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Review

A REVIEW ON ANTIVIRAL PLANTS EFFECTIVE AGAINST DIFFERENT VIRUS TYPES

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ABSTRACT

The treatment of microbial infections has proven challenging for humans in recent years. Synthetic medications, such as antimicrobial agents, are used for treating these infections. Antimicrobials derived from natural sources have gained popularity as an alternative to manufactured medications due to their lack of adverse effects. Plants, which play a significant role in this setting, have historically served as a reliable natural defence against several pathogens. In this study, studies on plants used against viral diseases are mentioned. Studies on viruses that cause disease have been compiled in the literature. According to the findings, it has been reported in the literature that many different plant species are effective against herpes simplex virus (HSV-1, HSV-2), human immunodeficiency virus (HIV), influenza virus (A, B) and parainfluenza, Poliovirus, Astrovirus, Parvovirus, Sindbis virus (SINV), Feline calicivirus (FCV), Rhinovirus, Echovirus, Rotavirus, Bovine alphaherpesvirus 1 (BoHV-1), Reovirus, Vaccinia virus (VACV), Cardiovirus A (Encephalomyocarditis virus; EMCV), Coxsackie virus, Semliki forest, Measles virus, Newcastle disease virus (NDV), Coronavirus, Adenovirus (ADV-3, ADV-5, ADV-8, ADV -11), Canine distemper virus (CDV), Lumpy skin disease virus (LSDV), Hepatitis A, B, C virus and Enterovirus. To combat viruses, plants can be considered a potentially invaluable natural resource.

KEYWORDS: Antimicrobial, Antivirals, Complementary medicine, Medicinal plants, Viral diseases.

1. Introduction

The use of medicinal plants by many people around the world is increasing [1,2]. Natural remedies, having healing abilities have been used by humans for millennia. The rise of organic chemistry and the Industrial Revolution led to the gradual replacement of natural substances with synthetic ones in the pharmaceutical industry [3]. This is because pharmaceutical corporations now have more economic clout than ever before, since pure chemicals can be obtained with relative ease and structural alterations can be made to create potentially more active and safer treatments. Furthermore, the use of natural items has had a magical-religious significance throughout the evolution of human society, and there have been varying viewpoints on the ideas of health and sickness in every culture [4,5]. Since prehistoric times, several societies have relied on plants for a wide variety of needs, including sustenance, shelter, clothing, flavouring, heating, and medical treatment. Dietary benefits may be found in abundance in plant-based foods. They also stand out due to the fact that of their therapeutic value [6]. Within their bodies, they generate a wide variety of bioactive chemicals. Because of these traits, plants may engage in a wide range of biological processes. Plants have been found to have several useful qualities, including antioxidant, anticancer, antiviral, antibacterial, antiproliferative, anti-aging, anti-inflammatory, hepatoprotective, DNA-protective, and many more [7-13]. The possible side effects of synthetic drugs have led people to treat themselves with natural products. In this context, drugs, which are difficult and costly to synthesize, are extracted from many natural products and their use has become widespread [14-17]. Interest in herbal-based pharmaceuticals is rising for several reasons, not the least of which is the fact that natural drugs made from botanical extracts often do not have adverse effects. Because of this, research into the therapeutic effects of herbs has been a fascinating area of study for quite some time [18]. In this study, viral infections reported in the literature and plants tested against them were compiled.

2. Antiviral Activity

The consequences of illnesses caused by microorganisms are now significant [19]. Scientists have been looking into new antimicrobial solutions in light of

the potential negative effects of antimicrobial medications and the rise of resistant microbes [20,21]. In this context, plants, which have a very important place among natural products, are the subject of this study. Our research collated cases of viral illnesses found in the literature and the plants utilized to treat them.

2.1. Herpes simplex virus (HSV-1, HSV-2) (Genus: Simplexvirus)

Humans are often infected with HSV-1 and HSV-2, two forms of the herpes simplex virus. Lip and nose infections are caused by HSV-1, whereas genital infections are caused by HSV-2 [22]. The viruses of this class are very contagious. When they infect anything, it usually manifests as a rash on the skin, which is then transferred to other organisms. Transmission through salivary fluids and other non-droplet routes has also been documented [23]. The sexual act itself is a means of transmission. They may infect the mucous membranes of the mouth, nose, and genital area. Its defining feature is a scab-like healing process. These viruses are particularly dangerous because they may evade the immune system by entering a dormant state called the latent phase [24]. Plants effective against Herpes simplex viruses in the study are shown in Table 1.

Table 1. Plants effective against herpes simplex viruses [25-61].

Virus name	Extract type	Plant species	Geographic regions
Herpes simplex virus (HSV-1, HSV-2)	Aqueous, ethanolic-aqueous, methanol, methanolic-aqueous, ethanol, aqueous, hexane, essential oil, acetone, dichloromethane, lipophilic, ethyl acetate	*Abutilon indicum, Achillea fragrantissima, Achyranthes aspera, Adansonia digitata, Ajuga chamaepitys ssp. chia var. ciliata, Allium sativum, Aloe vera, Aloysia gratissima, Anacardium occidentale, Anemopaegma setilobum, Annona sp., Anogeissus schimperi, Anthemis austriaca, Anthemis tinctoria subsp. tinctoria, Araucaria angustifolia, Aristotelia chilensis, Arrabidaea craterophora, Arrabidaea formosa, Arrabidaea pulchra, Arrabidaea sceptrum, Baccharis erioclada, Baccharis erioclada, Baccharis gaudichaudiana, Baccharis gaudichaudiana, Baccharis genistelloides, Baccharis genistelloides, Baccharis megapotamica, Baccharis spicata, Baccharis spicata, Baccharis uncinella, Banisteriopsis variabilis, Bauhinia blakeana, Bauhinia thonningii, Bergenia ligulata, Beta vulgaris, Bidens subalternans, Boswellia ameero, Boswellia dalzielii, Boswellia elongata, Bumelia sertorum, Buxus hildebrandtii, Buxus sempervirens, Byrsonima intermedia, Callisia grasilis, Calotropis gigantea, Calotropis gigantea, Campomanesia xanthocarpa, Cannabis sativa, Capparis sinaica, Carduus acanthoides, Carduus nutans, Carissa edulis, Cassia alata, Cassia stipulacea, Chelidonium majus, Cirsium hypoleucum, Cissus hamaderohensis, Cistus laurifolius, Cleome socotrana, Clerodendron myricoides, Clerodendrum inerme, Clitoria ternatea, Coffea arabica, Conyza aegyptiaca, Costus speciosus, Costus speciosus, Crassocephalum multicorymbosum, Cupressus sempervirens, Curcuma longa, Cymbopogon citratus, Cynara scolymus, Cyperus rotundus, Detarium senegalense, Dianthus caryophyllus, Dichrostachys glomerata, Digitalis lamarckii, Dracaena cinnabari, Drymis winteri, Dryopteris inaequalis, Endopleura uchi, Ephedra alata, Erythrina abyssinica, Erythroxilum deciduum, Escallonia illintia, Eucalyptus caesia, Eugenia michelii, Eugenia michelii, Euphorbia cestrifolia, Euphorbia cotinifolia, Euphorbia hirta, Euphorbia tirucalli, Evolvulus alsinoides, Exacum affine, Fumaria vaillantii, Galanthus elwesii, Glechon marifolia, Glechon spathulata, Globularia arabica, Glycine javanica, Guaiacum officinale, Guiera senegalensis, Gymnema sylvestre, Hedyotis auricularia, Hedyotis auricularia, Hibiscus sabdariffa, Holoptelia integrifolia, Hypericum cordifolium, Hypericum elodeoides, Hypericum hookerianum, Hypericum mysorense, Hypericum perforatum, Hypericum uralum, Ilex brevicuspis, Ilex theezans, Illicium verum, Indigofera tinctoria, Jasonia montana, Jatropha unicostata, Juniperus oxycedrus, Kalanchoe farinacea, Khaya senegalensis,Lacistema hasslerianum, Lannea humilis, Lappula barbata, Laurus nobilis, Leandra purpurensis, Leptospermum laevigatum, Leucas aspera, Leucojum aestivum, Limonium brasiliense, Luma apiculata, Lygodium japonicum, Lytropus chilensis, Maesa macrophylla, Markhamia lutea, Maytenus ilicifolia, Mentha arvensis, Mentha suaveolens, Moringa oleifera, Moringa peregrina, Nerium indicum, Nymphea alba, Ocimum basilicum, Ocimum sanctum, Ocotea pulchella, Origanum vulgare, Orthosiphon aristatus, Orthosiphon aristatus, Palisota hirsuta, Penstemon urinaria, Penstemon watsonii, Pergularia daemia, Petiveria alliacea, Phyllanthus niruri, Pistacia lentiscus, Pistacia palaestina, Pluchea sagittalis, Pluchea sagittalis, Plumbago zeylanica, Podocarpus henkelii, Polygonum minus, Polygonum minus, Psidium cattleyanum, Psidium guajava, Rheum ribes, Rhus coriaria, Rhus vulgaris, Ribes multiflorum, Ricinus communis, Ricinus communis, Rosmarinus officinalis, Rumex obtusifolius ssp. subalpinus, Salvia cedronella, Salvia officinalis, Sambucus nigra, Saponaria officinalis, Satureja boliviana, Satureja thymbra, Sedum hispanicum, Silene vulgaris, Sphaeranthus indicus, Sterculia setigera, Stizophyllum perforatum, Stryphodendron adstringens, Tabernaemontana catharinensis, Tagetes minuta, Tamarix nilotica, Terminalia chebula, Tessaria absinthioides, Thuja orientalis, Thymus maroccanus, Thymus vulgaris, Tibouchina mutabilis, Tillandsia recurvata, Uncaria tomentosa, Usnea complanta, Veratrum album, Veronica persica, Vitex trifolia, Xylopia aromatica, Zeyheria tuberculosa, Zingiber officinale*	Chile, Rwanda, Malaysia, Nepal, Bolivia, Colombia, Nigeria, Togo, Turkey, Morocco, Brazil, India, Yemen, Iran, Lebanon, Egypt, South Africa, South America, Malaysia, Argentina, America, China, Jamaica, Mexico, Bulgaria, Bolivia,

