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Potential Role of Medicinal Plants for the Treatment of Respiratory Viruses: A Review

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Abstract

Medicinal plants have many applications due to their efficiency, have lower side effects and their content of phytochemicals compounds that are efficient in the treatment of many diseases such as viral diseases respiratory system. In the last decades, traditional medicine uses medicinal plants in the treatment of viral diseases especially in treatment of respiratory viruses, including (Human Respiratory Syncytial Virus (RSV), Human Parainfluenza Viruses (HPIV), Human Metapneumovirus (HMPV), Rhinovirus (HRV), Respiratory Adenoviruses (HadV), Human Coronaviruses Unrelated to SARS (CoV), SARS Coronavirus (SARS-CoV), and Human Bocavirus (HBoV)). Treatment of these diseases via using efficient medicinal plants leads to prevent or decrease infections, this occurs via various mechanisms. Most of these mechanisms exert an antiviral effect through inhibiting the transcription of respiratory viruses. In this review article, we focus on the role of twenty-one medicinal plants in treatment of respiratory viruses due to importance of this subject in the last decades in treatment of various diseases.
Keywords: Respiratory viruses; Parainfluenza; Medicinal plants; Adenoviruses; Coronaviruses; Bocavirus

Introduction

Respiratory human viruses include a broad range of viruses that infect cells of the respiratory tract, elicit respiratory and other symptoms, and are transmitted mainly by respiratory secretions of infected persons. Respiratory virus infections often cannot be differentiated clinically. Respiratory viruses belong to diverse virus families that differ in viral and genomic structures, populations susceptible to infection, disease severity, seasonality of circulation, transmissibility and modes of transmission. Together, they contribute to substantial morbidity[1], mortality[2] and concomitant economic losses[3] annually worldwide.

Also, respiratory viruses are the most frequent causative agents of disease in humans, with a significant impact on morbidity and mortality worldwide, mainly in children. Approximately one-fifth of all childhood deaths worldwide are related to acute respiratory infections (ARIs), particularly in impoverished populations of tropical regions, where ARI case-to-fatality ratios can be remarkably higher than in temperate regions of the world. Eight human respiratory viruses circulate commonly in all age groups and are recognized as adapted to efficient person-to-person transmission (**Table 1**). In addition to these, SARS coronavirus (SARS-CoV) and avian influenza virus H5N1 have emerged in recent years as threats to public health. SARS-CoV has been out of circulation since 2003, and avian influenza virus H5N1 has caused limited outbreaks of human infections [4]. In addition, occasional pandemics cause extreme disruption to societies and economies as exemplified by the current COVID-19 pandemic. Until effective treatments or vaccines for COVID-19 are available, we have to rely heavily on population-based and individual-based public health measures to mitigate transmission. The effectiveness and the suitability of a non-pharmaceutical intervention (NPI) to mitigate transmission depends substantially on the

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ease of transmission (transmissibility) and the mechanism of transmission (modes of transmission) specific to that virus, as these interventions can target some but not all potential modes of transmission.

Table 1. Common respiratory viruses, their classification, principal syndromes, and main detection methods **[1]**

Virus	**Classification** [a]	**Principal syndromes**	**Virus detection methods**
HRSV	Groups A and B	URI, bronchiolitis, croup, bronchitis, pneumonia	Culture, Ag detection, RT–PCR
HPIV	Types 1, 2, 3, 4	URI, croup, bronchiolitis, bronchitis, pneumonia	Culture, Ag detection, RT–PCR
HRV	Species A, B, and C With 100 serotypes	URI; asthma and COPD exacerbation	Culture, RT–PCR
ADV	51 serotypes	URI, PCF, bronchitis, pneumonia	Culture, Ag detection, PCR
HCoV	Types OC43, 229E, NL(NH), HKU1	URI, bronchitis, pneumonia	Culture, RT–PCR
SARS-CoV	1 type	SARS	Culture, RT–PCR
HMPV	Groups A and B	URI, bronchitis, pneumonia	Culture, RT–PCR
HBoV	2 lineages	URI, bronchiolitis, asthma exacerbation, bronchitis, pneumonia	PCR

Classification [a] in species, subgroups, serotypes, or lineages.
ADV, adenovirus; Ag, antigen; HBoV, human bocavirus; HCoV, human coronavirus; HMPV, human metapneumovirus; HPIV, human parainfluenza virus; HRSV, human respiratory syncytial virus; HRV, human rhinovirus; PCF, pharyngoconjunctival fever; SARS, severe acute respiratory syndrome; SARS-CoV, Coronavirus associated with SARS; URI, upper respiratory infection; RT–PCR, reverse transcription-polymerase chain reaction, which includes both conventional and real-time methods.

Therefore, understanding how to evaluate the transmissibility and evidence supporting different modes of transmission will aid in the control of respiratory virus transmission.

As the currently known respiratory viruses still do not account for all clinically relevant human viral respiratory illnesses, systematic searches for new agents using molecular tools are expected to discover previously unidentified agents. Although respiratory viruses cause a great burden of diseases, only a few preventive or therapeutic interventions are currently available. However, recent advances in the molecular and cell biology of respiratory viruses will hopefully result in the development of useful interventions [4].

