) belongs to the Mahogany family. It is a fast-growing tree with various medicinal, pesticidal and organic agronomic applications. It also find its use in various cosmetic formulations and ayurvedic preparations. It is used as antiallergenic, antioxidant, antidiabetic, anticancer, antiviral, antibacterial, antigingivitic, antidermatic, antifungal, anti-inflammatory, antipyorrhoeic, anti-scabic, cardiac, and diuretic and other activities.

Traditional usage: The herbal cures from medicinal plants are used traditionally all over the world, but its admittance as Phytotherapy is limited. Over 3000 years the Neem tree is well known in India and its neighbouring countries due to its wide spectrum biological activities. It was usually used as natural pesticides and to protect against erosion. As herbal medicines are easily available, economically affordable and show fewer side effects rural population still depends on phytomedicines. Besides its ameliorative effects, Neem has already established its potential insecticides and agrochemicals as it showed oviposition deterrence, the anti- feedent effect on larvae and toxicity to eggs and larval of the beet armyworm. Interestingly, the Neem trees are an excellent alternative for modern tooth care products.

Medicinal usage: The Neem leaf is used in the treatment of many diseases that include leprosy, nose bleeds, eye disorders, intestinal worms, diabetes, heart diseases, diseases of the blood vessels and gum diseases. The most remarkable and popular use of Neem is for its skin benefit [17] .Neem leaves contain nimbolide, nimandial and over 130 various biologically active compounds that help in the treatment of skin and gum disease, detoxifies the blood and helps in skin toning, reducing acne, promote a healthy respiratory and digestive system, nourish hair.

Neem plant also shows antimicrobial properties and Ayurveda uses Neem plant for various diseases as shown in **Table 2** and **Table 3**

Table 2. Ayurvedic uses of Neem

Plant Part	**Medicinal use**
Leaf	Leprosy, eye problem, epistaxis, intestinal worms, anorexia, skin ulcers
Bark	Analgesic, alternative and curative of fever
Flower	Bile suppression, elimination of intestinal worms and phlegm
Fruit	Piles, intestinal worms, urinary disorder, epistaxis, phlegm, eye problem, diabetes, wounds and leprosy
Twig	Cough, asthma, piles, phantom tumour, intestinal worms, spermatorrhea, obstinate urinary disorder, diabetes
Gum	Scabies, wounds, ulcers, skin diseases
Seed	Leprosy and intestinal worms
Oil	Leprosy and intestinal worms

Table 3. Antimicrobial properties [18] (Dhayanithi *et al*., 2010)

Antimicrobial	Plant Part	Effects on microbe species
Antibacterial	Neem leaves and seeds	*Bacillus subtilis, Staphylococcus aureus, S.pyogenes, Proteus valgaris, Salmonella typhi, Pseudomonas aeruginosa, Escherichia coli*
Antifungal	Neem leaves	Rhizopus, *Aspergillus, Candida albcians*
Antiviral	Bark and leaves extract	*Herpes simplex virus 1, Dengue virus type 2*

Active constituents of Neem: Azadirachtin, nimbolinin, nimbin, nimbidin, nimbidol, sodium nominate, gedunin, salannin, and quercetin. Leaves contained nimbin, nimbanene, 6-desacetylnimbinene, nimbandiol, nimbolide, ascorbic acid, sterols, sesquiterpene derivatives, polyphenols and flavonoids.

Nutritional properties of Neem: Neem leaves are rich source of protein -7.1%, carbohydrates 22.9%, vitamins, minerals, fatty acids and several amino acids like., alanine, tyrosine, glutamic acid, praline, glutamine and cysteine.

Antiviral activity: Neem leads as a powerful antiviral agent and boost the immune system. Killer-T cells destroy microbes, viruses and cancer cells by injecting toxic chemicals into the invaders. Neem also boost the body's macrophage response, which stimulates the lymphocytic system and enhances the production of white blood cells. The Neem bark inhibits the entry of herpes virus (HSV-1) strain[19]. The Neem leaf extract inhibit the growth of the Dengue virus, type 2, a viral hemorrhagic fever related to Ebola.