In this regard, a prior research conducted in Bulgaria looked at the impact of components taken from the roots and aerial portions of plant species belonging to various genera on HSV-1. It has been reported that flavonoids, triterpene saponins, phenolic acids, tannins and polysaccharides obtained from the species *Sambucus nigra, Hypericum perforatum* and *Saponaria officinalis* have antiviral activity [25]. In a study conducted in Chile, the effect of ethanolic-aqueous extracts of the plant species *Cassia stipulaceua, Escaffonia illintia, Aristotefia chilensis, Drymis winteri, Elytropus chilensis* and *Lumu apiculata* against HSV-1 and HSV-2 was investigated. Results showed that *C. stipulacea* and *E. illintia* had respective IC50 values of 80 and 40 µg/mL against HSV-1. It has also been reported that *A. chilensis* is effective against HSV-2 at an extract concentration of 40 µg/mL, *D. winteri* at 35 and 80 µg/mL, and *E. chilensis* and *L. apiculata* at an extract concentration of 100 µg/mL [26]. The anti-HSV-1 activity of ethanol extracts from one hundred distinct Rwandan plant species was investigated in a separate investigation. Among these plants, it has been reported that *Clerodendron myricoides, Crassocephalum multicorymbosum, Dryopteris inaequalis, Euphorbia hirta, Erythrina abyssinica, Glycine javanica, Markhamia lutea* have 10^3 and *Rhus vulgaris* 10^4 viral titration reduction ratios [27]. In another research, the effectiveness of ethanol extracts from 61 Malaysian plant species against HSV-1 was investigated. Results have shown that *Calotropis gigantea, Costus speciosus, Eugenia michelii, Mentha aruensis, Hedyotis auricularia, Polygonum minus, Orthosiphon aristatus,* and *Ricinus communis* are effective, with an effect range of 0.002-0.1 mg/mL [28]. Twenty-one plant species were investigated in Nepal for their potential to inhibit the spread of HSV-1 using methanol extracts. According to the results obtained, it was reported that *Macaranga pustulata, Hypericum uralum, Sibbaldia micropetala* and *Princepia utilis* were effective at 200 µg/mL extract concentration, *Maesa macrophylla, Corallodiscus lanaginosus* and *Anemone obtusiloba* at 100 µg/mL concentration and *Hypericum cordifolium* 50 µg/mL with the highest effect [29]. In a study conducted in Bolivia, the effects of ethanol and aqueous extracts of seven plant species against HSV-1 were investigated. As a result of the study, it was reported that *Phoradendron crassifolium, Satureja boliviana* and *Baccharis genistelloides* were effective at 25-75 µg/mL extract concentration [30]. The effects of methanol and ethanol extracts of nine plant species collected from Colombia against HSV-2 were investigated. According to the results obtained, *Callisia gracilis, Annona* sp. and *Beta vulgaris* have been reported to have antiviral effects [31]. In a different study, the effects of ethanol extracts of 17 plant species collected from Nigeria against HSV-1 were investigated. According to the reported results, *Anogeissus schimperi, Guiera senegalensis, Bauhinia thonningii, Anacardium occidentale, Boswelia dalzielii, Khaya senegalensis, Detarium senegalensis, Dichrostachys glomerata, Lannea humilis, Sterculia setegera* were reported to be effective at 100-400 µL extract concentrations [32]. The effects of 19 medicinal plants collected from Togo against HSV-1 were investigated. According to the results obtained, it has been reported that *Conyza aegyptiaca, Adansonta digitata, Palisota hirsuta, Davallia chaerophylloides, Sida acuta, Ficus ovata, Mitracarpus villosus, Zanthoxylum zanthoxyloides, Harrisonia abyssinica* and *Paullinia pinnata* have anti-inflammatory effects at different extract concentrations (62.5-500 µg/µL) [33]. The effects of ethanol extract obtained from 16 different plant species in Turkey against HSV-1 were investigated. Among the used *Galanthus elwesii, Rheum ribes, Leucojum aestivum, Buxus sempervirens, Fumaria vaillantii, Veratrum album, Cistus laurifolius* species, it has been reported that *G. elwesii* and *R. ribes* species have a strong antiviral effect compared to other species [34]. In a study conducted with methanol extracts of 75 plants in Morocco, the effect on HSV-1 was investigated. As a result of the study, it was reported that *Pistacia lentiscus* and *Thymus maroccanus* showed a strong antiviral effect [35]. In another study conducted in Nepal, the effect of methanolic and methanolic-aqueous extracts of 23 plant species on HSV-1 was investigated. Among the plant species used, *Bergenia ligulata, Nerium indicum, Holoptelia integrifolia, H. integrifolia* and *N. indicum* were reported to exhibit significant antiviral activity against HSV-1 [36]. The effect of *Euphorbia cotinifolia, E. tirucalli* and *E. cestrifolia* species of Euphorbia genus grown in Colombia on HSV-1 was investigated. As a result of the study, the viral titer reduction factors of the species used were respectively; 10^4, 10^3 and 10^2 have been reported [37]. In Brazil, ethanolic and aqueous extracts of 50 plant species were investigated for their effects against HSV-1 using the vero cell line. It has been reported that ethanolic-aqueous extracts of the species used, *Maytenus ilicifolia, Ilex theezans, I. brevicuspis, Baccharis erioclada* and *Aloysia gratissima*, have antiviral effects [38]. The effect of 18 plant species on HSV-1 was investigated in India. It has been reported that the LC50 effect of the species used, *Hypericum mysorense, H. hookerianum* and *Usnea complanta*, was 100 µg/mL and these results showed an antiviral effect [39]. The effect of methanol extract of 17 plant species on HSV-1 in Yemen was investigated. Among the species used, *Boswellia ameero, B. elongata, Buxus hildebrandtii, Cissus hamaderohensis, Cleome socotrana, Dracaena cinnabari, Exacum affine, Jatropha unicostata* and *Kalanchoe farinacea* have been reported to have antiviral activities [40]. The effect of crude extract of 25 plant species on HSV-1 was investigated in Iran. Among the species used, it has been reported that the effect of *Nymphea alba, Rhus coriaria, Chelidonium majus* and *C. majus* from *Terminalia chebula* is high [41]. The effect on HSV-1 was investigated by using different plant species growing in Lebanon. Among the species used, *Laurus nobilis, Juniperus oxycedrus, Thuja orientalis, Cupressus sempervirens, Pistacia palaestina, Salvia officinalis* and *Satureja thymbra* the best effect have been reported for *J. oxycedrus* (IC50: 200 µg/mL) [42]. In a study conducted in Mexico, the effect of compounds obtained from the plant species used on HSV-1 was investigated. As a result of the study, it has been reported that compounds such as eugenol, methyleugenol, caryophyllene, humulene and eucalyptol obtained from *Ocimum basilicum* and *O. sanctum* have antiviral effects [43]. In a study conducted in Turkey, It has been reported that the *Salvia cedronella* sample used has an antiviral effect between 0.50-3.00 ug/mL against HSV-1 and HSV-2 [44]. In a study conducted in Turkey, the effect of plant species belonging to many genera on HSV-1 was investigated. It has been reported that the range of effect values on

Digitalis lamarckii, Anthemis tinctoria subsp. *tinctoria, A. austriaca, Carduus acanthoides, C. nutans, Cirsium hypoleucum, Cynara scolymus, Silene vulgaris, Ajuga chamaepitys* subsp. *chia* var. *ciliata, Lappula barbata, Rumex obtusifolius* ssp. *subalpinus* and *Sedum hispanicum* is 0.05–0.025 mg/mL [45]. In a study conducted in Egypt, the effect of ethanolic-aqueous extract of 42 plant species on HSV-1 was investigated. It has been reported that the best effect among the species used was exhibited by *Capparis sinaica, Tamarix nilotica, Cyperus rotundus, Ephedra alata* and *Moringa peregrina* with Rf (Reduction factor) 10^4 [46]. In a study conducted in India, the effect of 30 plant species on HSV-1 was investigated. Among the species used, it was reported that *Gymnema sylvestre, Pergularia daemia, Sphaeranthus indicus, Cassia alata, Evolvulus alsinoides, Clitoria ternatea, Indigofera tinctoria, Abutilon indicum, Vitex trifolia, Clerodendrum inerme* and *Leucas aspera* showed the best effects with a mean potency of 0.4 µg/mL [47]. In a study conducted in Egypt, the effect of the crude extract of *Dianthus caryophyllus* on HSV-1 was investigated. It has been reported that the effect value of the plant species used, *D. caryophyllus*, is 92.3% [48]. In a study conducted in Brazil, the effect of ethanol extract of 18 plant species on HSV-1 was investigated. Among the species used, the effect value of *Anemopaegma cetilobum, Arrabidaea craterophora, A. formosa, A. pulchra, A. sceptrum, Stizophyllum perforatum* and *Zeyheria tuberculosa* was reported to be EC50≤100 µg/mL [49]. In a study conducted in South Africa, the effect of hexane, dichloromethane, acetone and methanol extracts of 6 plant species on HSV-1 was investigated. Among the species used, *Carissa edulis* was reported to have an EC50 <70 µg/mL [50]. In a study conducted in South America, the effect of methanolic extracts of 24 plant species on HSV-1 was investigated. Among the species used, the effect value of *Limonium brasiliense, Psidium guajava* and *Phyllanthus niruri* was reported to be 185, 118 and 60 µg/mL, respectively [51]. In a study conducted in Brazil, the effect of crude aqueous extract of 27 plant species on HSV-1 was investigated. Among the species used, the antiviral effect of *Bauhinia blakeana, Bumelia sertorum, Coffea arabica, Endopleura uchi, Leandra purpurensis, Origanum vulgare, Psidium cattleyanum, Tibouchina mutabilis* and *Uncaria tomentosa* was reported to be in the range of 62.5-1000 µg/mL [52]. In a study conducted in Malaysia, the effect of different extracts of plant species used on HSV-1 and HSV-2 was investigated. Among the species used, *Penstemon watsonii* and *P. urinaria* were reported to have a strong SI >33.6 [53]. In a study conducted in Argentina, the effect of different extracts of plant species used on HSV-1 was investigated. Among the species used, *Baccharis gaudichaudiana* was reported to be the most effective with >117 selectivity index (SI) values [54]. The effect of different extracts of *Tabernaemontana catharinensis* used in a study conducted in the USA on HSV-1 was investigated. As a result of the study, it was reported that the effect value of *T. catharinensis* species was SI = 12.28 [55]. In a study conducted in Turkey, the effect of plant extract on HSV-1 was investigated. As a result of the study, it was reported that the CPE (Cytopathogenic Effect) value of *Ribes multiflorum* was 15.62 µg/mL as a minimum and 31.25 µg/mL at the maximum [56]. In a study conducted in Iran, the effect of methanol extract of *Veronica persica* species on HSV-1 and HSV-2 was investigated. As a result of the study, it was reported that the plant species was 80% effective [57]. In a study conducted in Turkey, the effect of water and ethanol extracts of 14 plant species on HSV-1 was investigated. Among the species used, it has been reported that the antiviral activity value of *Helichrysum arenarium* and *H. armenium* is 2-32 µg/mL [58]. In a study conducted in Brazil, the effect of extracts of plant species belonging to different genera on HSV-1 was investigated. Among the species used, *Banisteriopsis variabilis, Byrsonima intermedia, Campomanesia xanthocarpa, Erythroxilum deciduum, Lacistema hasslerianum, Ocotea pulchella, Stryphodendron adstringens* and *Xylopia aromatica* were found to have significant effects. It has also been reported that the best effect is seen in *B. intermedia* [59]. In a study conducted in China, the effect of different extracts of plant species used on HSV-1 was investigated. Among the species used, *Glechon marifolia, G. spathulata, Thymus vulgaris Cymbopogon citratus, Rosmarinus officinalis, Illicium verum, Leptospermum laevigatum, Eucalyptus caesia* and *Mentha suaveolens* were found to have significant effects. It has also been reported that *I. verum* shows the best effect and the effect range is between 1 –160 µg/mL [60]. In a study conducted in Jamaica, the effect of different extracts of the plant species used on HSV-1 and HSV-2 was investigated. Among the species used, *Hibiscus sabdariffa, Allium sativum, Guaiacum officinale, Moringa oleifera, Curcuma longa, Zingiber officinale, Petiveria alliacea, Aloe vera, Cannabis sativa* and *Tillandsia recurvata* have been reported to have antiviral effects [61]. In this context, it is seen that different parts and different extracts of many plants have antiviral effects against HSV-1 and HSV-2. As a result of the literature research, it is thought that the plants can be used as a natural product against HSV-1 and HSV-2.

