- Review paper

Anti-viral Activity of 62 Medicinal Plants, Herbs and Spices Available in Bangladesh: A Mini Review

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ABSTRACT: Microorganisms can cause devastating diseases leading to a pandemic, such as COVID-19 which has created a devastating situation throughout the world. The SARS-CoV-2 or severe acute respiratory syndrome coronavirus-2 is the major concern for creating this pandemic situation. Viruses are the major pathogenic microorganisms that have the potential to be detrimental to human beings and animals in many ways. By entering the human body through different routes and commanding different machinery of the body to generate a higher number of their genomic copies and proteins they create pathogenesis. Phytomedicines may act as suitable weapons to halt the reproduction of such viruses and combat diseases caused by these viruses. Bangladesh is the habitat of about 500 medicinal and aromatic plants. Many of these plants have been found to show anti-viral activity. The anti-viral activity of *Terminalia chebula*, a well-known Bangladeshi medicinal plant has been proven to combat Newcastle Disease virus, Herpes Simplex Virus, Adenovirus type 5, Measles virus, Echovirus type 11, Rotavirus, Influenza A virus, Hepatitis B virus and Enterovirus. This review article was aimed to search available medicinal plants as novel anti-viral drugs.

Key words: Medicinal and aromatic plants, Viral diseases, Anti-viral activity of medicinal plant, Newcastle Disease virus, New drug development

INTRODUCTION

Medicinal plants are a precious blessing from nature to humans to help them live healthy and disease-free life. The latest pharmacological research found that medicinal and herbal plants possess anti-viral properties.[1] Thus, by nature we are blessed with several anti-viral herbs that have broad anti-viral spectrum properties.[2]

Viruses are small biological organisms found practically everywhere. They can infect humans, live stocks, plants, fungi and microbes as well. A virus can cause many diseases that can be lethal. A virus's influence on different creatures varies, as does its complexity. They contain ribonucleic acid (RNA) or deoxyribonucleic acid (DNA) covered by protein, lipid (fatty components), or glycoprotein (figure 1). They are parasitic because they cannot reproduce without a host.[3,4]

Viruses have the power to induce a ton of diseases in humans and other living organisms.[5,6] Among these diseases are smallpox, flu, measles, mumps, chicken pox, hepatitis, sore throat, polio, rabies, ebola virus disease, AIDS (caused by human immunodeficiency virus), respiratory infections, dengue, Epstein-Barr and Guillain-Barre syndrome (caused by cytomegalovirus), etc. Human papillomavirus (HPV) is a type of virus that can cause

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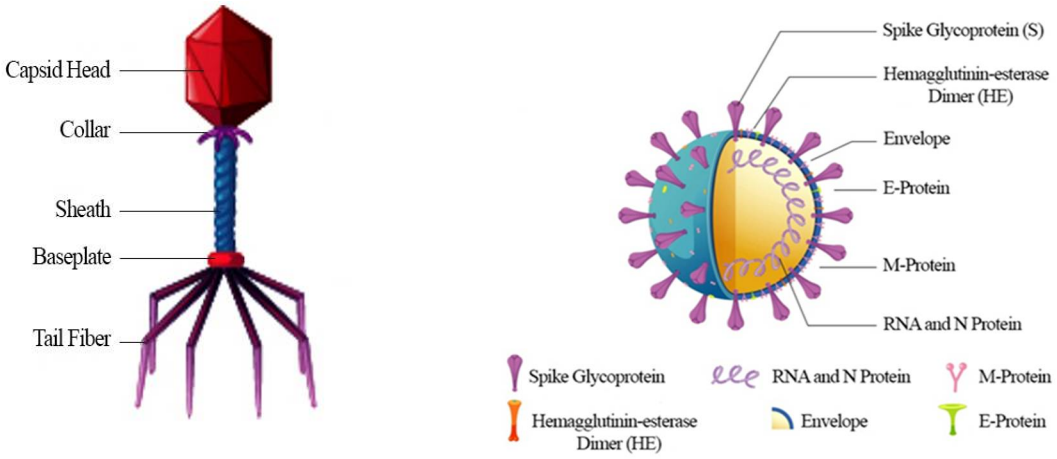
cancer. We will be focusing on the anti-viral characteristics of plants that are cultivated or native to Bangladesh in this article.



(a) Bacteriophage (b) Ordinary human virus

Figure 1. Schematic diagram of the structure of a virus.

MATERIALS AND METHODS

Different electronic sources of databank were searched for the review of the article. Among the sources some are - PubMed, Springer link, MDPI link, ResearchGate, Google and Google Scholar and Science Direct etc.

List of medicinal plants for anti-viral activity. Plants are an excellent source of very novel chemical compounds that can combat bacteria, viruses, fungi, and other microorganisms. In the context of COVID-19 we searched for medicinal plants that have anti-viral activities. These plants may be good anti-viral sources to combat COVID-19 since they possess anti-viral action against several viral infections. The Ayurvedic Pharmacopeia of Bangladesh has published a detailed description of some indigenous medicinal plants of Bangladesh. The local names of the plants have been written in romaji followed by their botanical name. A list of the searched medicinal plants having anti-viral activity is shown in table 1.

Anti-viral potential of specific plant. Medicinal plants are used for viral infections since ancient times. Extracts collected from leaves, seeds, roots and different parts of medicinal plants have been applied against human viruses. Reviews of several studies are pieces of evidence of the fact that hundreds of medicinal plants possess strong potential against viruses. As the study points out about the potential benefits of antiviral plants, after careful investigations these plants extracts can be used for alleviating different viral infection symptoms including diseases like COVID-19. The anti-viral action of methanolic extracts *Terminalia chebula* was examined in BHK cells against the NDV. The physiological changes generated by NDV in BHK cell lines are the same as those caused by an infection with HIV, which results in the creation of a syncytium by cell-to-cell fusion. These viruses are similar to COVID-19 as the virus induces the formation of syncytia (figure 2)[3]. Thus *T. chebula* has potential anti-viral activity against the coronavirus.[3]

Table 1. List of 62 medicinal plants searched for anti-viral activity.