Much discussion has been dedicated to the use of herbal medicine for the common cold. The use of herbs as ailments in the island of Crete has been mentioned since the Bronze Age. Herbal medicine also has a long history in ancient Greece. Popular medical handbooks from the Byzantine era forward incorporated material rooted in ancient medicine and routinely claimed Hippocrates and Galen (among others) as sources. In current times, the antioxidant activity of herbs in rural Crete has been investigated and it has been shown that herbal extracts decrease lipid peroxidation in cultured lung cells exposed to iron or ozone [5].

Medicinal plants are Nature’s gift to human beings to help them pursue a disease-free healthy life. Herbal Medicine is the oldest form of medicine known to mankind. It was the mainstay of many early civilizations and still the most widely practiced form of medicine in the world today. The knowledge of plant properties was acquired by ancient civilizations that passed down from generation to generation. Recent estimates suggest that over 9,000 plants have known medicinal applications in various cultures and countries. Plants as in (**Figure 1**) produce chemical compounds as part of their normal metabolic activities. Plants are a valuable source of a wide range of secondary metabolites, which are used as pharmaceuticals, agrochemicals, flavors, fragrances, colors, biopesticides, and food additives [6].

Several herbs are effective against influenza virus, herpes simplex virus, and coronaviruses. The previous study on common essential oils also showed that marjoram, clary sage, and anise essential oils were most effective at reducing visible cytopathic effects of the anti-influenza [7].

Medicinal plants species that are closely related may also produce similar or chemically similar compounds responsible for their biological activity [8]. This forms the basic definition for chemotaxonomy, which is the "closely related plants contain the same or similar chemical profiles" [9].

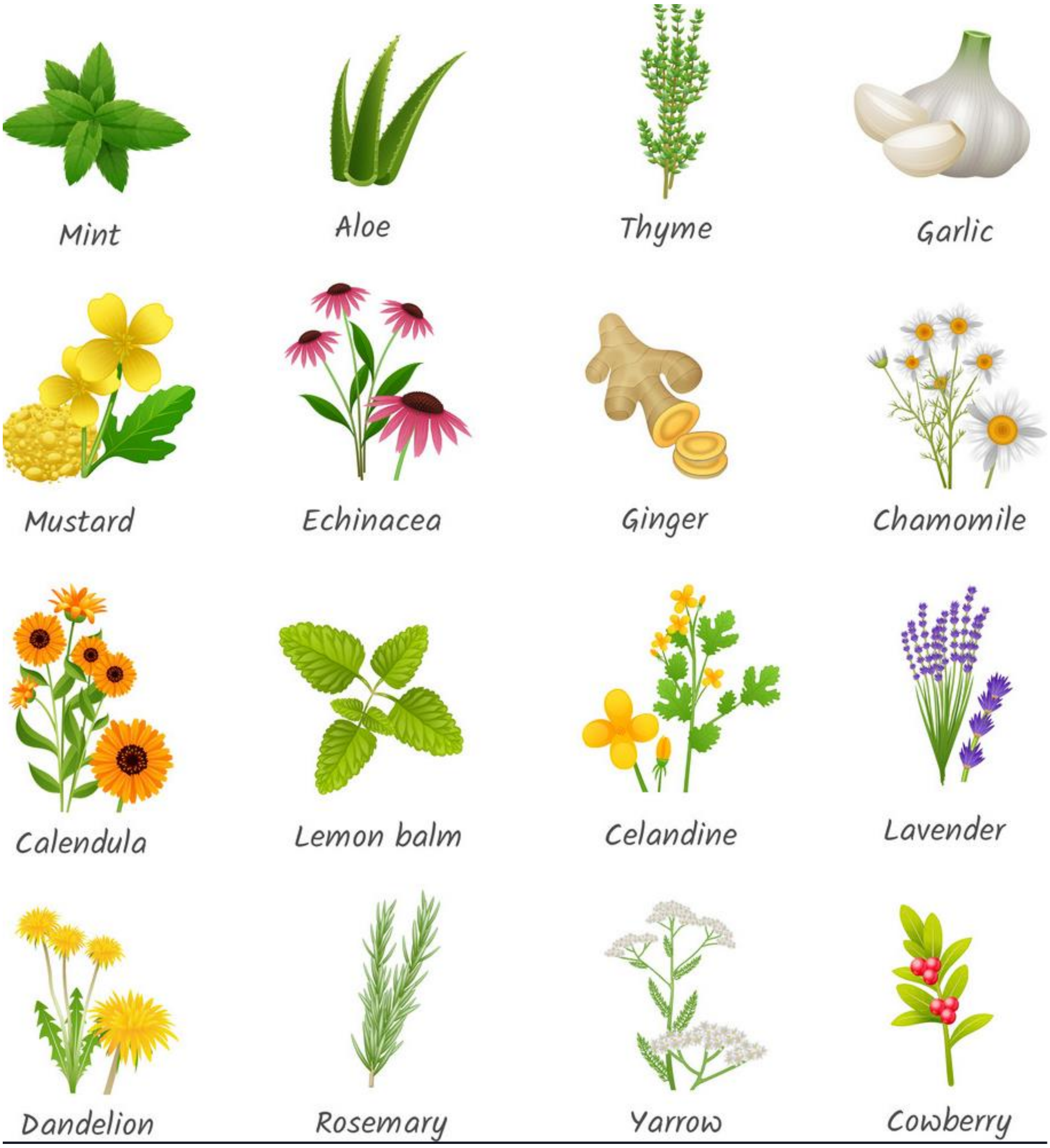

Figure 1: Some medicinal plants that contain active compounds [66]