2.2. Human immunodeficiency virus (HIV) (Genus: Lentivirus)

The human immunodeficiency virus (HIV) refers to a group of diseases brought on by retrovirus infection. After a viral infection, you may have either no symptoms at all or mild flu-like symptoms. The duration of the incubation period is usually much longer than the time between when the first symptoms of influenza infection appear and when full recovery is achieved. The immune system may be increasingly compromised as the virus worsens [62]. This may lead to a depletion of immune system components, making people more susceptible to illness from a wide range of illnesses. Extreme weight loss may be a sign of this condition. AIDS is an acronym for "acquired immune deficiency syndrome" which describes these infectious disease symptoms (AIDS). During pregnancy, delivery, and nursing HIV may be transmitted from mother to the child It can be transmitted as well via unprotected intercourse, infected blood transfusions, hypodermic needles, and other similar situations. Contrary to popular belief, body fluids including saliva, perspiration, and tears have very little impact on the spread of the virus [63]. Effective safe association, the use of sterile needles, treatment of affected patients, and the avoidance of contact are all important in halting the spread of the virus. In the first half of the twentieth century, HIV was transmitted to humans from monkeys in west-central Africa. There have been an estimated 40 million fatalities globally due to AIDS since the illness

Table 2. Plants effective against human immunodeficiency virus [26, 66-69].

Virus name	Extract type	Plant species	Geographic regions
Human immunodeficiency virus (HIV)	aqueous, ethanolic-aqueous, methanol, water, ethanol, essential oil	*Achyranthes aspera, Aleurites moluccana, Andrographis paniculata, Aristotelia chilensis, Aspilia pluriseta, Cassia stipulacea, Clermontia aborescens, Drymis winteri, Escallonia illintia, Eugenia malaccensis, Luma apiculata, Lytropus chilensis, Pipturus albidus, Pluchea indica, Psychotria hawaiiensis, Rumex bequaertii, Scaevola sericea, Trifollium sp.*	America, Chile, Rwanda, China, Taiwan, India

was first identified. There is currently no cure or vaccine available for HIV/AIDS, however antiretroviral medication may help halt the disease's progression. Starting therapy soon after diagnosis is highly recommended [64,65]. While the efficacy of complementary medicine for HIV has not been shown, the great majority of people benefit from it. Patients who use alternative medicine report improved health outcomes. Herbal remedies, in particular, are often used to stimulate hunger and encourage rapid weight gain. When it comes to boosting the immune system and decreasing the viral infection's impact, herbal medications are the favoured choice. Plants effective against HIV infections in the study are shown in Table 2.In this context, the effect of aqueous and ethanolic-aqueous extracts of 36 plant species on HIV was investigated in a study conducted in Chile. Among the species used, *Cassia stipulacea, Aristotelia chilensis, Drymis winteri, Lytropus chilensis, Luma apiculata* and *Escallonia illintia* have been reported to have low effects at different concentrations [26]. In a study conducted in the USA, the effect of aqueous extract of 17 plant species on HIV was investigated. It has been reported that the anti-HIV effect of *Eugenia malaccensis* and *Pluchea indica* extracts is 50% [66]. In a study conducted in Rwanda, the effect of ethanol extract of 21 different family species on HIV was investigated. It has been reported that the effect of *Aspilia pluriseta, Rumex bequaertii, Pipturus albidus, Aleurites moluccana, Psychotria hawaiiensis, Clermontia aborescens* and *Scaevola sericea* is 50% [67]. In a study conducted in China, the effect of extracts obtained from *Trifollium* species on HIV was investigated. As a result of the study, it was reported that some *Trifollium* species inactivate 50% of the virus at 10% of the toxic dose concentration [68]. In a study conducted in Taiwan, the effect of ethanol extract of *Andrographis paniculata* species on HIV was investigated. As a result of the study, it was reported that the Andrographolide compound obtained from the *A. paniculata* sample showed anti-HIV effect [69]. In a study conducted in India, the effect of some compounds obtained from the essential oil of the plant species on HIV was investigated. As a result of the study, it was reported that oleanolic acid obtained from *Achyranthes aspera* essential oil has an anti-HIV effect at 6.8-7.8 µg/mL [70]. According to literature data, many studies on HIV have shown that plants support the reduction of the effects of virus infections. In this context, it is thought that plants can be natural resources that support the HIV treatment.

2.3. Influenza virus A (Genus: Alphainfluenzavirus), Influenza virus B (Genus: Betainfluenzavirus) and Parainfluenza

There is a wide spectrum of severity in how this virus manifests. Typical symptoms include a high temperature, a runny nose, a sore throat, muscular pains, headaches, a cough, and extreme exhaustion. These signs and symptoms often appear 2 days after the first viral contact and remain for a week. Acute respiratory distress syndrome, meningitis, encephalitis, and preexisting diseases including asthma and cardiovascular disease are all possible precipitants and exacerbators of the infection [71]. There are 4 types: group A, which is common in swine, humans and mammals, group B and C, which cause infections in humans, and group D, which causes infections in cattle and pigs. Groups A and B circulate among humans, causing epidemics. Group C creates a mild infection, especially in children. Group D can cause infection in humans, but it is not known to cause disease [72]. When infected people cough or sneeze, they release virus-filled droplets into the air. If you want to limit the spread of germs, you should always cover your mouth and nose when you cough or sneeze. Another kind of defence is the yearly immunisation. Droplets expelled while coughing and sneezing are the most common mode of transmission of influenza viruses between people. Aerosols and infected surfaces and objects may also play a role in viral transmission [73]. In the tropics, influenza infections may happen at any time of year, however in the temperate areas of the globe, the number of cases rises in the winter months. Parainfluenza viruses in humans (HPIV) may infect both the upper and lower respiratory tracts [74]. Herbal remedies are often utilised to lessen the severity of influenza. Polyphenols, flavonoids, saponins, glucosides, and alkaloids are the building blocks of herbal medicine. Thus, studying wild plants is crucial for finding novel herbal medications. Plants effective against Influenza (A, B) and Parainfluenza are listed in Table 3.

In a study conducted in Bulgaria, the effect of essential oil components from different genus species on Influenza A virus was investigated. It has been reported that it has an antiviral effect thanks to the flavonoids, triterpene saponins, phenolic acids, tannins and polysaccharides obtained from the species used, *Sambucus nigra, Hypericum perforatum* and *Saponaria officinalis* [25]. In a study conducted in Nepal, the effect of methanolic and methanolic-aqueous extracts of 23 plant species on Influenza A virus was investigated. Among the species used, *Bergenia ligulata, Nerium indicum* and *Holoptelia integrifolia* were reported to have an effect of 50%, with a value of 10 µg/mL [36]. In a study conducted in Yemen, the effect of methanol and hot-aqueous extracts of 25 plant species on Influenza A virus was investigated. Among the species used, the antiviral effects of *Buxus hildebrandtii, B. ameero, B. elongata, Cissus hamaderohensis, Cleome socotrana, Dracaena cinnabari, Exacum affine, Jatropha unicostata* and *Kalanchoe farinacea* were reported for concentrations between 0.7-12.5 µg/mL [40]. A study

Table 3. Plants effective against Influenza (A, B) and Parainfluenza [25, 36, 40, 44, 45, 47, 50, 58, 60, 61, 75-80].

Virus name	Extract type	Plant species	Geographic regions
Influenza (A, B) and Parainfluenza	methanol, methanolic-aqueous, essential oil, ethanol, hexane-chloroform, ethyl acetate, hexane, dichloromethane, acetone	*Abutilon indicum, Ajuga chamaepitys ssp. chia var. ciliata, Allium sativum, Aloe vera, Anthemis austriaca, Anthemis tinctoria subsp. tinctoria, Bergenia ligulata, Boswellia ameero, Boswellia elongata, Buxus hildebrandtii, Calotropis gigantea, Cannabis sativa, Carduus acanthoides, Carduus nutans, Carissa edulis, Cassia alata, Cinnamomum cassia, Cinnamomum zeylanicum, Cirsium hypoleucum, Cissus hamaderohensis, Citrus bergamia, Cleome socotrana, Clerodendrum inerme, Clitoria ternatea, Curcuma longa, Cynara scolymus, Digitalis lamarckii, Dracaena cinnabari, Evolvulus alsinoides, Exacum affine, Foeniculum vulgare, Fragaria vesca, Guaiacum officinale, Gymnema sylvestre, Helichrysum arenarium, Heracleum aconitifolium, Heracleum lehmannianum, Heracleum ponticum, Hibiscus sabdariffa, Holoptelia integrifolia, Hypericum perforatum, Indigofera tinctoria, Jatropha unicostata, Kalanchoe farinacea, Lappula barbata, Lavandula angustifolia, Leucas aspera, Moringa oleifera, Nerium indicum, Pergularia daemia, Petiveria alliacea, Plumbago zeylanica, Podocarpus henkelii, Rubus idaeus, Rumex obtusifolius ssp. subalpinus, Salvia cedronella, Salvia officinalis, Sambucus nigra, Saponaria officinalis, Sedum hispanicum, Silene vulgaris, Sphaeranthus indicus, Thymus vulgaris, Tillandsia recurvata, Vaccinium myrtillis, Vaccinium vitis-idaea, Vitex trifolia, Zingiber officinale*	Nepal, Yemen, Turkey, India, China, Jamaica, Russia, Pakistan, Egypt, Bulgaria, South Africa