Potential to overcome on novel coronavirus: Compounds present in leaves of Neem tree works as potential inhibitors for covid-19 Main Protease (Mpro). This has been done by blind molecular docking. The docking study of meliacinanhydride, desacetylnimbin, nimocinol, isomeldenin, nimbolide, zafaral, nimbandiol, nimbin, nimbinene showed positive result against coronavirus. Hence, Meliacinanhydride may be a potential treatment option against covid-19. Leaves also contain quercetin, Zinc, Vitamin A, Vitamin B_1, B_2, B_6, Vitamin C, Vitamin E which boost immunity. So, neem could be used to treat covid-19.

Tulsi (*Ocimum sanctum*) Holy Basil

Figure 8: Tulsi (*Ocimum sanctum*) Holy Basil

Ocimum sanctum(**Figure 8**) is generally known as holy basil or Tulsi. It is an aromatic perpetual plant of the family Lamiaceae. It is naturally grown in the Indian subcontinent and a prevalent plant cultivated throughout the Southeast Asian tropics. It is widely used as herbal tea in Ayurveda and has a special place, in worship as the devotees use holy basil plants or leaves in the Vaishnava tradition of Hinduism.

Medicinal values: Basil is endorsed as a first aid in the management of asthma, gastrointestinal and dermatological problems. Tulsi has been reported to oppose the metabolic disturbance through regularization of blood pressure, blood sugar and cholesterol level, and psychological anxiety through positive effects on memory and cognitive function. It has wide-spectrum antimicrobial benefits, therefore it finds its applications in hand sanitizer, mouthwash and water purifier. Each part of this plant has medicinal properties.

The nutritional power of Basil is summarized in **Table 4**.

Table 4: *Nutritive values of Basil*

Nutrients	**Amount**	**Nutrients**	**Amount**
Total Calories	9.8	Thiamin	14 mcg
Calories from Carbohydrates	4.**0**	Riboflavin	32 mcg
Calories from Fat	2.3	Niacin	382 mcg
Calories from Protein	3.3	Vitamin B6	66 mg
Carbohydrates	2.7	Folate	29 mcg
Total Carbohydrates	1.1 gm	Pantothenic Acid	89 mcg
Dietary fiber	678 mg	Cholin	4.8 mg
Sugar	127 mg	Betain	0.17 mg
Fats and Fatty acids		Minerals	
Total fats	271 mg	Calcium	75 mg
Saturated fats	17 mg	Iron	1.3 mg
Monounsaturated fats	37 mg	Magnesium	27 mg
Polyunsaturated fats	165 mg	Phosphorus	24 mg
Omega 3 Fatty Acids	134 mg	Potassium	125 mg
Omega 6 Fatty Acids	31 mg	Sodium	1.7 mg
Vitamins		Zinc	343 mcg
Vitamin A	2237 IU	Copper	163 mcg
Vitamin C	7.6 mg	Manganese	487 mcg
Vitamin E	339 mcg	Selenium	0.13 mcg
Vitamin K	176 mcg		

Pharmacological Properties:

Tulsi plant contains various biologically active components (Figure 9) which can act against potent bacteria, virus and fungus. It has a variety of properties like anti-protozoal, anti-malarial, anti-diarrhoeal, analgesic, antipyretic, anti-inflammatory, anti-allergic, antihypertensive, cardio protective, central nervous system (CNS) depressant, memory enhancer, hepatoprotective, anti-diabetic, anti-asthmatic, antioxidant, anticancer, radio protective, immunomodulatory, anti-fertility, antiulcer, anti-arthritic, antistress, anticataract and anticoagulant activities. Its leaves help sharpen memory and in curing fever and the common cold. The plant increases physical endurance and prevented stress-induced ulcers.