1	Ada (*Zingiber officinale* Roxb.)	32	Kantakari (*Solanum xanthocarpum* Schrad. & Wendl.)
2	Akand (*Calotropis procera*)	33	Karbee (*Nerium indicum* Mill., Syn. *N. odorum* Soland.)
3	Am (*Mangifera indica* Linn.)	34	Katphal (*Myrica esculenta* Buch. / *M. nagi* Hook. f.)
4	Amalaki (*Phylanthus embelica / Embelica officinalis)*	35	Khayer (*Acacia catechu* Linn. f.)
5	Aparajita (*Clitoriaternatea*)	36	Khude dhekishak (*Ceratopteris thalictroides)*
6	Arjuna (*Terminalia arjuna*)	37	Kurchi (*Holarrhena antidysenterica* Roth.)
7	Ashoka (*Saraca asoka* Rosc/ *Saraca Indica* Linn)	38	Kusum fool (*Carthamus tinctorius)*
8	Ashwagandha (*Withania somnifera* Dunal)	39	Kutki [Birhalnokha](*Capparis spinosa*)
9	Bahera (*Terminalia bellerica* Roxb.)	40	Kutumkanta (*Caesalpinia crista*)
10	Banar-mul (*Vetiveria zizaniodes* Linn.)	41	Lajjabati (*Mimosa pudica* Linn.)
11	Barun (*Crataeva nurvala* Buch-Ham.)	42	Methi (*Trigonella foenum-graecum* Linn.)
12	Basak (*Adhatoda vasica* Nees.)	43	Morog fool (*Celosia cristata*)
13	Bathua (*Chenopodium album*)	44	Mutha (*Cyperus rotundus*)
14	Bel (*Aegle marmelos* Corr.)	45	Neem (*Azadirachta indica* A. Juss.)
15	Bherenda (*Ricinus communis* Linn.)	46	Nishinda (*Vitex negundo* Linn.)
16	Bhui-kumra (*Pueraria tuberosa* DC.)	47	Patte-madar (*Erythrina indica* Lam. / *E. variegate* L.)
17	Bhumi amalaki (*Phyllanthus niruri* Hook. / *P. fraternus* webst.)	48	Pipul (*Piper longum* Linn.)
18	Brahmi (*Bacopa monnieri* Linn.)	49	Punarnava (*Boerhavia diffusa*)
19	Calendula fool (*Calendula officinalis)*	50	Randhuni, Ajamoda (*Apium leptophyllum* Pers. / *A. graveolens* Linn.)
20	Dhutra (*Datura metel* Linn. / *D. fastuosa*)	51	Rasna (*Pluchea lanceolata* Oliver & Hiern.)
21	Drun-puspi (*Leucas cephalotes* Spreng. / *L. aspera*Spreng.)	52	Rasun (*Allium sativum* Linn.)
22	Durba (*Cynodon dactylon* Linn.)	53	Sajna (*Moringa oliefera* Lam. Syn.)
23	Gamar (*Gmelina arborea* Roxb.)	54	Sal-parni (*Desmodium gangeticum* DC.)
24	Gulancha (*Tinospora cordifolia* Willd.)	55	Sarisa (*Brassica campestris* Linn. / *B. nigra* Linn.)
25	Halud (*Curcuma longa* Linn.)	56	Shimul (*Bombax ceiba* Linn. / *Salmalia malabarrica* Sehott & Endl.)
26	Haritaki (*Terminalia chebula* Retz.)	57	Sondal (*Cassia fistula* Linn.)
27	Hurhuriya/Ajagandha (*Cleome gynandra* Linn.)	58	Supari (*Areca catechu* Linn.)
28	Jongli fool (*Astragalus hamosus*)	59	Tajpata (*Cinnamomum tamala* Buch. Ham.)
29	Kalabati (*Canna indica*)	60	Tulsi (*Ocimum sanctum* Linn.)
30	Kalajira (*Nigella sativa* Linn.)	61	Tut begun (*Solanum nigrum* Linn)
31	Kanchana (*Bauhinia variegate* Blume.)	62	Ulkushi (*Mucuna prurita* Hook. / *M. pruriens* Baker.)

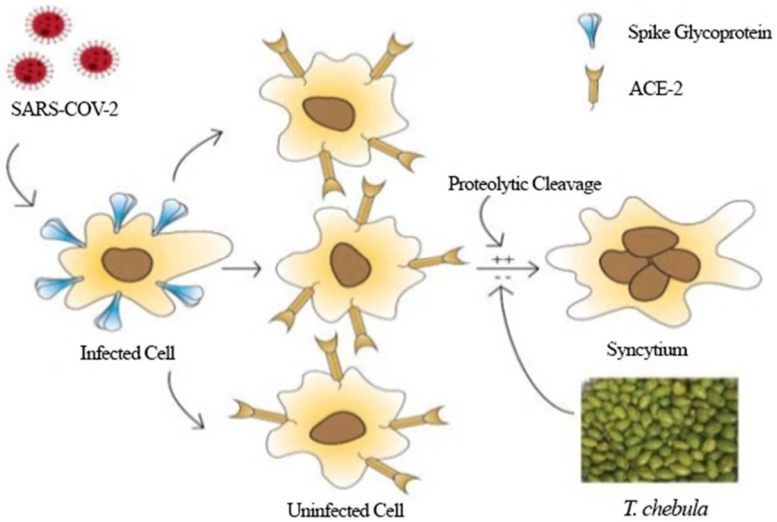


Figure 2. Schematic representation of inhibition of formation of syncytium by *T. chebula*.