1. Human Respiratory Syncytial Virus (RSV):

Respiratory syncytial virus (RSV) (**Figure 2**) is the most important cause of acute lower respiratory tract infection in young children worldwide. Generally, around a quarter of childhood admissions to hospitals with acute respiratory infections are due to RSV. Severe infections are most common in the first year of life, and RSV causes a characteristic disease entity called bronchiolitis. RSV was identified first in 1956 in a group of chimpanzees and accordingly called chimpanzee coryza agent (CCA), but was later documented to be a mainly human pathogen. Because no specific treatment is available, prevention through vaccine development is a high priority [4].

RSV is classified as a nonsegmented, negative-sense, membrane-bound RNA virus of the family Paramyxoviridae, spread by droplets, and causing repeated airway infections. RSV is the most common cause of hospitalization in infants and children with severe acute lower respiratory infections. Additionally, it is the third most common cause of death in children, through the development of fatal pneumonia, after *pneumococcal pneumonia* and *Haemophilus influenzae* type b infection. It had been estimated that between 66,000 and 199,000 children younger than 5 years died of RSV-associated diseases in 2005, with 99 % of these deaths occurring in developing countries. In the 1960s a formalin-inactivated vaccine (FI-RSV) given intramuscularly did not reduce the frequency of infection and among infected children (particularly in the youngest age cohort, immunized between 2 and 7 months of age) 80 percent required hospitalization and 2 died [10].

Plant medicines continue to play an important role in preventing and treating RSV. Here, herbs for treating such infections will be considered first, including both traditional treatments and those that have been scientifically researched. Then, research-based preventative measures will be discussed. These measures are particularly important to provide clinicians with evidence-based alternatives to antibiotics, which have no place in the treatment of purely viral infections [11].

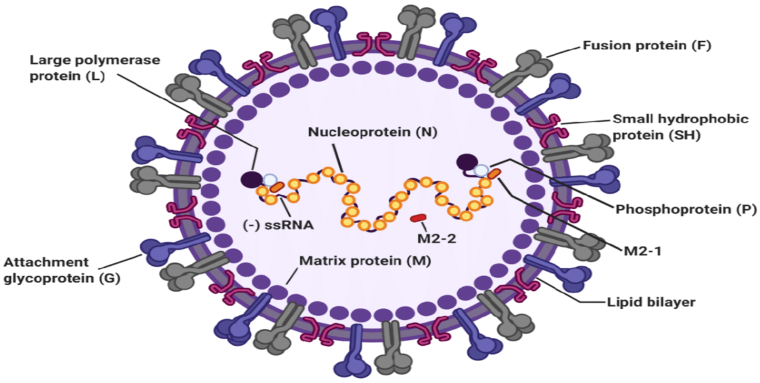

Figure 2. The structure of respiratory syncytial virus (RSV)[12]

2. Human Parainfluenza Viruses (HPIV):

Human parainfluenza viruses (HPIV) (**Figure 3**) were first discovered in the late 1950s when three different viruses recovered from children with lower respiratory disease proved to be unique and easily separated from the myxoviruses (influenza virus) they closely resembled [13]. Human parainfluenza viruses (HPIVs) are an important cause of respiratory illness in children and adults with a wide range of clinical manifestations including colds, croup, bronchiolitis, and pneumonia. Seasonal HPIV virus epidemics result in a significant burden of disease in children and account for 40% of pediatric hospitalizations for lower respiratory tract illnesses (LRTIs) and 75% of croup cases [14]. Currently, there are no antiviral agents with proven efficacy for parainfluenza virus infection. Treatment of HPIV infection is generally symptomatic in healthy children and adults [13]. HPIVs cause a significant burden of disease in children and adults. A wide spectrum of illnesses including colds, croup, bronchiolitis, and pneumonia are attributed to these ubiquitous pathogens. The most severe disease is found among immunocompromised patients and treatment at present remains largely supportive. Several promising antiviral drugs are in development and are in early-stage clinical trials. Continued research for new vaccines and therapeutics is needed [15]. Crude *Sanicula Europaea* extract has antiviral properties against human parainfluenza virus type 2, whereas its ethanol extract does not have such property [16].