conducted in Russia investigated the effect of essential oils obtained from different parts of *Heracleum* species on Influenza A and Influenza B viruses. As a result of the study, it has been reported that essential oils obtained from the roots of *Heracleum lehmannianum, H. ponticum* and *H. aconitifolium* species have more antiviral activity than essential oils obtained from fruits [75]. In a study conducted in Turkey, the effect of essential oil and different extracts of *Salvia cedronella* on Influenza A virus was investigated. As a result of the study, it was reported that *Salvia cedronella* has an effect at concentrations between 0.04-3.00 mg/mL [44]. In a study conducted in Turkey, the effect of extracts obtained from species belonging to different genera on parainfluenza virus was investigated. Among the species used, *Anthemis tinctoria* subsp. *tinctoria*, *A. austriaca, Carduus acanthoides, C. nutans*, *Cirsium hypoleucum, Cynara scolymus, Silene vulgaris, Ajuga chamaepitys* ssp. *chia* var. *ciliata*, *Lappula barbata, Rumex obtusifolius* ssp. *subalpinus*, *Digitalis lamarckii* and *Sedum hispanicum* were reported to have a range of effect values of 0.16 and <0.012 mg/mL [45]. In a study conducted in India, the effect of methanol extract of 30 plant species on Influenza A virus was investigated. Among the species used, *Gymnema sylvestre, Pergularia daemia, Sphaeranthus indicus, Cassia alata, Evolvulus alsinoides, Clitoria ternatea, Indigofera tinctoria, Abutilon indicum, Vitex trifolia, Clerodendrum inerme* and *Leucas aspera* were reported to have antiviral effects [47]. In a study conducted in South Africa, the effect of hexane, dichloromethane, acetone and methanol extract of 6 plant species on parainfluenza virus was investigated. Among the species used, *Podocarpus henkelii, Plumbago zeylanica* and *Carissa edulis* have been reported to have an effect on Parainfluenza [50]. In a study conducted in Bulgaria, the effect of methanol extracts of different genera on Influenza A virus was investigated. Among the species used, anthocyanins obtained from *Fragaria vesca, Rubus idaeus, Vaccinium myrtillis* and *V. vitis-idaea* were reported to be antiviral supportive [76]. In a study conducted in China, the effect of ethanol extract of *Calotropis gigantea* on Influenza A was investigated. As a result of the study, it was reported that the IC50 of *C. gigantea* extract was 13.4–39.8 µg/mL [77]. In a study conducted in Pakistan, the effect of crude extract of *Cinnamomum cassia* plant on Influenza A virus was investigated. As a result of the study, it was reported that the antiviral effect of *C. cassia* species was observed at 500 µg/mL [78]. In a different study conducted in Turkey, the effect of extracts obtained from species belonging to one genus on parainfluenza virus was investigated. As a result of the study, the value of antiviral activity of *Helichrysum arenarium* and *H. armenium* was reported to be 4-64 µg/mL [58]. In a study conducted in Egypt, the effect of ethanol extract of *Foeniculum vulgare* plant on Influenza A virus was investigated. As a result of the study, it was reported that *F. vulgare* extract had an inhibitory effect between 65.5% and 82.8% [79]. In a study conducted in China, the effect of essential oil obtained from many plant species on Influenza A virus was investigated. As a result of the study, *T. vulgaris*, *C. zeylanicum* and *C. bergamia* were reported to have antiviral effect at >3.1 µg/mL [60]. In a study conducted in Jamaica, the effect of extracts obtained from plant species belonging to different genera on Influenza A virus was investigated. Among the species used, the antiviral effects of *Hibiscus sabdariffa, Allium sativum, Guaiacum officinale, Moringa oleifera, Curcuma longa, Zingiber officinale, Petiveria alliacea, Aloe vera, Cannabis sativa* and *Tillandsia recurvata* were observed [61]. In a study conducted in Egypt, the effect of extracts obtained from species belonging to different genera on Influenza A virus was examined. Active substances were obtained from *Lavandula angustifolia* and *Salvia officinalis* species. Linalyl acetate and linalool from *L. angustifolia*, camphor and a-thujone from *S. officinalis* have been reported to have antiviral effects [80]. When the results obtained from the literature data are examined, it is seen that the plants show significant effects against influenza and parainfluenza viruses. In this context, it is thought that plants play an important role in reducing the effects of influenza infections.

2.4. Poliovirus (Genus: Enterovirus)

It is an RNA virus that causes poliomyelitis. It is a contagious infection that damages the nerve cells that initiate the contraction of the muscles in the spinal cord [81]. It causes small epidemics in summer and autumn. Symptoms start with high fever up to 40 °C, severe

Table 4. Plants effective against poliovirus [27, 29, 32, 33, 35, 46, 54, 84, 85].

Virus name	Extract type	Plant species	Geographic regions
Poliovirus	Ethanol, methanol, hexane, ethanolic-aqueous, petroleum ether, chloroform, organic, aqueous, ethyl acetate	*Abutilon figarianum, Acacia nilotica, Achillea fragrantissima, Adansonia digitata, Aloe sinkitana, Anacardium occidentale, Anogeissus schimperi, Aristolochia bracteolate, Avicennia marina, Baccharis gaudichaudiana, Baccharis spicata, Bauhinia thonningii, Bidens subalternans, Boswelia dalzielii, Butyrospermum parkii, Capparis sinaica, Caralluma retrospiciens, Cassia goratensis, Cissus quadrangularis, Clutia abyssinica, Conyza aegyptiaca, Crotalaria mesopontica, Croton zambesicus, Cyperus rotundus, Detarium senegalense, Dichrostachys glomerata, Diospyros mespiliformis, Dracaena steudtneri, Ephedra alata, Erythrina abyssinica, Euphorbia grantii, Euphorbia hirta, Globularia arabica, Guiera senegalensis, Harrisonia abyssinica, Hypericum cordifolium, Hypericum elodeoides, Hypericum uralum, Ipomoea carnea, Jasonia montana, Khaya senegalensis, Laggera brevipes, Lannea humilis, Lavandula coronopifolia, Leonotis nepetaefolia, Lygodium japonicum, Macaranga kilimandscharica, Maerua oblongifolia, Maesa macrophylla, Maytenus senegalensis, Moringa peregrina, Nigella sativa, Palisota hirsuta, Pinus halepensis, Piper regnelli subsp. pallescens, Pluchea sagittalis, Prosopis chilensis, Punica granatum, Rhus vulgaris, Sterculia setigera, Tagetes minuta, Tamarix nilotica, Tanacetum sinaicum, Tessaria absinthioides, Tribulus terrestris, Trigonella foenum-graecum, Vernonia aenulans, Vernonia amygdalina, Ziziphus mucronata, Zizyphus spina-christi*	Rwanda, Nepal, Nigeria, Morocco, Togo, Argentina, Egypt, Sudan, Brazil

headaches, nausea and back pain. After 4-5 days, flaccid paralysis that affects the muscles bilaterally but asymmetrically settles, after 2-3 weeks, some muscles completely return to normal, some do not recover at all [82]. The virus is spread through feces. It is largely eliminated with applied vaccines [83]. The plants studied in the literature against poliovirus are shown in Table 4. In this context, in a study conducted in Rwanda, the effect of extracts obtained from species belonging to different genera on Poliovirus was investigated. It has been reported that the viral titer reduction factors of *Crotalaria mesopontica, Dracaena steudtneri, Euphorbia grantii, E. hirta, Erythrina abyssinica, Laggera brevipes, Leonotis nepetaefolia, Macaranga kilimandscharica, Rhus vulgaris, Vernonia aenulans, Clutia abyssinica* and *V. amygdalina*, which are among the species used, vary between 10^3 and 10^5 [27]. In the study conducted in Nepal, the effect of extracts obtained from species belonging to different genera on Poliovirus was investigated. Among the species used, *Hypericum cordifolium, H. elodeoides, H. uralum, Lygodium japonicum* and *Maesa macrophylla* have been reported to have antiviral effects [29]. In a study conducted in Nigeria, the effect of methanol, ethanol and hexane extracts from different species on Poliovirus was investigated. Among the species used, the effect values of *Anogeissus schimperi, Guiera senegalensis, Bauhinia thonningii, Cassia goratensis, Anacardium occidentale, Butyrospermum parkii, Khaya senegalensis, Detarium senegalense, Dichrostachys glomerata, Ziziphus mucronata, Lannea humilis, Sterculia setigera* and *Boswelia dalzielii* were reported to be between 100-400 µg/µL [32]. In a study conducted in Togo, the effect of different extracts of 19 plant species on Poliovirus was investigated. As a result of the study, it was reported that *Adansonia digitata, Conyza aegyptiaca* and *Palisota hirsuta* have antiviral effects [33]. In a study conducted in Morocco, the effect of plant extracts obtained from *Pinus halepensis* and *Punica granatum* on Poliovirus was investigated. As a result of the study, it was reported that the minimum effect of *P. halepensis* and *P. granatum* species was at 6.5 µg/mL [35]. In a study conducted in Egypt, the effect of extracts obtained from species belonging to different genera on Poliovirus was investigated. Among the species used, the potency value of *Capparis sinaica, Tamarix nilotica, Cyperus rotundus, Ephedra alata, Moringa peregrina, Achillea fragrantissima, Tanacetum sinaicum, Jasonia montana* and *Globularia arabica* has been reported to be between 50-100 µg/mL [46]. In a study conducted in Sudan, the effect of extracts obtained from 23 plants on Poliovirus was examined. Among the species used, *Abutilon figarianum, Acacia nilotica, Aloe sinkitana, Aristolochia bracteolate, Avicennia marina, Caralluma retrospiciens, Cissus quadrangularis, Croton zambesicus, Diospyros mespiliformis, Harrisonia abyssinica, Ipomoea carnea, Lavandula coronopifolia, Maerua oblongifolia, Maytenus senegalensis, Nigella sativa, Prosopis chilensis, Tribulus terrestris, Trigonella foenum-graecum* and *Zizyphus spina-christi* species have been reported to have antiviral effects [84]. A Brazilian study *Piper regnelli* subsp. *pallescens* plant extracts such as hexane, chloroform and ethyl acetate on Poliovirus were investigated. As a result of the study, *P. regnelli* subsp. *pallescens* has been reported to show the best effect in ethyl acetate extract [85]. In a study conducted in Argentina, the effect of extracts obtained from species belonging to different genera on Poliovirus was investigated. Among the species used, *Baccharis gaudichaudiana*, *B. spicata, Bidens subalternans, Pluchea sagittalis*, *Tagetes minuta* and *Tessaria absinthioides* have been reported to exhibit antiviral properties [54]. According to the literature data, various plant species show effects against poliovirus. In this context, it is thought that plants may be effective in poliovirus infections.

2.5. Astrovirus (Family: Astroviridae)

Astrovirus is a type of virus discovered in 1975 as a result of the epidemic of diarrhea in humans. In addition to humans, it is also seen in mammals (Mamastrovirus) and poultry (Avastrovirus). Astroviruses are an important cause of gastroenteritis in young children. In addition, it causes gastrointestinal infections in animals [86,87]. In this study, studies reported in the literature and effective against astrovirus were compiled (Table 5). In this context, in a study conducted in Nigeria, the effect of ethanol, methanol and hexane extracts obtained from plant species belonging to different genera on Astrovirus was investigated. Among the species used,

the effect values of *Anogeissus schimperi, Guiera senegalensis, Bauhinia thonningii, Cassia goratensis, Anacardium occidentale, Butyrospermum parkii, Khaya senegalensis, Detarium senegalense, Dichrostachys glomerata, Ziziphus mucronata, Lannea humilis, Sterculia setgera* and *Boswelia dalzielii* were reported to be between 100-400 µg/µL [32]. As seen in the study, it has been reported that different plant species have a reductory effect on astrovirus infection.

2.6. Parvovirus (Family: Parvoviridae)

Parvoviruses are a type of viruses that cause diseases in different animal species. They cause skin diseases in dogs and cats. In addition, they can cause infertility in pigs. In humans, it is less severe. They usually cause respiratory tract infections [88]. In the literature (Table 5), the effect of ethanol, methanol and hexane extracts obtained from plant species belonging to different genera on Parvovirus was investigated in a study conducted in Nigeria. Effect of *Bauhinia thonningii, Cassia goratensis, Anacardium occidentale, Khaya senegalensis, Detarium senegalense, Dichrostachys glomerata, Sterculia setgera* and *Boswelia dalzielii* has been reported for concentrations between 100-400 µg/µL [32]. As reported in the study, the plants may be effective in reducing the effects of parvovirus.