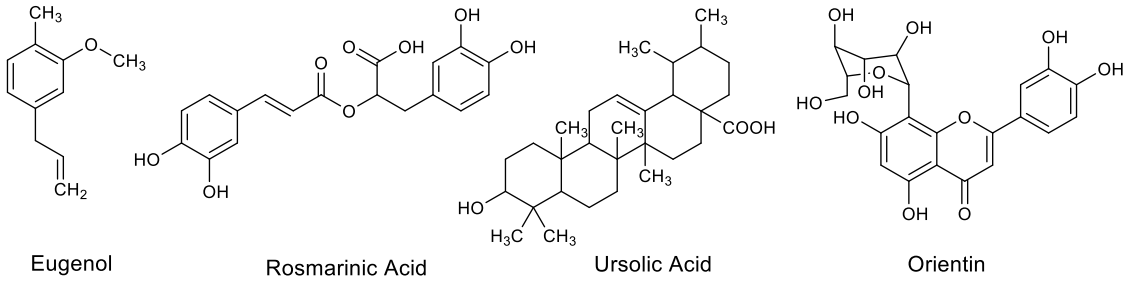

Figure 9: Structures of active components from Basil plant [20]

Antiviral properties: The antiviral activity of aqueous, ethanol, methanol and chloroform extract of powdered drugs was evaluated against economically important viruses of veterinary importance. The results of the study suggest that Tulsi can be used as antiviral agent. It is postulated that the phytochemicals present in Tulsi may inhibit corona virus replication and could contain its growth and spread.

Haldi (*Curcuma longa*) Turmeric

Figure 10: Haldi (*Curcuma longa*) Turmeric

Curcuma longa (Turmeric) is a member of the ginger family *Zingiberaceae* (**Figure 10**) and is thought to be native to the Indian subcontinent. It is mostly cultivated in India, China, and many other regions of tropical South Asia [21. A certain type of starch is also being extracted from a particular type of turmeric. Turmeric has been used traditionally for medication for many centuries in India to treat jaundice and other liver ailments. It has widely pharmacological activities such as antioxidant, anti-protozoal, anti-venom activities, anti-microbial, anti-inflammatory and anti aging properties.

Medicinal usage: It showed potent antioxidant activity by scavenging free radicals. It inhibits lipid peroxidation in renal cells against hydrogen peroxide-induced injury. Curcumin is a polyphenol responsible for several activities. It contains various active components as shown in **Figure 11.**

Pharmacological properties: The various pharmacological activities are as shown in Table 5

Table 5: Pharmacological activities of *Curcuma longa* (Turmeric)

Activity	**Short description [22]**
Antioxidant Effects	Water and fat-soluble extracts of turmeric showed strong antioxidant activity than vitamins C and E. In a study curcumin showed eight times more powerful than vitamin E in preventing lipid peroxidation.
Antimicrobial Effects	*Curcumin* showed antiviral activity against many viruses including hepatitis viruses, influenza virus and emerging arboviruses like the Zika virus (ZIKV) or chikungunya virus (CHIKV) [23]
Anti-Inflammatory Effects	Turmeric has ability to inhibit both biosynthesis of inflammatory prostaglandins from arachidonic acid, and neutrophil function during inflammatory states.
Cardiovascular Effects	Turmeric protects the circulatory system and lowers the cholesterol and triglyceride levels, reducing susceptibility of LDL to lipid peroxidation and inhibiting platelet aggregation [24] .
Hepato protective Effects	Turmeric impacts principally due to its ability to decrease the formation of pro inflammatory cytokines.
Anticarcinogenic Effects	*Curcumin* can inhibit carcinogenesis at three stages: tumor promotion, angiogenesis and tumour growth.