Table 2. Medicinal plants and their bio-active compounds for potential anti-viral effects.

Plant species	Bengali name	Family	Part used	Pharmacological action	Bioactive compounds	Effective against
Zingiber officinale Roxb.[7-12]	Ada	Zingiberaceae	Rhizome	Nausea, motion sickness, gastric ulcers, diabetes, xerostomia, sore throat, rheumatoid arthritis, migraine pain, and minor respiratory problems	Zingiberol, zingiberene, gingerols, shogaols, 1-dehydro-(10)-gingerdione, terpenoids, flavonoids	Human respiratory syncytial virus (HRSV), feline calicivirus, influenza type A (H_1N_1), hepatitis C virus (HCV), herpes simplex virus type 1 & 2 (HSV-1,2)
Calotropis procera[13,14]	Akand	Apocynaceae	Leaves, roots, flowers	Anti-diarrhoeal, anti-stomatitic, used to treat constipation and skin diseases	Cardenolides, terpenes, flavonoids etc.	Foot and mouth disease virus (FMDV)
Mangifera indica Linn.[15-17]	Am	Anacardiaceae	Leaves, root extracts	Antioxidant, anti-viral, anti-diabetic, gastroprotective, cardioprotective, anti-microbial, anti-allergic, antipyretic effects	Amino acids, carbohydrates, fatty acids, vitamins, saponins such as tetrahydroxy pyrrolidone saponin or mangiferin etc.	Influenza virus (H_9N_1), herpes simplex type 1 and type 2 (HSV-1,2)
Phylanthus Embelica[18-21]	Amalaki	Phyllanthaceae	Fruits, roots	Antimicrobial, antioxidant, anti-inflammatory, analgesic and antipyretic, adaptogenic, hepatoprotective, antitumor and antiulcerogenic activities	4′-hydroxy-phyllaemblicin B, nor-sesquiterpenoid glycosides, phyllaemblicin A, phyllaemblicin B and phyllaemblicin C, phyllaemblicin E and F, methyl ester of phyllaemblic acid, 1,2,4,6-tetra-O-galloyl-D-glucose (1246TGG)	Coxsackievirus B_3, human immunodeficiency virus (HIV), HSV (1 & 2)
Clitoria Ternatea[22,23]	Aparajita	Fabaceae	Flowers, leaves, seeds, stems, roots	Analgesic, insecticidal, antioxidant, anticancer activities	Flavonoids, alkaloids, anthraquinone, anthocyanins, volatile oils, steroids, stigmast-4-ene-3,6-dione	Bacteria, yeast, fungi
Terminalia Arjuna [24-26]	Arjuna	Combretaceae	Bark extracts	Anti-hypertensive, hypolipidemic, anti-thrombotic, anti-coagulant, antiviral, anti-bacterial, and anti-fungal effects	arjungenin, arjunin, arjunic acid, arjunolic acid, terminic acid, casuarinin, casurin, punicalagin, castalagin, asarjunone, arjunolone, luteolin, bicalein, gallic acid	Herpes simplex virus type 2 (HSV-2)
Saraca asoka Rosc/ *Saraca Indica* Linn.[27,28]	Ashoka	Fabaceae	Leaves	Spasmogenic, anti-tumor, anti-cancer, oxytocic, anti-bacterial, anti-implantation, and menorrhagic activities	Tannins, flavonoids, carbohydrates, proteins, steroids	*Bacillus sublitis*, *Pseudomonas aeruginosa*, *Candida albicans*, *Aspergillus niger*
Withania somnifera Dunal [29-31]	Ashwagandha	Solanaceae	Leaves, fruits, bark	Anti-viral, anti-microbial, anti-inflammatory, neuroprotective, cardioprotective, anti-tumor, and anti-diabetic effects	Withaferin A	Influenza virus (H_1N_1), HSV-1, infectious bursal virus disorder
Terminalia bellerica Roxb.[32-34]	Bahera	Combretaceae	Fruits	Anti-diabetic, anti-microbial, anti-bacterial, anti-fungal, anti-cancer, hepatoprotective, antipyretic, anti-diarrheal effects	Tannins, glycosides, flavonoids, phenolic compounds, amino acids, saponins	Newcastle disease virus (NDV), human papillomavirus (HPV), human immunodeficiency virus (HIV)