2.7. Sindbis virus (SINV) (Genus: Alphavirus)

Sindbis virus (SINV) is a type of virus transmitted by mosquitoes (Culex and Culiseta) and causes symptoms of arthralgia, rash and weakness. This virus is linked to Pogosta disease, Ockelbo disease, and Karelian fever. It is particularly common in insects and vertebrates from Eurasia, Africa and Oceania [89]. As a result, the disease is usually seen in these regions. Plants effective against Sindbis virus are shown in Table 5. Looking at the effects of plants on Sindbis virus in the literature, the effect of methanol extract of 21 plant species on SINV was investigated in a study conducted in Nepal. As a result of the study, it was reported that *Hypericum cordifolium, H. elodeoides, H. uralum, Lygodium japonicum* and *Maesa macrophylla* have antiviral effects [29]. In a study conducted in Togo, the effect of extracts obtained from plant species belonging to different genera on SINV was investigated. Among the species used, *Adansonia digitata, Conyza aegyptiaca* and *Palisota hirsuta* were reported to have antiviral effects [33]. In a study conducted in Turkey, the effect of ethanol extract obtained from 16 different plant species on SINV was investigated. Among the species used, *Galanthus elwesii, Rheum ribes, Leucojum aestivum, Buxus sempervirens, Fumaria vaillantii, Veratrum album* and *Cistus laurifolius* have been reported to have antiviral effects [34]. In a study conducted in Morocco, the effect of methanol extracts of 75 plants on SINV was examined. Among the species used, it was reported that the effect of *Acacia gummifera, Juglans regia, Thymus maroccanus, Lawsonia inermis, Pinus halepensis* and *Rosa canina* was observed at minimum 1.5 µg/mL [35]. In a study conducted in India, the effect of methanol extract of 30 plant species on SINV was investigated. As a result of the study, it was reported that *Gymnema sylvestre, Pergularia daemia, Sphaeranthus indicus, Cassia alata, Evolvulus alsinoides, Clitoria ternatea, Indigofera tinctoria, Abutilon indicum, Vitex trifolia, Clerodendrum inerme* and *Leucas aspera* have antiviral effects [47]. According to literature data, many different plant species were found to be effective against SINV.

2.8. Feline calicivirus (FCV) (Genus: Vesivirus)

Feline calicivirus (FCV) is a virus that causes respiratory infections in cats. There is no specific treatment for FCV. FCV can survive for weeks in a dry environment and much longer in a cold, wet environment [90]. The plant species studied in the literature against FCV are shown in Table 6. In a study conducted in India, the effect of methanol extract of 30 plant species on FCV was investigated. Among the species used, *Gymnema sylvestre, Pergularia daemia, Sphaeranthus indicus, Cassia alata, Evolvulus alsinoides, Clitoria ternatea, Indigofera tinctoria, Abutilon indicum, Vitex trifolia, Clerodendrum inerme* and *Leucas aspera* have been reported to have antiviral effects [47]. In a study conducted in Spain, the effect of ethanolic-aqueous extract of plant species belonging to different genera on FCV was investigated. Among the species used, it has been reported that plant species *Origanum*

Table 5. Plants effective against Astrovirus, Parvovirus and Sindbis virus [29, 32-35, 47, 86-89].

Virus name	Extract type	Plant species	Geographic regions
Astrovirus	Ethanol, methanol, hexane	*Anacardium occidentale, Anogeissus schimperi, Bauhinia thonningii, Boswelia dalzielii, Butyrospermum parkii, Cassia goratensis, Detarium senegalense, Dichrostachys glomerata, Guiera senegalensis, Khaya senegalensis, Lannea humilis, Sterculia setigera, Ziziphus mucronata,*	Nigeria
Parvovirus	Ethanol, methanol, hexane	*Anacardium occidentale, Bauhinia thonningii, Boswelia dalzielii, Cassia goratensis, Detarium senegalense, Dichrostachys glomerata, Khaya senegalensis, Sterculia setigera*	Nigeria
Sindbis virus (SINV)	Ethanol, methanol, essential oil	*Abutilon indicum, Acacia gummifera, Adansonia digitata, Buxus sempervirens, Cassia alata, Cistus laurifolius, Clerodendrum inerme, Clitoria ternatea, Conyza aegyptiaca, Evolvulus alsinoides, Fumaria vaillantii, Galanthus elwesii, Gymnema sylvestre, Hypericum cordifolium, Hypericum elodeoides, Hypericum uralum, Indigofera tinctoria, Juglans regia, Lawsonia inermis, Leucas aspera, Leucojum aestivum, Lygodium japonicum, Maesa macrophylla, Palisota hirsuta,* *Pergularia daemia, Pinus halepensis, Rheum ribes, Rosa canina, Sphaeranthus indicus, Thymus maroccanus, Veratrum album, Vitex trifolia*	Nepal, Togo, Turkey, Morocco, India

Table 6. Plants effective against Feline calicivirus, Rhinovirus and Echovirus [47, 90-98].

Virus name	Extract type	Plant species	Geographic regions
Feline calicivirus (FCV)	methanol, ethanolic-aqueous	*Abutilon indicum, Cassia alata, Clerodendrum inerme, Clitoria ternatea, Evolvulus alsinoides, Gymnema sylvestre, Indigofera tinctoria, Leucas aspera, Origanum bastetanum, Pergularia daemia, Sphaeranthus indicus, Thymus longiflorus, Thymus membranaceus, Thymus zygis-gracilis, Vitex trifolia, Ziziphora hispanica*	India, Spain
Rhinovirus	methanol, petroleum ether,ethyl acetate	*Abutilon indicum, Cassia alata, Clerodendrum inerme, Clitoria ternatea, Evolvulus alsinoides, Gymnema sylvestre, Indigofera tinctoria, Leucas aspera, Pergularia daemia, Raoulia australis, Sphaeranthus indicus, Vitex trifolia, Zanthoxylum piperitum, Zanthoxylum planispinum, Zanthoxylum schinifolium*	India, South Korea
Echovirus	methanol	*Ageratum conyzoides, Macaranga barteri, Mondia whitei*	Nigeria

bastetanum, T. zygis-gracilis, T. longiflorus, T. membranaceus and *Ziziphora hispanica* have antiviral effects [91]. In this context, it is seen that the plants are effective against FCV. According to literature data, it is thought that herbal medicines may have properties that reduce the effects of FCV or support treatments.

2.9. Rhinovirus (Genus: Enterovirus)

Rhinovirus is the most common viral infectious agent in humans and causes the common cold. 40% of winter diseases are caused by rhinoviruses. Although they are generally accepted as a cold virus, they can also cause other infections in the upper respiratory tract [92]. Symptoms begin to appear within 2 days after the virus enters the body. Symptoms of the disease include sore throat, runny nose, nasal congestion, sneezing and coughing, muscle aches, fatigue, weakness and loss of appetite [93]. The plant species effective against Rhinovirus reported from different countries in the literature are shown in Table 6. In a study conducted in India, the effect of methanol extract of 30 plant species on Rhinovirus was investigated. Among the species used, *Gymnema sylvestre, Pergularia daemia, Sphaeranthus indicus, Cassia alata, Evolvulus alsinoides, Clitoria ternatea, Indigofera tinctoria, Abutilon indicum, Vitex trifolia, Clerodendrum inerme* and *Leucas aspera* have been reported to have antiviral effects [47]. In a study conducted in South Korea, the effect of petroleum ether and ethyl acetate extracts of two different plant species on Rhinovirus was investigated. As a result of the study, it was reported that the mean effective concentration of *Zanthoxylum piperitum, Z. schinifolium, Z. planispinum* and *Raoulia australis* was 39.94-59.48 µg/mL [94,95]. According to these data, it is thought that the plants that are reported to be effective against rhinovirus in the literature may help in reducing the effect of the infection.

2.10. Echovirus (Family: Picornaviridae)

Enteric cytopathic human orphan (ECHO) viruses are a group of viruses that cause infections and skin rashes in different parts of the human body. This group of viruses especially affects the gastrointestinal system. It is most common in summer and autumn. It is transmitted through contact with the feces of an infected person or through the respiratory tract of an infected person [96,97]. Plants reported to be effective against Echovirus are shown in Table 6. In a study conducted in Nigeria, the effect of methanol extracts of 27 plant species on Echovirus was investigated. As a result of the study, it was reported that the effective concentration of *Macaranga barteri, Ageratum conyzoides* and *Mondia whitei* was between 0.007-0.028 mg/mL [98]. Considering the studies on plants effective against echovirus in the literature, it is thought that plants may contribute to reducing the effect of infection.

2.11. Rotavirus (Family: Reoviridae)

Rotavirus is an RNA virus that causes diarrhea in infants and children. Almost every child worldwide is infected with rotavirus at least once before the age of five [99]. After the first infection, immunity develops in the body with each infection and the severity of the disease is lesser in subsequent infections. There are 9 types from A to J. More than 90 percent of infections are caused by rotavirus A. It is rarely seen in adults [100]. The plant species used in studies against Rotavirus reported in the literature are listed in Table 7. In a study conducted in Brazil, the effect of ethanol extracts of different plant species on Rotavirus was investigated. Among the species used, components such as Tannins, flavonoids, saponins, coumarins and terpenes found in *Byrsonima verbascifolia, Eugenia dysenterica, Hymenaea courbaril* and *Myracrodruon urundeuva* have been reported to have antiviral effects [101]. Plants effective against rotavirus have been reported in literature and can be used in pharmacological designs as a natural antiviral product.

2.12. Bovine alphaherpesvirus 1 (BoHV-1) (Genus: Varicellovirus)

Bovine alphaherpesvirus 1 (BoHV-1) is a virus that causes a variety of diseases in cattle, including rhinotracheitis, vaginitis, balanoposthitis, abortion, conjunctivitis, and enteritis. It is spread through sexual contact, artificial insemination and respiration [102]. Although these symptoms are not primarily life-threatening, they are an economically important disease as they can reduce production. A vaccine is available that reduces the severity and incidence of the disease. Although the infection can be seen in cattle of any age, it is most common between the ages of 6-18 months [103]. Plants effective against BoHV-1 reported in the literature are shown in Table 7. In a study conducted in Brazil, the effect of extracts from 18 plants on BoHV-1 was investigated. It has been reported that the effect percentage of *Erythroxylum deciduum, Lacistema hasslerianum, Xylopia aromatica, Banisteriopsis variabilis, Byrsonima intermedia, Campomanesia xanthocarpa* is between 90-96% [104]. In another study conducted in Brazil, the effect of extracts obtained from 27 plants on BoHV-1 was investigated. Among the species

Table 7. Plants effective against Rotavirus, Bovine Herpesvirus, Reovirus, Vaccinia, and Cardiovirus A [49, 52, 99-107].

Virus name	Extract type	Plant species	Geographic regions
Rotavirus	ethanol	*Byrsonima verbascifolia, Eugenia dysenterica, Hymenaea courbaril, Myracrodruon urundeuva*	Brazil
Bovine Herpesvirus (BoHV-1)	aqueous	*Banisteriopsis variabilis, Bumelia sertorum, Byrsonima intermedia, Campomanesia xanthocarpa, Coffea arabica, Endopleura uchi, Erythroxylum deciduum, Lacistema hasslerianum, Leandra purpurensis, Prunus myrtifolia, Psidium cattleyanum, Symphyopappus compresses, Uncaria tomentosa, Xylopia aromatica*	Brazil
Reovirus	aqueous	*Banisteriopsis variabilis, Byrsonima intermedia, Campomanesia xanthocarpa, Gochnatia polymorpha, Lithraea molleoides*	Brazil
Vaccinia virus (VACV)	ethanol	*Anemopaegma setilobum, Arrabidaea brachypoda, Arrabidaea formosa, Arrabidaea pulchra, Arrabidaea sceptrum, Mussatia prieurei, Stizophyllum perforatum, Zeyheria tuberculosa*	Brazil
Cardiovirus A (Encephalomyocarditis virus; EMCV)	Ethanol	*Anemopaegma setilobum, Arrabidaea brachypoda, Arrabidaea craterophora, Arrabidaea formosa, Stizophyllum perforatum*	Brazil

used, the effective concentration of *Bumelia sertorum, Coffea arabica, Endopleura uchi, Leandra purpurensis, Origanum vulgare, Psidium cattleyanum, Tibouchina mutabilis* and *Uncaria tomentosa* has been reported to be between 62.5-250 µg/mL [52]. When the studies reported in the literature are examined, it is seen that plant species have significant effects against BoHV-1. In this context, it is possible to reduce the effect of BoHV-1 infection with herbal treatments.