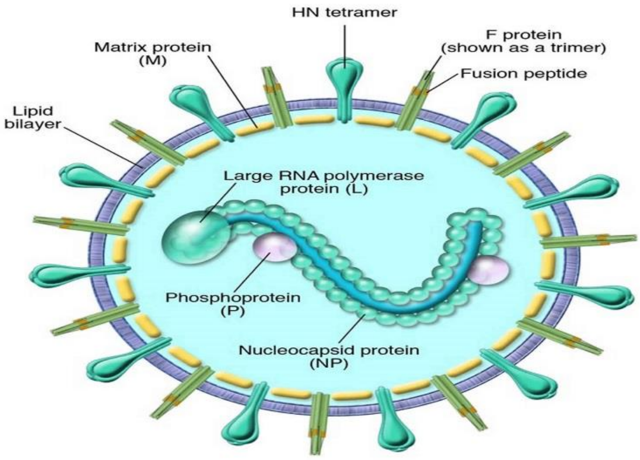

Figure 3: Human parainfluenza virus [17]

3. Human Metapneumovirus (HMPV):

Human metapneumovirus (HMPV) (**Figure 4**) is a common aetiological agent of lower respiratory tract infections (LRTIs) in children worldwide [18]. The impact of human metapneumovirus (HMPV) in children aged >5 years and the risk factors associated with disease severity for all ages have not been well characterized. A retrospective a cohort study of 238 children aged 0–15 years hospitalized over 3 years was performed [19]. Metapneumovirus (MPV) is a negative-sense single-stranded RNA enveloped virus of the *Metapneumovirus* genus belonging to the *Paramyxoviridae* family. This family includes viruses responsible for causing respiratory diseases in turkeys and humans. In chickens, the MPV is involved in the etiology of a multi-factorial disease also known as the Swollen Head Syndrome (SHS). Another member of the *Paramyxoviridae* family that is relevant to the poultry industry is the Newcastle disease virus. Metapneumovirus may cause significant economic losses to the poultry industry. Although vaccination is the main tool for the control and prevention of diseases caused by MPV, pharmaceutical intervention is required under some circumstances. Furthermore, vaccinated subjects may acquire incomplete protection, and/or there may be a reversion of the vaccine virus to pathogenicity [20].

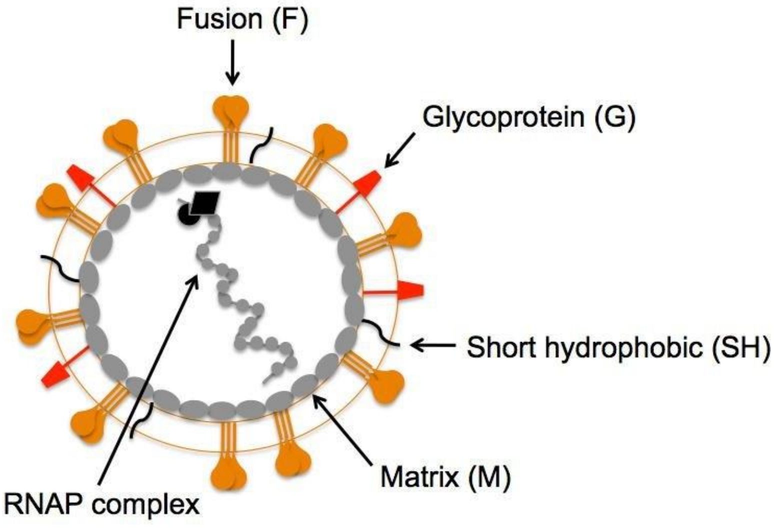

Figure 4: Human metapneumovirus (MPV)[21]

Metapneumovirus (MPV) is a negative-sense single-stranded RNA enveloped virus of the *Metapneumovirus* genus belonging to the *Paramyxoviridae* family. This virus may cause significant economic losses to the poultry industry, despite vaccination, which is the main tool for controlling and preventing MPV. This study aimed to evaluate the antiviral activity of extracts of four different native plants of the Brazilian Cerrado against MPV. The antiviral activity against MPV was determined by titration. This technique measures the ability of plant extract dilutions (25 to 2.5 µg mL^{-1}) to inhibit the cytopathic effect (CPE) of the virus, expressed as inhibition percentage (IP). The maximum non-toxic concentration (MNTC) of the extracts used in the antiviral assay was 25 µg mL^{-1} for *Aspidosperma tomentosum* and *Gaylussacia brasiliensis*, and 2.5 µg mL^{-1} for *Arrabidaea chica* and *Virola sebifera*. Twelve different extracts derived from four plant species collected from the Brazilian Cerrado were screened for antiviral activity against MPV. *G. brasiliensis, A. chica,* and *V. sebifera* extract presented inhibition rates of 99 % in the early viral replication stages, suggesting that these extracts act during the adsorption phase. On the other hand, *A. tomentosum* inhibited 99 % virus replication after the virus entered the cell. The biomonitoring fractioning of extracts active against MPV may be a tool to identify the active compounds of plant extracts and to determine their precise mode of action [22].