Vetiveria zizaniodes Linn.[35-37]	Banar-mul	Poaceae	Roots	Anti-bacterial, insecticidal, herbicidal, and antioxidant properties	Khushimol, α-vetiverone, β-vetiverone, ethyl 4-(4-methylphenyl)-4-pentenoate	Dengue virus
Crataeva nurvala Buch-Ham.[38,39]	Barun	Capparaceae	Leaves	Used to treat inflammatory diseases, paralysis, urogenital problems, nephrotic disorders, breast cancer, thyroid problems	Lupeol, cadabicine, lupenone, mannitol, phragmalin triacetate, succinic acid, betulinic acid, lactic acid, stigmasterol, kaemferol-3-O-D-glucoside, quercitin-3-O-D-glucoside	Bacteria, fungi
Adhatoda vasica Nees. / Justicia adhatoda L.[40-43]	Basak	Acanthaceae	Leaves, roots, bark	Anti-inflammatory, antioxidant, anti-fungal, anti-viral, antitussive, anti-ulcer, thrombolytic, hepatoprotective, and cardioprotective properties	vasicine, l-vasicinone, deoxyvasicine, maiontone, vasicinolone and vasicinol	Influenza virus, human immunodeficiency virus (HIV)
Chenopodium album [44,45]	Bathua	Amaranthaceae	Leaves	Used to treat tumors, cancer, headaches, bacterial and fungal infections, amoebiasis, inflammation, also used for contraception, diarrhea, hepatic disorders, diabetes, and immune disorders	alkaloids, flavonoids, anthocynidine, saponins, glycosides, tannins, carbohydrates	Tobacco mosaic virus (TMV), sunn hemp rosette virus (SRV)
Aegle marmelos Corr.[46-50]	Bel	Rutaceae	Leaves, fruits, bark	Antidiarrhoeal, antimicrobial, antiviral, radioprotective, anticancer, and chemopreventive effects, antipyretic, ulcer healing, antigenotoxic, diuretic, anti-fertility and anti-inflammatory properties	Marmelide, Steroids, terpenoids, flavonoids, phenolic compounds, lignin, fat and oil, inulin, proteins, carbohydrates	Human coxsackievirus B_3
Ricinus communis Linn.[51-53]	Bherenda	Euphorbiacae	Leaves, fruits	Antioxidant, antihistaminic, Antinociceptive, antiasthmatic, antiulcer, anti-diabetic, hepatoprotective, Antifertility, anti-inflammatory, antimicrobial, central nervous system stimulant, lipolytic, wound healing, insecticidal and larvicidal properties	Steroids, saponins, alkaloids, flavonoids, glycosides, ricinine, N-demethylricinine, gallic acid, quercetin, gentisic acid, rutin, epicatechin, ellagic acid	Coxsackievirus B_3, HSV-1, vesicular stomatitis virus (VSV)
Pueraria tuberosa DC.[54,55]	Bhui-kumra	Fabaceae	Leaves, tuber	Antioxidant, anti-inflammatory, wound healing effects, anticancer, anti-diabetic, contraceptive, anti-convulsant, anxiolytic, anti-ulcer, hepatoprotective, cardioprotective, lipid-lowering, neuroprotective, nephroprotective properties	Biochanin A and B, puerarin, genistein, daidzein, quercetin, irisolidone, isoorientin, mangiferin	*Escherichia coli*, *Staphylococcus aureus*, *Salmonella paratyphi*, *Bacillus cereus*, *Candida albicans*, *Alternaria solani*, *Aspergillus fumigates*
Phyllanthus niruri Hook.[56-59]	Bhumi amalaki	Phyllanthaceae	Leaves	Used for jaundice, gonorrhea, frequent menstruation, and diabetes, topically used as a poultice	4-O-caffeoylquinic acid, quercetin-3-O-rhamnoside	Hepatitis C Virus (HCV), Hepatitis B virus (HBV), Woodchuck

				for skin ulcers, sores, swelling, and itchiness		Hepatitis virus (WHV), Human immunodeficiency virus type-1 (HIV-1)
Bacopa monnieri Linn.[60]	Brahmi	Scrophulariaceae	Leaves, flowers	Used for memory enhancement, improvement of concentration and learning, relieves anxiety and epilepsy, cardiotonic, gastroprotective, hepatoprotective effects	alkaloids, brahmine, herpestine, saponins, d-mannitol, hersaponin, monnierin, bacosides, bacopasaponins	Bacteria, fungi
Calendula officinalis [61,62]	Calendula fool	Asteraceae	Leaves, flowers	Antioxidant, anti-microbial, anti-proliferative, anti-inflammatory, anti-ulcer, glucose controlling, lipid-lowering, and wound healing properties	Phenolic compounds, flavonoids, carotenoids, fatty acids, saponins, amino acids, steroids, carbohydrates	Human immunodeficiency virus type-1 (HIV-1)
Datura metel Linn. / *D. fastuosa* [63-66]	Dhutra	Solanaceae	Fruits, seeds, flowers	Treats asthma symptoms, epilepsy, hysteria, insanity, heart and skin diseases, mental disorders	Atropine, hyoscyamine, and scopolamine alkaloids, tannin, phenol, lignins, lipids, proteins, saponin, glycosides, sterols	Rabies virus (RV)
Leucas aspera Spreng.[67,68]	Drun-puspi	Lamiaceae	Leaves, stem, roots, flowers	Antipyretic, insecticidal, anti-fungal, antioxidant, anti-microbial, anti-nociceptive, cytotoxic effects	Alkaloids, steroids, flavonoids, terpenoids, saponins, carbohydrates, proteins, amino acids	Mouse coronavirus (MCV), herpes simplex virus (HSV)
Cynodon dactylon Linn.[69-73]	Durba	Poaceae	Whole plant	Cardiovascular, antidiabetic, gastrointestinal, antioxidant, immunological, antiallergic, anti-inflammatory, antipyretic, analgesic, anticancer, dermatological, diuretic, protective, antimicrobial, antiparasitic, insecticidal, and repellent properties	Flavonoids, alkaloids, glycosides, terpenoids, triterpenoids steroids, saponins, tannins, resins, phytosterols, reducing sugars, carbohydrates, proteins, volatile oils, and fixed oils	White spot syndrome virus (WSSV), porcine reproductive and respiratory syndrome virus (PRRSV), chikungunya virus
Gmelina arborea Linn.[74-76]	Gamar	Verbenaceae	Root, bark	Fever, dyspepsia, hallucinations, hyperdipsia, hemorrhoids, gastralgia, burning sensation	Apigenin	*Staphylococcus aureus*, *Escherichia coli*, *Salmonella typhi*
Tinospora cordifolia Willd.[77,78]	Gulancha	Menispermaceae	Leaves, fruits, seeds	Antipyretic, anti-diarrhoeal, anti-leprotic, anti-diabetic, nephroprotective and healing effects for skin diseases	Alkaloids, terpenoids, lignans, steroids	Hepatitis A virus (HAV)
Curcuma longa Linn.[79-85]	Halud	Zingiberaceae	Rhizome	Anti-inflammatory, antioxidant, antimutagenic, antidiabetic, antibacterial, hepatoprotective, expectorant, anticancer properties	Curcumin, dimethoxy curcumin, bisdemethoxy curcumin, β-turmerone, terpinolene, α-phellandrene, curcumadiol	Hepatitis B virus (HBV), Newcastle disease virus (NDV), dengue virus type 2, influenza virus (H_1N_1 and H_9N_2)