2.13. Reovirus (Family: Reoviridae)

Reovirus is a RNA virus with a wide host such as vertebrates, invertebrates, plants, protists and fungi. It is frequently seen in humans. However, these infections are usually mild. In children, it can cause severe diarrhea and intestinal disorders [105]. Plant species reported to be effective against Reovirus are shown in Table 7. In a study conducted in Brazil, the effect of aqueous extracts from 18 plants on Reovirus was investigated. Among the species used, *Gochnatia polymorpha, Lithraea molleoides, Banisteriopsis variabilis, Byrsonima intermedia* and *Campomanesia xanthocarpa* were reported to have an efficacy of < 90% [104]. Depending on the literature data, it is thought that the plants used may be a natural product against reovirus.

2.14. Vaccinia virus (VACV) (Genus: Orthopoxvirus)

Vaccinia virus (VACV) is a virus that causes smallpox. The infection progresses very mildly and symptoms may not be seen in healthy individuals. But sometimes it can cause redness and fever. The protection of vaccines is high [106]. The plant species studied against VACV are shown in Table 7. In a study conducted in Brazil, the effect of ethanol extracts of plant species belonging to different genera on VACV was investigated. Among the species used, the potency value of *Arrabidaea brachypoda, A. formosa, A. pulchra, A. sceptrum, Anemopaegma cetilobum, Mussatia prieurei, Stizophyllum perforatum and Zeyheria tuberculosa* was reported to be EC50≤100 µg/mL [49]. It is thought that the plants used in this literature study may be applied against vaccinia virus infections.

2.15. Cardiovirus A (Encephalomyocarditis virus; EMCV) (Family: Picornaviridae)

Cardiovirus A causes encephalomyocarditis and reproductive disease in pigs. Pigs are classified as domestic hosts, although a variety of mammals can harbor the virus. It is also thought to be spread by rodents [107]. Plants reported to be effective against Cardiovirus A are listed in Table 7. In a study conducted in Brazil, the effect of ethanol extracts of plant species belonging to different genera on EMCV was investigated. Among the species used, the effect value of *Anemopaegma cetirobum, Arrabidaea brachypoda, Arrabidaea craterophora, Arrabidaea formosa* and *Stizophyllum perforatum* was reported to be EC50≤100 µg/mL [49]. In the literature search, different plant species were found to be effective against EMCV.

2.16. Coxsackie virus (Family: Picornaviridae)

Coxsackie viruses are the leading RNA viruses of aseptic meningitis. It shows features similar to polio [108]. Plant species reported to be effective against Coxsackie virus are listed in Table 8. The effect of ethanol extracts of 100 different plant species from Rwanda on Coxsackie virus was investigated. Among the species used, the viral titer reduction factors of *Acacia sieberian, Cajanus cajan, Capparis tomentosa, Clutia abyssinica, Crassocephalum multicorymbosum, Dracaena steudtner, Euphorbia granti, E. hirta, Laggera brevipes, Markhamia lutea, Plantago palmata, Polygonum pulchrum, Solanum incanum, Triumfetta rhomboide* and *Vernonia lasiopus* were reported to be between 10^3 and 10^5 [27]. In a study conducted in South Korea, many plant species were used as material and its effect on Coxsackie virus was investigated. As a result of the study, it was reported that *Raoulia australis* and *Osmunda regalis* have antiviral effects [94]. In a study conducted in Bulgaria, the effect of methanol extracts of different genera on Coxsackie virus was investigated. Among the species used, anthocyanins obtained from *Fragaria vesca, Rubus idaeus, Vaccinium myrtillis* and *V. vitis-idaea* were also reported to be antiviral supportive [76]. In a study conducted in China, the effect of different extracts of plant species used on Coxsackie virus was investigated. As a result of the study, it was reported that *Eucalyptus*

Table 8. Plants effective against Coxsackie, Semliki forest, Measles and Newcastle disease virus [27, 60, 61, 76, 94, 94, 108-115].

Virus name	Extract type	Plant species	Geographic regions
Coxsackie virus	Ethanol, essential oil, petroleum ether,ethyl acetate, aqueous, methanol	*Acacia sieberian, Allium sativum, Aloe vera, Cajanus cajan, Cannabis sativa, Capparis tomentosa, Clutia abyssinica, Crassocephalum multicorymbosum, Curcuma longa, Dracaena steudtner, Dysphania ambrosioides, Eucalyptus bicostata, Euphorbia granti, Euphorbia hirta, Fragaria vesca, Guaiacum officinale, Hibiscus sabdariffa, Laggera brevipes, Markhamia lutea, Moringa oleifera, Osmunda regalis, Petiveria alliacea, Plantago palmata, Polygonum pulchrum, Raoulia australis, Rubus idaeus, Solanum incanum, Tillandsia recurvata, Triumfetta rhomboide, Vaccinium myrtillis, Vaccinium vitis-idaea, Vernonia lasiopus, Zingiber officinale*	Rwanda, China, Jamaica, South Korea, Bulgaria
Semliki forest virus	Ethanol	*Erythrina abyssinica, Glycine javanica, Markhamia lutea*	Rwanda
Measles virus	Ethanol	*Indigofea arrecta, Solanum incanum*	Rwanda
Newcastle disease virus (NDV)	methanol, petroleum ether, chloroform	*Abutilon figarianum, Acacia nilotica, Aloe sinkitana, Aristolochia bracteolate, Avicennia marina, Caralluma retrospiciens, Cissus quadrangularis, Commiphora swynnertonii, Croton zambesicus, Diospyros mespiliformis, Harrisonia abyssinica, Ipomoea carnea, Lavandula coronopifolia, Maerua oblongifolia, Maytenus senegalensis, Nigella sativa, Prosopis chilensis, Tribulus terrestris, Trigonella foenum-graecum, Zizyphus spina-christi*	Sudan, Tanzania

bicostata and *Dysphania ambrosioides* have antiviral effects [60]. In a study conducted in Jamaica, the effect of different extracts of plant species used on Coxsackie virus was investigated. Among the species used, *Hibiscus sabdariffa, Allium sativum, Guaiacum officinale, Moringa oleifera, Curcuma longa, Zingiber officinale, Petiveria alliacea, Aloe vera, Cannabis sativa* and *Tillandsia recurvata* have been reported to have antiviral effects [61]. As seen in the literature studies, many plant species have effects against Coxsackie virus. It is thought that the plants reported in this context may be a natural agents against Coxsackie virus.

2.17. Semliki forest virus (Genus: Alphavirus)

Semliki Forest virus is an alphavirus found in central, eastern and southern Africa. It is known to cause disease in animals, especially humans. It is transmitted by mosquito bites. People usually have mild symptoms [109]. The plant species used against the Semliki forest are shown in Table 8. The effect of ethanol extracts of 100 different plant species from Rwanda on the Semliki forest was investigated. As a result of the study, the viral titer reduction factors of plant species of *Erythrina abyssinica, Glycine javanica* and *Markhamia lutea* varying between 10^3 and 10^5 have been reported [27]. According to the literature data, it is thought that the plants reported may be a source of natural agents against the Semliki Forest virus.

2.18. Measles virus (Genus: Morbillivirus)

Measles virus causes measles, a highly contagious disease transmitted by respiratory aerosols that triggers a temporary but severe immunosuppression [110]. Symptoms include fever higher than 40°C (104°F), cough, runny nose, inflammation of the eyes, erythematous rash. Also, small white spots known as Koplik spots can be seen in the mouth [111]. The virus is spread through close personal contact through coughing and sneezing, or through direct contact with secretions. Although it is usually seen as a childhood disease, it can affect people of all ages. A person usually gets the disease once in their lifetime. Vaccines are highly effective in preventing the disease [112]. Plants effective against Measles virus are listed in Table 8. The effect of ethanol extracts of 100 different plant species from Rwanda on Measles virus was investigated. Among the species used, the viral titer reduction factors of *Indigofea arrecta* and *Solanum incanum* were reported to be 10^3 [27]. In this context, it is thought that plants that are reported to be supportive of measles disease, which do not have a general treatment other than vaccine, can be used.

2.19. Newcastle disease virus (NDV) (Genus: Orthoavulavirus)

Newcastle disease virus (NDV) causes a contagious viral avian disease that affects many domestic and wild bird species [113]. It can also infect humans. Although it can infect humans, most cases are asymptomatic. Rarely, it may cause mild fever and flu-like symptoms and/or conjunctivitis. There is no known cure for NDV [114]. Plant species effective against NDV are shown in Table 8. In a study conducted in Sudan, the effect of extracts from 23 plants on NDV was investigated. Among the species used, *Abutilon figarianum, Acacia nilotica, Aloe sinkitana, Aristolochia bracteolate, Avicennia marina, Caralluma retrospiciens, Cissus quadrangularis, Croton zambesicus, Diospyros mespiliformis, Harrisonia abyssinica, Ipomoea carnea, Lavandula coronopifolia, Maerua oblongifolia, Maytenus senegalensis, Nigella sativa, Prosopis chilensis, Tribulus terrestris, Trigonella foenum-graecum* and *Zizyphus spina-christi* have been reported to have antiviral effects [84]. It has been reported that *Commiphora swynnertonii*, grown in Tanzania, has an antiviral effect on NDV [115]. In this context, it is thought that the plants reported in the literature can be used as a natural source against NDV.

2.20. Coronavirus (Family: Coronaviridae)

Diseases in both birds and mammals may be caused by coronaviruses, which are RNA viruses. Some of them, such as MERS-CoV, SARS-CoV, and COVID-19 (SARS-CoV 2), might induce potentially fatal respiratory tract infections in humans [116, 117]. In 2019, researchers identified a novel coronavirus they call SARS-CoV-2 or Covid-19. High

Table 9. Plants effective against coronavirus [42,61,68, 116-135].