Potential effects of curcumin towards COVID-19: C*urcumin* have been proved as the best possible agent in the prevention of COVID-19. Titanium dioxide-coated curcumin and a few alternative materials, in its nano form, have been used in the PPE kits or masks. C*urcumin* and *Artemisinin* are used in an oral spray

to target viral infections with an inflammatory problem. These constituents are antioxidants and posses benefits against virus, inflammation, and applicable to numerous features of the physiopathology connected with COVID- 19 [25]. Curcumin has an influence on membrane proteins by moderating the characteristics of the host lipid bilayer. The molecular docking with target receptors including SARS-CoV-2 protease, spike glycoprotein-RBD and PD-ACE2 which are supposed to contribute to virus infection in comparison with the known ligand or drug-recipients. Their result demonstrated that several compounds such as Curcumin could bind to the target receptors.

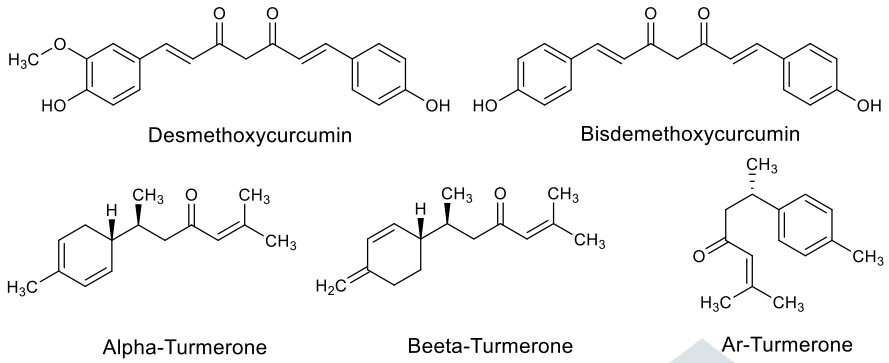

Figure 11: Structures of identified compounds from the turmeric plant

Giloy (*Tinospora cordifolia*) Guduchi

Figure 12: Giloy (*Tinospora cordifolia*) Guduchi

Tinospora cordifolia (**Figure 12**) is commonly known as "Guduchi" or "Giloy" belong to the family *Menispermaceae*. It can be grown anywhere, genetically diverse, deciduous climbing shrub, large. All parts of Giloy are used in the treatment of various diseases. Giloy plant contains various active components such as alkaloids, aliphatic, diterpenoid lactones, steroids, and glycosides. These components are present in the root, stem, leaves and whole plant. Now a days, this plant has been used by researchers for preparing several dosages because of its medicinal properties. Giloy comprises various chemical components that might influence the body. These chemical components have antioxidant effects as well as increase the body's immune system. Various parts of the Giloy plant can be used for medication. The efficacy of Giloy has been reported as a bio-sorbent for removing cadmium ions from industrial effluents. They calculated biosorption capacity using batch and column experiments in the range of 38.91 to 43.06 mg Cd/g at variable pH, bio-sorbent dosages (1-8 g), contact time (5-240 min) and initial metal concentration (10-1000 mg/L). They studied the dose-response behaviour by Langmuir and Freundlich isotherm models [26]. Giloy contains various active constituents.

Active Constituents of Giloy: Active components of Giloy with their biological response have been listed below in **Table 6**.

Table 6: Active components of Giloy

Components	**Phytochemicals name**	Plant Part	**Biological activity**

Alkaloids	Tembetarine, Magnoflorine, Berberine, Choline, Palmatine, IsocolumbinTinosporin,	Stem Root	Neurological Disorder, Anticancer, Antiviral infections and Anti-diabetic
Diterpenoid	Furanolactone	Whole plant	Vaso relaxants, Antiviral, Antimicrobial, Antihypertensive, Anti-inflammatory
Glycosides	Tinocordiside, Cordioside	Stem	Treat Neurological Disorder
Aliphatic compound	Octacosanol	Whole plant	anti-inflammatory and Anti-nociceptive
Steroids	Beta-Sitosterol	Stem Aerial Part	Induce Osteoporosis in early inflammatory arthritis
Others	Giloin, Tinosporic acid	Root	Protease inhibitors for HIV, also used to treat anxiety,

Immunity Enhancer: A study on free radical scavenger property of ethanolic extract of herb giloy has been reported. These free radicals are generated during aflatoxicosis. Giloy is also used as an immunity booster [27]. Giloy has several antioxidants for scavenging free-radicals, keep you healthy and free of diseases. Giloy also helps to detoxify the body, fights against bacteria and purifies blood. It also induces nephrotoxicity due to the alkaloids such as isocolumbin, choline, tetrahydropalmatine, tinosporin, palmatine and magnoflorine.