Terminalia chebula Retz.[86-90,]	Haritaki	Combretaceae	Fruits	Increase appetite, digestive aid, liver stimulant, stomachic, gastrointestinal prokinetic agent, and mild laxative	Chebulagic acid, chebulinic acid, pyrogallol, gallic acid, ellagic acid, corilagin, chebulanin, neochebulinic acid, casuarinin	Newcastle disease virus (NDV), hepatitis B virus (HBV), herpes simplex virus (HSV-1,2), influenza A virus (IAV), adenovirus type 5, HIV
Cleome gynandra Linn.[91-94]	Hurhuriya	Cleomaceae	Leaves, shoots	Anti-inflammatory, anti-cancer, antioxidant, anti-diabetic, and immune modulating properties	Alkaloids, flavonoids, phenols, proteins, amino acids, carbohydrates, steroids, saponins and tannins	*Staphylococcus aureus*, *Candida albicans*
Astragalus hamosus Linn.[95]	Jongli fool	Papilionaceae	Flowers, seed pods	Used for headaches, gastritis, vertigo, stroke, dementia	Flavonoids, fatty acids, steroids, alkene and terpenoids	Hepatitis B virus (HBV)
Canna indica Linn.[96,97]	Kalaboti	Cannaceae	Roots, flowers, rhizomes	Anti-bacterial, anti-viral, anthelmintic, anti-inflammatory, analgesic, immunomodulatory, antioxidant, cytotoxic, hemostatic, hepatoprotective, anti-diarrheal properties	Alkaloids, flavonoids, terpenoids, carbohydrates, proteins, cardiac glycosides, steroids, tannins, saponins, phlobatinins	Human immunodeficiency virus type-1 (HIV-1)
Nigella sativa [98-104]	Kalajira	Ranunculaceae	Seeds	Antioxidant, antidiabetic, immunomodulator, anti-inflammatory, anticancerous activities	Alkaloids, terpenes, phenols, fixed oils, carbohydrates	Hepatitis C virus (HCV), murine cytomegalovirus (MCMV), influenza virus (H_9N_2 & H_5N_1), severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2)
Bauhinia variegate Blume.[105,106]	Kanchana	Caesalpiniaceae	Flowers, leaves, bark	Anti-cancer, anti-bacterial, anti-inflammatory, hepatoprotective, hemagglutination properties	Phenolic compounds, terpenoids, tannins, flavonoids	Rotavirus
Solanum xanthocarpum Schrad. & Wendl.[107,108]	Kantakari	Solanaceae	roots, stems, leaves, fruits	anti-asthmatic, hypoglycemic, hepatoprotective, anti-bacterial, insecticidal effects	Solasodine, diosgenin	*Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Aspergillus niger*
Nerium indicum Mill.[109-111]	Karabee	Apocynaceae	Flowers, leaves, seeds, bark	Cardioprotective, anti-asthmatic, antioxidant, antiulcer, wound healing, anticancer, antiepileptic properties	Oleandrin, phenols, flavonoids, glycosides	Herpes simplex virus (HSV), HIV
Myrica esculenta Buch.[112-116]	Katphal	Myraceae	Bark extracts	Analgesic, anti-allergic, anxiolytic, anti-microbial, anti-diabetic, anti-hypertensive, anti-ulcer, anti-inflammatory properties	Phenols, glycosides, alkaloids, triterpenoids, volatile oils, Dodecanol, phytol, furfurals, 4-H-pyran-4-one	*Staphylococcus aureus*, *Escherichia coli*, *Streptococcus pyogenes*
Acacia catechu Linn.f.[117-119, 21]	Khayer	Fabaceae	Stem bark,	Antibacterial, antifungal, anti-diarrhoeal,	Tannins, catechin, phlobatannins,	Newcastle disease virus