4. Rhinovirus (HRV):

Human rhinoviruses (HRV) (**Figure 5**) were first discovered in the 1950s to identify the etiology of the common cold. Nearly 60 years later, the search for a "cure" for the common cold virus is still ongoing. Worldwide and nearly year-round, HRV is the most common cause of upper respiratory tract infection (URI), leading to considerable economic burdens in terms of medical visits and school and work absenteeism [23].

Echinacea preparations include expressed juice from aerial parts as well as extracts of roots or aerial parts, or both, from one or more species of the genus Echinacea (*E. Angustifolia*, *E. purpurea*, and *E. pallida*). They are the most recognized botanicals for the prevention and treatment of common cold and flu and account for the second top-selling herbal products in the US market [24]. Sharma *et al*. used cytokine antibody arrays to investigate the changes in the pro-inflammatory cytokines and chemokines released from human bronchial epithelial cells exposed to HRV 14 [25].

Application of two chemically characterized Echinacea extracts showed a reversion of the stimulated release of numerous pro-inflammatory cytokine related molecules, e.g. for the cytokine IL-6, and the chemokines IL-8 and eotaxin. In a similar study, Echinacea extract rich in polysaccharides and another rich in alkamides and caffeic acid derivatives were as well able to neutralize the effects of HRV-infected epithelial cells [26].

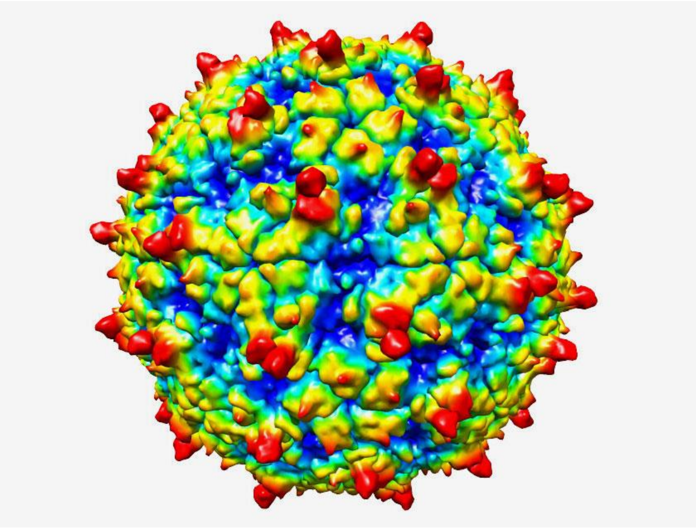

Figure 5: Human rhinoviruses (HRV)[27]

Using gene expression analysis both studies revealed the anti-HRV benefit of Echinacea preparations being involved in multiple immune response signaling pathways. Taken together, the numerous pharmacological findings from the literature, the potential of Echinacea preparations, and their constituents to combat or prevent common cold can be deduced to immune-modulating, anti-inflammatory, and anti-oxidative properties that may also act in some combination of these events, rather than acting directly on HRV [28].

The garlic is chewed, cut, or pressed, its main ingredient, the sulfur-containing alliin, is broken down by the enzyme alliinase to the thiosulfinate allicin. By steam distillation allicin is transformed to diallyl disulfide and diallyl trisulfide that are responsible for the distinctive smell of garlic. Further, allicin transformation compounds, such as E- and Z-ajoene, are not found in fresh garlic, but in lipophilic extracts. By investigation of different garlic extracts and isolates against many different human pathological viruses, Weber et al. could show that allicin was the most active virucidal component from fresh garlic and fresh extracts. Results of the direct pre-HRV-2-infection incubation assay let suggest allicin to bind to the viral protein capsid, leading to subsequent inhibition of viral adsorption and penetration. Although the garlic thiosulfinates are endowed with significant cytotoxicity, the antiviral effects were obtained in nontoxic concentrations [29]. Besides the direct anti-HRV effect of fresh garlic extract and allicin, many human immune functions were found to be enhanced in vitro by aqueous garlic extract, its polar, and thiosulfate fractions [30].

5. Respiratory Adenoviruses (HadV):

Human adenoviruses (HadV) (**Figure 6 and 7**) have at least 51 serotypes; with prototype adenovirus type 5. These viruses are associated with a wide range of illnesses, including ocular, respiratory, gastrointestinal, and urinary infections. Adenovirus infections are usually mild and always heal without the need for any special therapy. However, severe and life-treating adenovirus infections have been reported in some patients, including immune-compromised patients [31, 32].

Adenoviruses are ubiquitous, double-stranded DNA viruses that are most commonly associated with pediatric illnesses of the upper respiratory tract, including the common cold. Adenoviral infections can also manifest with gastrointestinal, ophthalmologic, genitourinary, and neurologic symptoms. In this discussion, we will review the pathobiology of the virus and the broad clinical spectrum of disease manifestation in immune-competent and immuno-compromised patients. We will review global trends along with management strategies [33].Among the tested medicinal plants, anti-ADV activities of *B. gracilis* and S. japonica, and the anti-ADV activity of *A. squamulosa* and *A. princeps* are encouraged for further investigation [34].