Anti-diabetic effects: Giloy is also used to cure Type 2 diabetes and to reduce blood sugar as a hypoglycaemic agent [28]. Plant stem contains Isoquinoline alkaloids which have jatrorrhizine, palmatine and magnoflorine. These were investigated in vitro and in vivo for insulin hormone effects. Giloy acts as an anti-diabetic agent through mitigating oxidative stress, also promotes insulin secretion and inhibit its the glycogenolysis and gluconeogenesis. Therefore, it regulates blood glucose.

Chronic fever and reduces asthmatic symptoms: Giloy acts as antipyretic agent. It helps to recover our body from several life-threatening fevers like Swine Flu, Dengue and Malaria etc. It improves the blood platelets in fever. Asthma as we know causes shortness of breath, chest tightness, wheezing, coughing, etc. Therefore, Giloy shows anti-inflammatory action and helps to recover from respiratory problems like cold, frequent cough tonsils.

Used in Arthritis treatment: Giloy stem contains anti-arthritic and anti-inflammatory properties. Giloy stem powder can be used to treat rheumatoid arthritis, joint pain etc. It affects the differentiation, proliferation, and mineralization of bone. So, Giloy act as an anti-osteoporotic agent.

Improves digestion, Vision and reduces Signs of Aging: Giloy plant help in vision clarity, improve digestion and acts as anti-aging agent. Giloy reduces dark spots on face, fine lines, acne, pimples, and wrinkles and makes the skin glowing and flawless.

Results and Discussion

The coronavirus affects the respiratory system and on severity it may cause multiple organ failure which leads to the death of the COVID-19 patients. The mentioned plants in this project displayed very significant antiviral potential against several viruses. These plants have also been used to treat COVID-19 infected persons and showed positive results. All the selected plants are a rich source of secondary metabolites, vitamins and minerals. Viral infections directly attack the immune system of the human body. These plants also play a significant role to boost our immune system. The Amla, Haritaki, and Basil are a rich source of vitamin C which is known for its immunity booster power. Gooseberry contains chromium which can reduce bad cholesterol and prevent cardiac arrest. Curry leaf plants showed excellent antiviral potential due to the presence of complex alkaloids. The Neem plant has already been proved for its antiviral potential and in recent studies it also showed potential against COVID-19 infection. Giloy is one of the best herbal remedies to fight against all the viral infections. An ayurvedic formulation (NyagrodhadiKashayam) made from the mixture of three plants namely, Giloy, Ginger and Haritaki is very effective in the treatment of COVID-19 patients. Recently, this formulation has been successfully trialed on coronavirus infected patients. Turmeric has a number of polyphenolic compounds that have been proved to show the antiviral potential against novel corona virus in docking experiments. The main constituent from turmeric, curcumin has the ability to overcome COVID-19 infection. The plant Murraya koenigii is the richest source of carbazole alkaloids. The carbazole alkaloids have also been proven in docking experiments to inhibit all the

three proteins of the novel coronavirus. Despite the antiviral potential, all these plants showed a diverse range of biological activities. In present review we have concised the various pharmacological properties of the selected plants. The main focus of this review is to disclose the antiviral potential of these plants. Hence, based on the recent reports it can be concluded that the selected Indian medicinal plants can serve as good alternative treatment for novel coronavirus infection in the future.

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Conflict of Interest

The authors have declared that there is no conflict of interest.

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