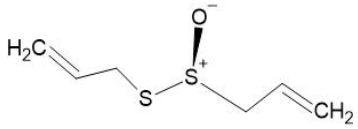
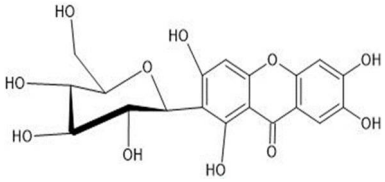
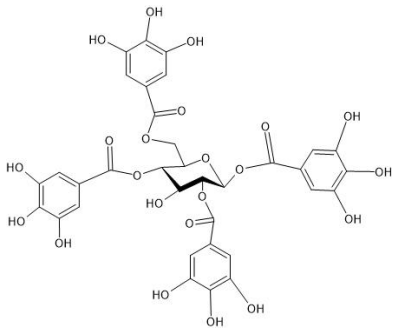
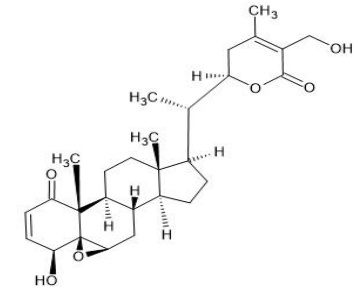
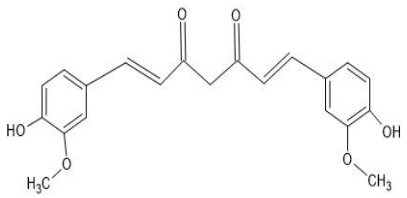
			leaves	antioxidant, immunomodulator, antipyretic effects	catechutannic acid, quercetin, quercitrin, fisetin, gums, resins	(NDV), herpes simplex virus type-2 (HSV-2), HIV-1
Ceratopteris thalictroides [120-123]	Khude dhekishak	Pteridaceae	Whole plant	Used as poultice for skin disorders, wound healing properties	Cyanovirin-N, alkaloids, steroids, coumarins, tannins, saponins, flavonoids, quinones, protein, carbohydrate, glycosides, catechin, terpenoids	HIV-1, Ebola virus, influenza viruses
Holarrhena antidysenterica Roth.[124-127]	Kurchi	Apocynaceae	Stem bark, seeds	Anti-bacterial, analgesic, free radical scavenging effects, anti-diarrheal, CNS stimulant properties, anti-inflammatory, anti-amoebic, anti-hemorrhoidal, anti-malarial, anti-diabetic, anti-mutagenic effects	Coumarins, flavonoids, steroidal alkaloids, ergosterol, phenolic compounds, tannins, saponins, triterpenoids, resins	Bacteria, fungi
Carthamus tinctorius L.[128,129]	Kusum fool	Asteraceae	Flowers	Cardiovascular, blood stasis, cerebrovascular illnesses, anti-bacterial, anti-microbial, and anti-inflammatory properties	Carthamidin, isocarthamidin, safflor yellow A, hydroxysafflor yellow A, luteolin, safflamin C etc.	Kaposi's sarcoma-associated herpes virus (KSHV)
Capparis spinosa [130,131]	Kutki	Capparaceae	Fruits, flowers, leaves, bark	Anti-bacterial, antiviral, antifungal, antioxidant, antihypertensive, antidiabetic, lipid-lowering, anti-allergic, hepatoprotective effects	Flavonoids, alkaloids, streroids, terpenoids, tocopherols	Herpes simplex virus type-2 (HSV-2)
Caesalpinia crista[132,133]	Kutum-kanta	Caesalpiniaceae	Seed	Anti-microbial, antioxidant, anti-cancer, hepatoprotective, anti-diabetic, anti-convulsant, insecticidal properties	Flavonoids, alkaloids, tannins, phytosterols, triterpenoids, coumarins	Paramyxovirus, orthomyxovirus
Mimosa pudica Linn.[134,135]	Lajjabati	Mimosaceae	Whole plant	Used to treat gastrointestinal issues and sleeplessness, cancer, numerous urogenital infections	Terpenoids, phenolics, flavonoids, glycosides, alkaloids, quinines, tannins, saponins, coumarin	Mumps virus
Trigonella foenum-graecum Linn.[136-138]	Methi	Fabaceae	Seeds, leaves	Anti-microbial, hypotensive, antioxidant, anti-inflammatory, and antitumor activity	Sapogenins, isoleucine, galactomannans, flavonoids, phenolic compounds	Bacteria
Celosia Cristata[139-141]	Morog fool	Amaranthaceae	Leaves	Hepatoprotective, lipid-lowering, antimicrobial, anthelmintic, antioxidant, antimelanocyte, anti-aging effects	phenolic compounds, tannins, flavonoids, sterols	Bovine viral diarrhea (BVDV), Hepatitis B virus (HBV)
Cyperus rotundus[142-146]	Mutha	Cyperaceae	Whole plant	Used for diarrhea, diabetes, inflammation, malaria, digestive and bowel diseases, gastrointestinal issues	Sesquiterpenoids, kaempferol, luteolin, quercetin	Hepatitis B virus (HBV), herpes simplex virus type 1 (HSV-1), Coxsackie virus
Azadirachta indica A. juss.[147-151]	Neem	Maliaceae	Leaves, fruits, seeds, stem bark	Treats eczema and acne, wound healing, antidiabetic, anti-inflammatory and antiheperglycemic properties	Azadirachtin A-G, alkaloids, flavonoids, triterpenoids, phenolic compounds, carotenoids, steroids, ketones	Coxsackie B-4 virus, HSV-1, polio virus type-1 (PV-1)