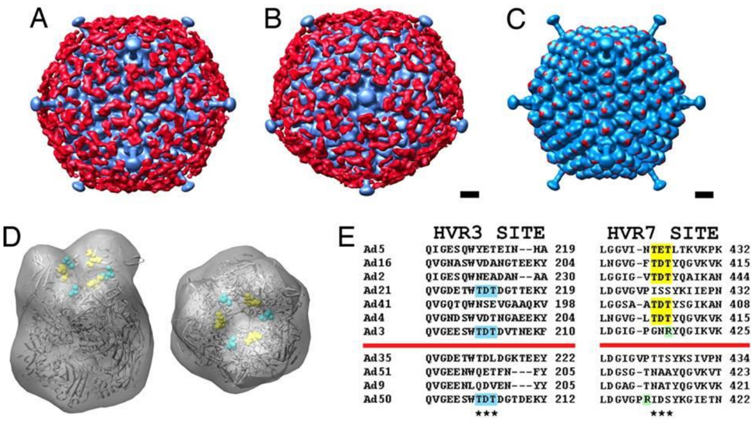

Figure 6: Human adenoviruses (HadV)[35]

6. Human Coronaviruses Unrelated to SARS (CoV):

Coronaviruses are spherical enveloped viruses that range between 100 and 160 nm in diameter. The positive-sense single-stranded RNA genome (27 - 32 kb), contained in each particle, forms a complex with the nucleocapsid protein [36-39]. Active compounds of oils contained linalool, suggesting that this may have anti-influenza activity [40]. Triterpene glycosides saikosaponins (A, B2, C, and D) isolated from medicinal plants are also effective against coronavirus [41]. These natural compounds effectively prevent the early stage of HCoV-22E9 infection, including viral attachment and penetration [42]. Researchers suggested that if this approach of herbal therapy brought into practice and validated, the rapid immunological response of such herbs or extracts could be effective and timely in the fight against COVID-19 [43]. Medicinal plants, especially Southern African plants, are used for the potential inhibition against coronaviruses. Only a few of the plant species (*Artemisia Afra*, *Cissampelos sympodialis*, *Ziziphus mucronate*, *Pelargonium sidoides*, *Dodonaea viscosa*, *Rauvolfia caffra*, and *Prunus Africana*) have been tested for their antiviral potential, indicating the major gap in scientifically assessing the medicinal potential of traditionally used plants [44].

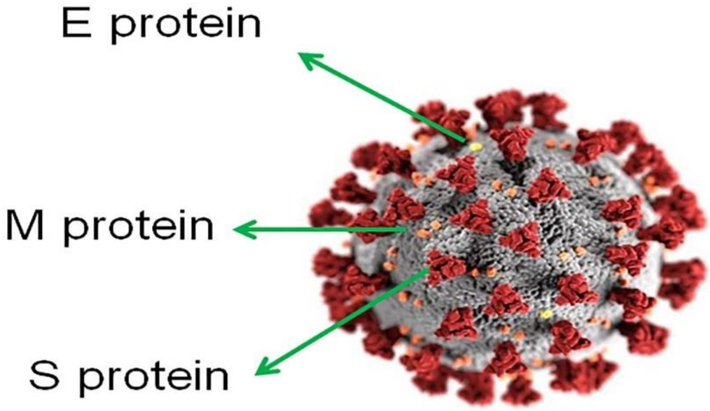

Figure 7: Human adenoviruses (HadV) [45]

7. SARS Coronavirus (SARS-CoV):

Severe acute respiratory syndrome coronavirus (SARS-CoV) (**Figure 8**) is a highly contagious viral infection that causes considerable morbidity and mortality. This virus is known to cause respiratory, enteric, and neurological diseases in humans [46]. The SARS-CoV is part of the family Coronaviridae, which are enveloped viruses with single and positively stranded RNA [47]. Extracts from plants have also been documented to display anti–SARS-CoV effect from a screening analysis using hundreds of Chinese medicinal herbs. Natural inhibitors against the SARS-CoV enzymes, such as the nsP13 helicase and 3CL protease, have been identified on myricetin, scutellarein, and phenolic phytochemicals [48]. Other anti-CoV natural medicines include the aqueous extract of a medicinal plant which exhibited several antiviral mechanisms against SARS-CoV, such as inhibiting the viral 3CL protease and blocking the viral RNA-dependent RNA polymerase activity. Recent outbreaks of coronavirus disease have significantly hampered public health due to the lack of an exact antiviral vaccine. The whole genome of SARS-CoV-2 has 86% similarity with SARS-CoV7 [49]. Researchers would bring a new SARS-CoV-2- based vaccine but while waiting for a specific vaccine, a herbal consumption approach for immunotherapies could represent an option to fight against SARS-CoV-2 [50].