Virus name	Extract type	Plant species	Geographic regions
Coronavirus	essential oil, aqueous, methanol, ethyl acetate, methanolic-aqueous, water, ethanol, crude extract	*Aegle marmelos, Aesculus hippocastanum, Allium sativum, Aloe vera, Anastatica hierochuntica, Asteriscus hierochunticus, Azadirachta indica, Bombax ceiba, Camellia sinesis, Cannabis sativa, Cenostigma pluviosum* subsp. *peltophoroides, Cinnamomum verum, Citrus reticulata, Citrus sinensis, Cupressus sempervirens, Curcuma longa, Cyperus rotundus, Echinaceae purpurea, Eucalyptus globulus, Filipendula ulmaria, Gingko biloba, Glycyrrhiza glabra, Guaiacum officinale, Hibiscus sabdariffa, Houttuynia cordata, Juniperus oxycedrus, Justicia adhatoda, Kickxia aegyptiaca, Laurus nobilis, Mentha piperita, Moringa oleifera, Morus alba* subsp. *alba, Morus alba* subsp. *rosea, Morus rubra, Nicotiana benthamiana, Ocimum basilicum, Ocimum tenuiflorum, Origanum vulgare, Panax ginseng, Petiveria alliacea, Piper longum, Piper nigrum, Pistacia palaestina, Rhodiola rosea, Salvia officinalis, Sambucus nigra, Satureja thymbra, Silybum marianum, Thuja orientalis, Thymus vulgaris, Tillandsia recurvata, Trifollium* sp., *Vitis vinifera, Withania somnifera, Zingiber officinale*	Lebanon, Jamaica, China, Belgium, India, Brazil, Tunusia, Korea, Bangladesh, Egypt, Nigeria, Iran, Italy

temperature, dry cough, weakness, trouble breathing, anosmia, and loss of taste are only few of the symptoms. On average, it takes the virus anything from one day to two weeks to become noticeable after first exposure. Mild symptoms are typical. However, it has been linked to a severe respiratory illness in a small percentage of patients. In turn, this may lead to complications including blood clots and organ failure. Transmission of SARS-CoV-2 often takes place via close contact between infected individuals [118, 119]. Several vaccines against SARS-CoV 2 have been developed. The condition may be easily recovered from with the use of supportive therapies. In this context, the plant species tested against Coronavirus are shown in Table 9.

In a study conducted in China, the effect of extracts obtained from *Trifollium* species on SARS-CoV was investigated. As a result of the study, some *Trifollium* sp. species have been reported to have a certain effect [68]. The effect of different plant species on SARS-CoV was investigated in Lebanon. As a result of the study, it was determined that *Laurus nobilis, Juniperus oxycedrus, Thuja orientalis, Cupressus sempervirens, Pistacia palaestina, Salvia officinalis* and *Satureja thymbra* showed significant effects. In addition, it has been reported that the best effect is at 120 µg/mL in *L. nobilis* species [42]. In another study conducted in China, it was reported that *Houttuynia cordata* has an effect on SARS-CoV [120]. In a study conducted in India, the effects of extracts obtained from species belonging to different genera on SARS-CoV-2 were reported. As a result of the study, it has been reported that the leaves, rhizome or bulb parts of *Justicia adhatoda, Ocimum tenuiflorum, Piper longum, Camellia sinesis* and *Zingiber officiale* can be effective [121]. In a study conducted in Tunisia, the effect of extracts obtained from different parts of species belonging to the Morus genus on human coronavirus 229E (HCoV-229E) was investigated. Of the species used, *Morus rubra, M. alba* subsp. *alba* and *M. alba* subsp. *rosea* leaves exhibited maximum antiviral activity on HCoV-229E, while the average effective concentration range was reported to be 50-200 µg/mL [122]. In a study conducted in India, the effects of components obtained from many different species on SARS-CoV-2 were examined. Among the species used, Silybin, an active ingredient in *Silybum marianum*, and withaferin A from *Withania somnifera* have been reported to have an inhibitory effect on SARS-CoV-2 [123]. In the study conducted in Jamaica, the effect on SARS-CoV was investigated by using plant extracts of different genera. Among the species used, *Hibiscus sabdariffa, Allium sativum, Guaiacum officinale, Moringa oleifera, Curcuma longa, Zingiber officinale, Petiveria alliacea, Aloe vera, Cannabis sativa* and *Tillandsia recurvata* have been reported to have antiviral effects [61]. In a study conducted in India, the effect of *Justicia adhatoda* on SARS-CoV was investigated. As a result of the study, vasicoline, vasicolinone, vasicinone, vasicine, adhatodine and anisotine alkaloids of *J. adhatoda* were obtained by certain methods and it was reported that these alkaloids have antiviral effects [124]. The effects of the components obtained from *Nicotiana benthamiana*, which was used in a study conducted in Korea, on SARS-CoV-2 were investigated. It has been reported that compounds from the *N. benthamiana* sample used induced antibodies and elicited a humoral immune response in mice, and that these antibodies potently neutralized live SARS-CoV-2 in vitro [125]. In a study conducted in Bangladesh, the effects of different extracts obtained from 46 plant species on SARS-CoV-2 were investigated. Among the species used, it has been reported that components such as curcumin, 6-gingerol, gingerononе A, hesperidin, luteolin, vitamin C, seselin, guaiol, gedunin, pongamol, azadirachtin, humulene epoxide, caryophyllene oxide, kaempferol-3-O-(6″-O-Ep-coumaroyl)-ß-D glucopyranoside, feralolide, 9-dihydroxyl-2-O-(z)-cinnamoyl-7-methoxy-aloesin, aloeresin, quercetin, catechin hydrate, kaempferol, ajoene, allicin, alliin, allyl methyl thiosulfinate, methyl allyl thiosulfinat, allitridin, diallyl sulfide, garlicin, lectin and anisotine obtained from *Justicia adhatoda, Allium sativum, Aloe vera, Bombax ceiba, Cyperus rotundus, Azadirachta indica, Piper nigrum, Aegle marmelos, Citrus sinensis, Zingiber officinale* and *Curcuma longa* have an effect on SARS-CoV-2 [126]. In a study conducted in Bangladesh, the effects of *Cannabis sativa* on SARS-CoV-2 were investigated. It has been reported that *C. sativa* used in the study suppresses viral entry and viral activation by downregulating ACE2 receptor and TMPRSS2 enzymes in the host cellular system [127]. The effects of methanol extract obtained from *Asteriscus hierochunticus* used in a study conducted in Nigeria on SARS-CoV-2 were investigated. It has been reported that the binding ability

of (-)-(2Z,6E,9E)8a-hydroxy-2,6,9-humulatrien-1(12) obtained from *A. hierochunticus* (ΔG) = 20.05-28.93 kcal/mol [128]. In a study conducted in Egypt, the effects of methanol extract obtained from different plant species on SARS-CoV-2 were examined. The effect of the preferred *Anastatica hierochuntica, Citrus reticulata* and *Kickxia aegyptiaca* species in the study was reported to be between 2.5 and 66.72 µg/mL (LC50) [129]. In another study conducted in India, the effect of a component in *Aegle marmelos* on SARS-CoV-2 was investigated. It has been reported that the seselin compound purified from the leaf extracts of *A. marmelos* has a binding energy of 6.3-6.9 kcal/mol in the spike protein S2, the main protease of COVID-19 and the free enzyme of the main protease of SARS-CoV-2 (2019-nCoV) [130]. In a study conducted in Iran, the effects of essential oils of plant species belonging to different genera on SARS-CoV-2 were evaluated. It has been reported that the compounds obtained from *Zingiber officinale, Glycyrrhiza glabra Sambucus nigra, Panax ginseng, Ocimum basilicum* and *Origanum vulgare* used in the study exhibit significant binding strength on ACE2 [131]. In a study conducted in Italy, the effect of the extract obtained from *Vitis vinifera* on SARS-CoV-2 was examined. It was reported that most of the compounds obtained from *V. vinifera* preferred in the study were quercetin derivatives, among others luteolin, kaempferol, apigenin, isorhamnetin, myricetin, chrysoeriol, biochanin, isoocanin and scutellarein. It has also been reported that this strain has the ability to inhibit SARS-CoV-2 at a very low concentration of 10 µg/mL [132]. In a study on drug development recommendations against SARS CoV-2, it was reported that Glycyrrhizin and its metabolite 18-ß-glycyrrhetinic acid and Baicalin may be useful in accelerating drug development [133]. In a study conducted in Brazil, the effect of *Cenostigma pluviosum* subsp. *peltophoroides* on SARS-CoV was investigated. It was reported that the ethyl acetate extract obtained from the plant species used was 100% effective [134]. The effect on SARS-CoV was investigated by using different plant species in Belgium. It has been reported that *Aesculus hippocastanum, Camellia sinensis, C. verum, Curcuma longa, Echinaceae purpurea, Eucalyptus globulus, Filipendula ulmaria, Gingko biloba, Glycyrrhiza glabra, Mentha piperita, Rhodiola rosea, Salvia officinalis, Thmus vulgaris* and *Zingiber officinale* act at concentrations of 3.125-50 µg/mL [135]. According to literature data, plants that are effective on Coronavirus have been determined. In this context, it is thought that these plants can be a source, especially in drug designs.

2.21. Adenovirus (ADV-3, ADV-5, ADV-8, ADV-11) (Family: Adenoviridae)

Adenoviruses are pathogens that cause diseases in humans and animals. They can cause respiratory diseases, conjunctival diseases, cystitis and sometimes gastroenteritis. Table 10 lists the plant species reported to be effective against Adenovirus. In a study conducted in Iran, it was reported that the effect of *Chelidonium majus* on ADV-5 is high [41]. In a study conducted in Brazil, the effect of ethanol extracts of *Cymbopogon citratus* and *C. nardus* on ADV-5 was investigated. At the end of the study, it was reported that the plant extracts had an effect at average concentration of 75 µg/mL [136]. In a study reported from Pakistan, it was reported that *Ocimum basilicum* had effects on ADV-3 at 74.1 and >1000 µg/mL, effects on ADV-8 at 129.6 and > 200 µg/mL and on ADV-11 at 91.9 µg/mL and 129.1 µg/mL [137]. In this context, many plants have been reported to be effective on different Adenovirus types.

2.22. Canine distemper virus (CDV) (Genus: Morbillivirus)

Canine distemper virus (CDV) is a virus that infects many mammals, including domestic and wild dog breeds, coyote, fox, panda, wolf, ferret, skunk, raccoon, and feline. Its symptoms include high fever, conjunctivitis, runny nose, shortness of breath, coughing, vomiting, diarrhea, lethargy [138]. The plants tested in the literature against CDV agents are shown in Table 10. In a study conducted in South Africa, the effects of hexane, dichloromethane, acetone and methanol extracts of *Plumbago zeylanica* and *Carissa edulis* plants on CDV were investigated. As a result of the study, it was reported that the inhibition was 50% and 75%, respectively [50]. According to literature data, herbal medicines are thought to be effective against CDV.

2.23. Lumpy skin disease virus (LSDV) (Genus: Capripoxvirus)

Lumpy skin disease virus (LSDV) is a contagious virus that causes lumpy skin disease. High fever is its typical symptom. Infected cattle may develop edematous swellings on the limbs and lameness may occur. The virus can have significant economic effects. It causes permanent damage to the skin of infected animals and the commercial value of their hides decreases. The disease can often result in chronic fatigue, decreased milk production, poor growth, infertility, miscarriage and sometimes death [139,140]. Plant species reported to be effective against LSDV are listed in Table 10. In a study conducted in South Africa, it was reported that acetone extract of *Podocarpus henkelii* had an effect on LSDV [50]. According to this data, it is thought that *P. henkelii* may contribute to reducing the effect of LSDV infections.

2.24. Enterovirus (Family: Picornaviridae)

Enterovirus is an RNA virus associated with various human and mammalian diseases that affect many people worldwide each year [141]. It is usually found in the respiratory secretions and feces of the infected person. The vast majority of patients are children younger than 5 years old. Symptoms include many different manifestations such as hand, foot and mouth disease, acute hemorrhagic conjunctivitis, aseptic meningitis, myocarditis, acute flaccid paralysis [142,143]. Treatment of enterovirus is usually supportive therapy. Studies on enterovirus are shown in Table 10. In studies conducted in South Korea and India, the effects of acetone, ethanol, aqueous, petroleum ether and ethyl acetate extracts obtained from plant samples on Enterovirus were investigated. Among the species used, *Antidesma bunius, Caseria graveolens, Cleistanthus patulus, Calycadenia oppositifolia, Hypericum gaitii, Millettia extensa, Prionium serratum, Rubus ellipticus, Ventilago maderaspatana* and *Raoulia australis* have been reported to have antiviral effects on Enterovirus [94,144]. According to the literature data, the use of plants reported in the literature may be beneficial in reducing the effects of Enterovirus.