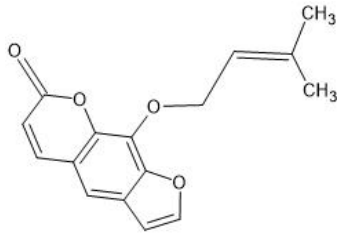
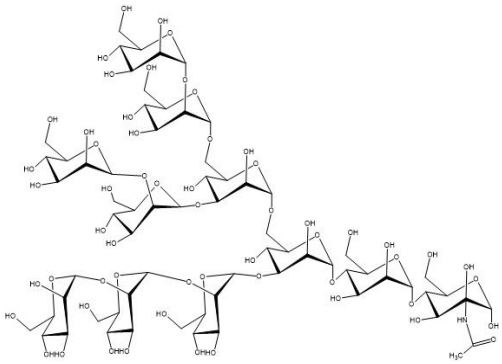
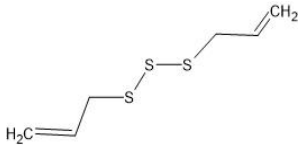
Vitex negundo Linn.[152-154]	Nishinda	Lameaceae	Leaves, bark, roots	Antioxidant, anti-inflammatory, analgesic, stimulatory properties, anti-bacterial and anti-tumor properties, anti-arthritic properties, anxiolytic properties, larvicidal, nephroprotective, anti-HIV properties, anti-snake venom properties	Flavonoids, essential oils, flavonoid glycosides, terpenes, lignans, stilbene derivatives	HIV-1, chikungunya virus
Erythrina variegata L.[155-157]	Patte-madar	Fabaceae	Leaves	Anti-asthmatic, anti-epileptic, antiseptic, astringent, anti-inflammatory, analgesic, anthelmintic, smooth muscle relaxant, central nervous system depressive properties	Polyphenolic compounds, flavonoids, triterpenes, gallic acid, caffeic acid	*Pseudomonas aeruginosa, Staphylococcus aureus, Escherichia coli, Bacillus subtilis, Bacillus cereus*
Piper longum L.[158-161]	Pipul	Piperaceae	Roots, seeds, fruits, whole herb	Insecticidal, antifungal, antiamoebic, antimicrobial, antiviral, antimicrobial, antioxidant, anticancer, antiasthmatic, hypocholestrelomic, and analgesic activities	Piperine, alkaloids, volatile oils, amides, lignans, esters	Hepatitis B virus (HBV)
Boerhavia diffusa [162-165]	Punarnava	Nyctaginaceae	Roots, leaves	Analgesic, anti-inflammatory, diuretic, hepatoprotective, immunomodulator, nephroprotective, antiulcer, antihistaminic properties	Punarnavine, boeravinone A-F, punarnavoside, dimethylflavone, boerhavin, boerhavic acid, caffeoyltartaric acid, quercetin, kaempferol	Potato X virus, yellow mosaic virus, bacteriophages
Apium leptophyllum Pers.[166-168]	Randhuni	Apiaceae	Stem, leaves	Asthma, flatulence, dyspepsia, diarrhoea, laryngitis, rheumatoid arthritis, bronchitis	Thymohydroquinone dimethyl ether, thymol methyl ether, isothymol methyl ether, cuminaldehyde, p-cymene, γ-terpinene	*Staphylococcus aureus, Escherichia coli, Pseudomonas aeruginosa, Bacillus cereus, and Bacillus subtilis*, fungi
Pluchea lanceolata Oliver & Hiern.[169-172]	Rasna	Asteraceae	Leaves, rhizome	Anti-tumor, wound healing effects, anti-parasitic, anti-malarial, anti-microbial, anti-hyperglycemic, anti-inflammatory effects	Alkaloids, tannins, flavonoids, steroids, phenols, glycosides, triterpenes, proteins, carbohydrates	*Vibrio cholerae*
Allium sativum Linn.[173-176]	Rasun	Amaryllidaceae	Bulb	common cold, influenza, hypertension, diabetes	Allitridin, alliin, allicin, diallyl sulfide, diallyl disulfide, diallyl trisulfide, ajoene, and S-allylcysteine	Human cytomegalovirus (HCMV) influenza B virus (IBV), HSV types 1 and 2, parainfluenza virus type 3, vaccinia virus, and human rhinovirus type 2
Moringa oleifera Lam.[177-184]	Sajna	Moringaceae	leaves, fruits, seeds	Used for diabetes, skin infections, anemia, malaria, tuberculosis, headaches, and diseases that are transmitted through sexual contact	Alkaloids, saponins, tannins, steroids, phenolic compounds, glucosinolates, flavonoids, terpenes	Herpes simplex type 1 & type 2 (HSV-1,2), Newcastle disease virus (NDV), human

						immunodeficiency virus (HIV-1), foot and mouth disease virus (FMDV)
Desmodium gangeticum DC.[185-188]	Sal-parni	Fabaceae	Flowers, leaves	Antioxidant, anti-inflammatory, anti-leishmanic, cardioprotective, antiulcer, nephron-protective, wound healing activities	Flavonoids, alkaloids, steroids, terpenoids, pterocarpans, coumarins, volatile oils, phenylpropanoids	Peste des Petits Ruminants (PPR) virus
Brassica nigra Linn.[189-192]	Sarisa	Brassicaceae	Seeds, flowers, leaves	Cytotoxic, anti-inflammatory, anti-diabetic, mutagenic, hepatoprotective, nephroprotective, anti-obesity, antioxidant, immunomodulator, cardiovascular, hypolipidemic effects	Essential oil, flavonoids, sulphur-containing compounds, phenylpropanoid derivatives, indole alkaloids, sterol glucosides, glucosinolates, phenanthrene, isothiocyanate anthocyanins	*Spodoptera littoralis*, *Escherichia coli*, *Klebsiella pneumonia*, *Salmonella paratyphi*, *Pseudomonas aeriginosa*, *Staphylococcus aureus*
Bombax ceiba Linn.[193-195]	Shimul	Malvaceae	Flowers, young roots, leaves, gums, barks	Antibacterial, wound healing, tissue and bone regenerating properties, improves bowel movement, anti-diarrheal, aphrodisiac properties	Mangiferin, quercetin, shamimin, shamimoside, β-sitosterol, taraxeryl acetate, lupeol, simalin A, simalin B, shamimicin, bombamalones A-D, bombaxquinone B, bombamaloside, bombasin	Bacteria, fungi, yeasts
Cassia fistula Linn.[196,197]	Sondal	Caesalpiniaceae	Fruits, flowers, bark, roots	Anti-microbial, insecticidal, anti-neoplastic properties, anti-inflammatory, hepatoprotective, and hypoglycemic properties	Tannins, terpenoids, alkaloids, flavonoids, glycosides, anthraquinones, flavan-3-ol derivatives	Infectious bovine rhinotracheitis (IBR) virus
Areca catechu Linn.[198-201]	Supari	Arecaceae	Nuts, buds, shoots, leaves	Antiparasitic, anti-bacterial, antiviral, improve oral hygiene and motility of food	Procyanidin, areca tannin B_1, tannins, terpenoids, alkaloids, flavonoids, fatty acids	Human immunodeficiency virus (HIV), gram-positive bacteria
Cinnamomum tamala Buch. Ham.[202-204]	Tajpata	Lauraceae	Leaves, bark	Carminative, used in colic and diarrheal conditions	Reducing sugar, glycoside, tannins, steroid, amino acids, alkaloids, essential oils	Bacteria, fungi
Ocimum sanctum Linn.[205-208]	Tulsi	Lamiaceae	Leaves	Rejuvenating and vitalizing properties, antiseptic, anti-allergic, anti-cancer effects	Oleanoic acid, rosmarinic acid, B-elemene, eugenol, limonene, carvacrol, germacrene	Newcastle disease virus (NDV), influenza virus (H_9N_2)
Solanum nigrum Linn.[209-211]	Tut begun	Solanaceae	Fruits, leaves	Antioxidant, anti-cancer, anti-inflammatory, diuretic, hepatoprotective, anti-bacterial, and anti-convulsant properties	Alkaloids, glycoprotein, polyphenolic components including catechin, gallic acid, epicatechin, caffeic acid, naringenin	Hepatitis C virus (HCV)
Mucuna prurita Hook. / *Mucuna pruriens* Baker.[212-214]	Ulkushi	Fabaceae	Seeds	Cholestrolemic, anti-parkinson, anti-diabetic, aphrodisiac, anti-inflammatory, anti-bacterial properties	Alkaloids, flavonoids, tannins, phenols	Bacteria, fungi, yeasts