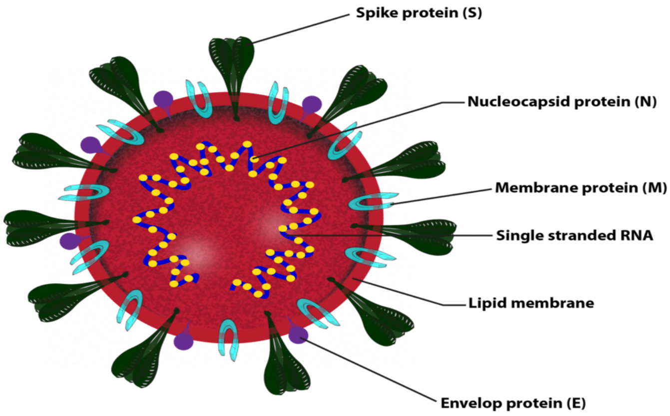

Figure 8: Severe acute respiratory syndrome coronavirus (SARS-CoV)[51]

Plants and their secondary metabolites, with activity against targets associated with the SARS-CoV infection, could provide valuable leads for the development of drugs for the novel SARS-CoV-2. The prospects of using computational methods to screen secondary metabolites against SARS-CoV targets are briefly discussed, and the drawbacks have been highlighted. The plants are traditionally used in Southern Africa for symptoms associated with respiratory viral infections and influenza, such as coughs, fever, and colds. However, only a few of these plants have been screened against SARS-CoV. Natural products hold a prominent role in discovering novel therapeutics to mitigate the current COVID-19 pandemic; It has spread from China to many other countries around the world approximately all world; however, further investigations regarding in vitro, in vivo, pre-clinical, and clinical phases are still required [44, 65].

8. Human Bocavirus (HBoV):

Human Bocavirus (HBoV) (**Figure 9**) is a recently discovered virus and was first detected in the nasopharyngeal aspirate samples and after in stool samples, suggesting that HBoV may be a causative agent for human enteric infections [52]. HBoV belongs to the *Parvoviridae* family, *Parvovirinae* subfamily, *Bocaparvovirus* genus [53, 54]. This parvovirus is a small single-stranded DNA virus with a diameter of 18–26 nanometers and contains a non-enveloped icosahedral capsid [55]. The genome of HBoV consists of three ORFs that encode two non-structural proteins (NS1 and NP1) and two structural proteins (VP1 and VP2) [55, 56]. Based on the genetic variability of the VP1 region, HBoV is divided into 4 species: HBoV1 - HBoV4. Several groups have detected HBoV1 in respiratory tract infections, while HBoV2, 3, and 4 were reported in fecal samples [57, 58].

HBoV has been detected mostly in respiratory tract secretions and stool, however, the viruses have been found in serum and cerebrospinal fluid causing viremia [59]. Likewise, several studies have reported HBoV in sewage and river water [60].

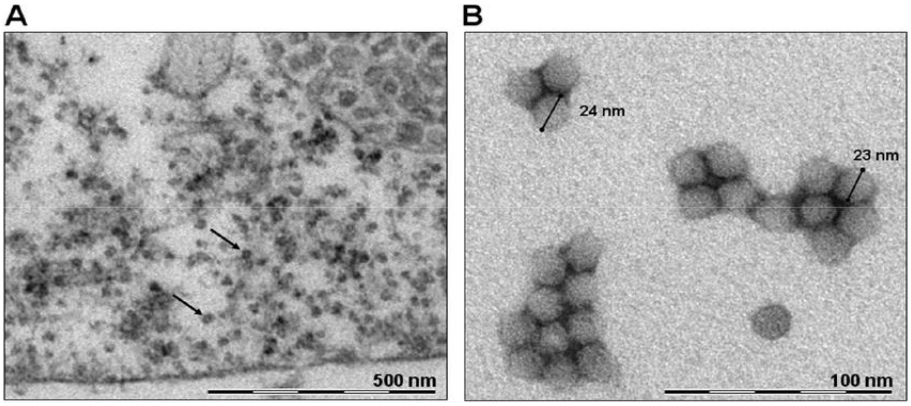

Figure 9: Human Bocavirus (HBoV) [61]

Anti - respiratory-viruses Medicinal Plants

It is, therefore, necessary to replace these medications with high-value ones with comparatively lower toxicity. Many medicinal plants that are traditionally used have antiviral properties, and some of them are used to treat animals and people suffering from viral diseases [62]. Medicinal plants have several phytochemicals that have potent antioxidant properties including alkaloids, carotenoids, saponins, flavonoids (isoflavones, flavanones, anthocyanins, catechins, flavones, isocatechins, and quercetin), terpenoids, polyphenols (ellagic acid, gallic acid, and tannins), vitamins (A, C, E, and K), carotenoids, minerals (manganese, selenium, copper, chromium, zinc, and iodine), polysaccharides, enzymes (superoxide dismutase, catalase, and glutathione peroxidase), lignins, saponins, xanthones a pigments [63].

There are many medicinal plants with Anti - respiratory-viruses **Table 2**.