Isolated pure chemical compounds responsible for specific antiviral actions. Many investigations had been conducted to isolate pure chemical compounds from different medicinal plants and their potential antiviral activities against various viruses were explored. A few chemical compounds found in some of these medicinal plants and their anti-viral activities are shown in table 3.

Table 3. The chemical structures of a variety of substances obtained from various medicinal plants.

Active compound	Chemical structure	Anti-viral activity
Allicin [215] (*Zingiber officinale* Roxb.)		Allicin is an influenza cytokine that has anti-viral activity against the Influenza virus (H1N1)[11]
Mangiferin[216] (*Mangifera indica*)		Mangiferin is a tetrahydroxy pyrrolidone saponin extracted from *Mangifera indica* that possesses anti-viral activity against HSV-2 [16]
1,2,4,6-Tetra-O-galloyl-β-D-glucose[217](1246TGG) (*Phylanthus embelica*)		The polyphenolic compound 1246TGG suppresses the replication cycle of HSV-1 and HSV-2[20]
Withafarin A[218] (*Withania somnifera* Dunal.)		Withafarin A, as a neuraminidase inhibitor, has anti-viral efficacy against H_1N_1 influenza neuraminidase (NA) and can limit NA activity by inhibiting the production of progeny viruses [219]
Curcuminoids [220] (*Curcuma longa* Linn.)		Curcuminoids derived from methanolic extracts of *Curcuma longa* were found to have significant inhibitory activity on the neuraminidases of several influenza virus variants such as H_1N_1 and H_9N_2, when tested[84]

Marmelide[50] (*Aegle marmelos* Corr.)		Marmelide is a pure compound that is the most effective virucidal agent against human coxsackievirus B_1-B_6[48]
Cyanovirin-N (CVN) [221] (*Ceratopteris thalictroides*)		Cyanovirin-N (CVN) isolated from *Ceratopteris thalictroides*is an anti-HIV protein[122]
Allitridin[222] (*Allium sativum* Linn.)		Allitridin, a diallyl trisulfide extracted from *A. sativum*, can suppress human cytomegalovirus (HCMV), IEA expression surprisingly *in vitro*, which is possibly a crucial mechanism in the anti-HCMV function of allitridine[174]

Recommendations. Hippocrates cured every disease with herbs and the art of healing from the magical-religious conceptions of the past freed by him. The abundance and potency of indigenous plants influenced him to acquire a strong belief in the healing properties of Mother Nature, which he used further for his medical studies. We, therefore, observe that nature is the major source of the drugs. In this review, we found that *Terminalia chebula* Retz, Haritaki in Bengali, contained different bioactive components which were effective in treatment of SARS COV-2 infection, hence, this plant showed potential antiviral activity against COVID-19.

CONCLUSION

In this paper we studied 62 Bangladeshi medicinal plants for the antiviral activity and found that 45 plants possess the activity. It has been acknowledged from ancient times that medicinal plants have established anti-viral efficacy against different viruses and in particular, against viral infections with characteristics similar to COVID-19. Therefore, further investigation for isolation of the active constituents from the selective medicinal plants, elucidation of the biochemical mechanism of trafficking inhibition and *in vitro*, *in vivo* & *in silico* analyses are warranted. This appears to be a potential technique for decreasing the infectivity of corona virus in a worldwide situation and as a result, reducing the morbidity and mortality that has occurred due to COVID-19.

Consent for publication. All the authors who contributed to completing this review article have consent for the publication of this article. With consent, every author gives permission to publish this article and all authors guarantee that the information used in this article has not been previously published anywhere. It is to be noted that any one or more of the authors will not withdraw the consent later.

Author contributions. MSA is the one who came up with the original concept and laid out the general layout of the study. The first draft of the manuscript was written by AF, FA and TA. The illustrations in the manuscript have been drawn by AF. The literature survey was carried out by SK,

AAC, JAC and SMB. All authors improved the manuscript through mutual discussion by several offline and online meetings. Before submitting the final document, all authors have gone through it thoroughly and given their approval for the final version.

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