Table 2. Medicinal Plants demonstrating active antiviral properties against various viruses [64]

Botanical Name	Family Name	Antiviral benefit	Phytochemical composition
***Amaryllis belladonna* L.**	**Amaryllidaceae**	**RSV**	Phenanthridine Lycorine Tazetine
***Blumea laciniata* (Wall. ex Roxb.) DC.**	**Asteraceae**	**RSV**	Borneol, β-caryophyllene, Germacrene D, Sabinene Protocatechuic acid, chrysoeriol, apigenin, 4-hydroxy-3,5-dimethoxbenzoic acid, scopolet.

Botanical Name	Family Name	Antiviral benefit	Phytochemical composition
***Elephantopus scaber* L.**	**Asteraceae**	**RSV, HMPV**	3,4-dihydroxy benzaldehyde, p-coumaric acid, Vanillic acid, Syringic acid, Isovanillic acid, p-hydroxybenzoic acid, Ferulic acid, 3-methoxy-4-hydroxyl cinnamic aldehyde, Tricin 2-hydroxybenzolate acid
***Mussaenda pubescens* Dryand**	Rubiaceae	**RSV**	Triterpene esters, 3-palmitoyllupeol, 3-benzoylepi-betulin and β-sitosterol
***Rosmarinus officinalis* L.**	**Lamiaceae**	**RSV, HRV**	Rosmarinic acid, Carnosol, Carnosic
***Schefflera heptaphylla* L.**	Araliaceae	**RSV**	Two highly active pure triterpenoids
***Scutellaria indica* L.**	**Lamiaceae**	**RSV, HBoV**	Scutellarin, Luteolin, Naringenin, Wogonoside, Apigenin, Hispidulin, Wogonin, Chrysin
***Selaginella sinensis* (Desvaux) Spring**	Selaginellaceae	**RSV**	Alkaloid, Phenolic compounds, Terpenoid, Amentoflavone
***Narcissus tazetta* L.**	**Amaryllidaceae**	**RSV, HPIV**	Pseudolycorine, Galanthamine,1-hydroxygalanthine. Isoquinolone derivatives
***Piper nigrum* L.**	Piperaceae	**HPIV**	Polyphenols, Piperidine, Piperine
***Allium porrum* L.**	Alliaceae	**HadV, HRV**	Dipropyl disulfide and Dipropyl trisulfide quercetin, Zalcitabine, Allicin, Ribavirin
***Bryonia alba* L.**	Cucurbitaceae	**CoV**	Bryonicine, Saponarin, Vitexin, Isovitexin, lutonarin, Isoorientin, Glycosides 22-deoxocucurbitosides A and B, Arvenin IV
***Camellia sinensis* (L.) Kuntze**	Theaceae	**CoV**	Epigallocatechin gallate, Epigallocatechin, Epicatechin gallate, Epicatechin, Catechin
***Glycyrrhiza glabra* L.**	Fabaceae	**CoV, SARS-CoV**	Glycyrrhizic acid, Glycyrrhizin, Glycyrrhetinic acid, Chalcone
***Citrus reticulata* Blanco**	Rutaceae	**SARS-CoV**	Tangeretin, Nobiletin, Hesperetin, Tangeretin, Naringenin, Nobiletin
***Galanthus nivalis* L.**	**Amaryllidaceae**	**SARS-CoV**	Ethyl-a-D-glucopyranoside, Ethyl-a-D-ribo side, Ethyl linoleate. O N4-hydroxycytidine, N-(4-fluorophenylsulphonyl)-L-valyl-L leucinal.
***Houttuynia cordata* Thunb.**	Saururaceae	**SARS-CoV**	Houttuynoside A (1) and Houttuynamide A, Anthocyanins,
***Isatis indigotica* L.**	Brassicaceae	**SARS-CoV**	Epigoitrin, Indirubin

Botanical Name	Family Name	Antiviral benefit	Phytochemical composition
***Lindera aggregate* (Sims) Kosterm.**	Lauraceae	**SARS-CoV**	Benzylisoquinoline alkaloids
***Lycoris radiata* (L'Her.) Herb.**	**Amaryllidaceae**	**SARS-CoV**	Lycorine
***Pyrrosia lingua* (Thunb.) Farw.**	Polypodiaceae	**SARS-CoV**	Chlorogenic acid, Flavonoids

CONCLUSION

Recently, due to the many side effects and the presence of medicinal residues of the chemical drugs for the treatment of viral diseases, especially respiratory viruses, attention has been paid to medicinal plant-derived products has increased.

There are several plants for the treatment of respiratory viruses, including (Human Respiratory Syncytial Virus (RSV), Human Parainfluenza Viruses (HPIV), Human Metapneumovirus (HMPV), Rhinovirus (HRV), Respiratory Adenoviruses (HadV), Human Coronaviruses Unrelated to SARS (CoV), SARS Coronavirus (SARS-CoV), and Human Bocavirus (HBoV)), which prevent or decrease infection via various mechanisms.

The action mechanism of many anti- respiratory viruses' drugs has been understood. Most of them exert an antiviral effect by inhibiting the transcription of HBV in hepatocytes; however, the action mechanism of many plants remains unknown and needs to be further studied. It should be noted that usually phenolic compounds in medicinal plants possess antimicrobial activities.

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