Table 10. Plants effective against Adenovirus, Canine distemper, Lumpy skin disease and Enterovirus [41, 50, 91, 94, 136-144].

Virus name	Extract type	Plant species	Geographic regions
Adenovirus (ADV-3, ADV-5, ADV-8, ADV-11)	ethanolic-aqueous, aqueous, ethanol	*Chelidonium majus, Cymbopogon citratus, Cymbopogon nardus, Nymphea alba, Ocimum basilicum, Rhus coriaria, Terminalia chebula*	Iran, Brazil, Pakistan
Canine distemper virüs (CDV)	hexane, dichloromethane, acetone, methanol	*Carissa edulis, Podocarpus henkelii, Plumbago zeylanica*	South Africa
Lumpy skin disease virus (LSDV)	hexane, dichloromethane, acetone, methanol	*Carissa edulis, Podocarpus henkelii, Plumbago zeylanica*	South Africa
Enterovirus	acetone, ethanol, aqueous, petroleum ether, ethyl acetate	*Antidesma bunius, Caseria graveolens, Cleistanthus patulus, Calycadenia oppositifolia, Hypericum gaitii, Millettia extensa, Prionium serratum, Raoulia australis, Rubus ellipticus, Ventilago maderaspatana*	South Korea, India

2.25. Hepatitis A, B, C virus (Genus: Hepatovirus)

Hepatitis is an inflammation of the liver tissue with types A, B, C, D and E, which is marked by a yellow color in the skin and whites of the eyes [145]. In addition, loss of appetite, vomiting, fatigue, abdominal pain and diarrhea may occur. Depending on the course of the disease, it is acute if it resolves within 6 months, and chronic if it lasts longer than 6 months [146]. Acute hepatitis can resolve on its own. But chronic hepatitis can cause cirrhosis, liver failure, and liver cancer. Excessive alcohol consumption, drugs, toxins, autoimmune diseases can cause hepatitis [147,148]. Types A and E are spread through contaminated food and water. In addition, type B can be transmitted sexually, from mother to the baby during pregnancy and through infected blood. Type C is usually transmitted by blood. Type D can be transmitted to people infected with type B. A, B and D can be prevented by vaccination. Antiviral drugs are usually recommended for patients with C. Hepatitis causes more than one million deaths per year. Generally, cirrhosis and liver cancer are seen in the majority of deaths [149-151]. In our study, plants effective on hepatitis were compiled in the literature (Table 11).

In a study conducted in China, the effect of the components obtained from *Senecio* spp. on Hepatitis B was investigated. It was reported that the sesquiterpene lactone isolated at the end of the study reduced the number of virions in quantitative PCR analysis [152]. In a study conducted in South Korea, it was reported that the average effect value of *Paeonia lactiflora* species on Hepatitis B virus was between 1.0 and 8.1 µg/mL [153]. In a study conducted in Egypt, the effect of crude extract of *Dianthus caryophyllus* and *Lupinus termes* on Hepatitis A virus was investigated. At the end of the study, it was reported that the effect values were 92.6% and 93.7%, respectively [48]. In a study conducted in Pakistan, the effect of *Acacia nilotica* on Hepatitis C was examined. As a result of the study, it was reported that acetone and methanol extracts showed 50% inhibition [154]. In a study conducted in Indonesia, the effect of extracts obtained from plant species belonging to different genera on Hepatitis C was investigated. As a result of the study, it was reported that *Toona sureni, Melicope latifolia, Melanolepis multiglandulosa* and *Ficus fistulosa* have antiviral effects on HCV [155]. It has been reported that *Acanthus ilicifolius* ethanol extract, used in a study conducted in China, has an effect on hepatitis B virus [156]. In a study conducted in Sudan, the effect of different extracts obtained from 60 plant species on Hepatitis B was investigated. Among the species used, the effect values of *Guiera senegalensis, Pulicaria crispa, Coccinea grandis, Fumaria parviflora, Capparis decidua, Corallocarpus epigeus, Indigofera caerulea, Abutilon figarianum* and *Acacia oerfota* were reported to be 10.65, 14.45, 31.57, 35.44, 66.82, 71.9, 73.21, 99.76 and 101.46, respectively, as LC50 [157]. Ethanol extracts of *Hibiscus sabdariffa, Allium sativum, Guaiacum officinale, Moringa oleifera, Curcuma longa, Zingiber officinale, Petiveria alliacea, Aloe vera, Cannabis sativa* and

Table 11. Plants effective against hepatitis virus [48, 61, 91, 152-157].

Virus name	Extract type	Plant species	Geographic regions
Hepatit A virus	water, ethanol	*Dianthus caryophyllus, Lupinus termes, Origanum bastetanum, T. zygis-gracilis, Thymus longiflorus, Thymus membranaceus, Ziziphora hispanica*	Egypt, Spain
Hepatit B virus	ethyl acetate, aqueous, alcoholic, ethanol, sequential organic, dichloromethane, hexane, methanol	*Abutilon figarianum, Acacia oerfota, Acanthus ilicifolius, Allium sativum, Aloe vera, Cannabis sativa, Capparis decidua, Coccinea grandis, Corallocarpus epigeus, Curcuma longa, Fumaria parviflora, Guaiacum officinale, Guiera senegalensis, Hibiscus sabdariffa, Indigofera caerulea, Moringa oleifera, Paeonia lactiflora, Petiveria alliacea, Pulicaria crispa, Senecio* sp., *Tillandsia recurvata, Zingiber officinale*	South Korea, Jamaica, China, Sudan
Hepatitis C virus	ethanol, aqueous, acetone, methanol	*Acacia nilotica, Allium sativum, Aloe vera, Cannabis sativa, Curcuma longa, Ficus fistulosa, Guaiacum officinale, Hibiscus sabdariffa, Melanolepis multiglandulosa, Melicope latifolia, Moringa oleifera, Petiveria alliacea, Tillandsia recurvata, Toona sureni, Zingiber officinale*	Jamaica, Indonesia, Pakistan

Tillandsia recurvata have been reported to have antiviral effects on Hepatitis B virus in Jamaica. In addition, in the same study, it was reported that *Hibiscus sabdariffa, Allium sativum, Guaiacum officinale, Moringa oleifera, Curcuma longa, Zingiber officinale, Petiveria alliacea, Aloe vera, Cannabis sativa* and *Tillandsia recurvata* have antiviral effects against Hepatitis C [61]. In a study conducted in Spain, the effect of ethanolic-aqueous extract of plant species belonging to different genera on Hepatitis A virus was investigated. *Origanum bastetanum, Thymus zygis-gracilis, T. longiflorus, T. membranaceus, Ziziphora hispanica* plants have been reported to have antiviral effects [91]. According to the literature data, the plants reported can make a significant contribution in reducing the effects of Hepatitis A, B and C viruses. In this context, it is thought that the plants reported in the literature can be used against hepatitis in pharmacological designs.

3. Conclusions

The severity of viral infections' consequences for living things has been rising in recent years. The current selection of antiviral medications is woefully inadequate. This research collects information on the harmful effects of viruses on living things and the plants that may be used to counteract such effects. Studies have shown that a wide variety of plant species may serve as effective tools in the fight against and treatment of viral infections. Thus, natural remedies are being seen as the primary tool in the fight against viruses. In addition, it is very important to carry out pharmacological studies by paying attention to the synergistic effects of compounds found in plant extracts.

Author(s) contributions

Conceptualization, F.S.M and M.S.; methodology, F.S.M and M.S.; validation, I.U., F.S.M and M.S.; investigation, I.U., F.S.M and M.S.; resources, I.U., F.S.M and M.S.; data curation, I.U., F.S.M and M.S.; writing—original draft prep-aration, I.U., F.S.M and M.S.; writing—review and editing, I.U., F.S.M and M.S. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

The authors declare no conflict of interest.

References

1. Korkmaz, N.; Dayangaç, A.; Sevindik, M. Antioxidant, antimicrobial and antiproliferative activities of *Galium aparine*. *J. Fac. Pharm. Ankara*, **2021**, *45*(*3*), 554-564.
2. Unal, O.; Eraslan, E. C.; Uysal, I.; Mohammed, F. S.; Sevindik, M.; Akgul, H. Biological activities and phenolic contents of *Rumex scutatus* collected from Turkey. *Fresenius Environmental Bulletin*, **2022**, *31(7),* 7341-7346.
3. Mohammed, F. S.; Korkmaz, N.; Doğan, M.; Şabik, A. E.; Sevindik, M. Some medicinal properties of *Glycyrrhiza glabra* (Licorice). *Journal of Faculty of Pharmacy of Ankara University*, **2021**, *45(3),* 524-534.
4. Mohammed, F. S.; Akgul, H.; Sevindik, M.; Khaled, B. M. T. Phenolic content and biological activities of *Rhus coriaria* var. *zebaria*. *Fresenius Environmental Bulletin*, **2018**, *27(8),* 5694-5702.
5. Krupodorova, T.; Sevindik, M. Antioxidant potential and some mineral contents of wild edible mushroom *Ramaria stricta*. *AgroLife Scientific Journal*, **2020**, *9(1),* 186-191.
6. Mohammed, F. S.; Günal, S.; Şabik, A. E.; Akgül, H.; Sevindik, M. Antioxidant and Antimicrobial activity of *Scorzonera papposa* collected from Iraq and Turkey. *Kahramanmaraş Sütçü İmam Üniversitesi Tarım ve Doğa Dergisi*, **2020**, *23(5),* 1114-1118.
7. Mohammed, F. S.; Karakaş, M.; Akgül, H.; Sevindik, M. Medicinal properties of *Allium calocephalum* collected from Gara Mountain (Iraq). *Fresen Environ Bull*, **2019**, *28*(*10*), 7419-7426.
8. Mohammed, F. S.; Pehlivan, M.; Sevindik, E.; Akgul, H.; Sevindik, M.; Bozgeyik, I.; Yumrutas, O. Pharmacological properties of edible *Asparagus acutifolius* and *Asparagus officinalis* collected from North Iraq and Turkey (Hatay). *Acta Alimentaria*, **2021**, *50*(*1*), 136-143.
9. Ohiagu, F. O.; Chikezie, P. C.; Chikezie, C. M.; Enyoh, C. E. Anticancer activity of Nigerian medicinal plants: a review. *Future Journal of Pharmaceutical Sciences*, **2021**, *7*(*1*), 1-21.
10. Rungruang, R.; Ratanathavorn, W.; Boohuad, N.; Selamassakul, O.; Kaisangsri, N. Antioxidant and anti-aging enzyme activities of bioactive compounds isolated from selected *Zingiberaceae* plants. *Agriculture and Natural Resources*, **2021**, *55*(*1*), 153-160.
11. Saidurrahman, M.; Mujahid, M.; Siddiqui, M. A.; Alsuwayt, B.; Rahman, M. A. Evaluation of hepatoprotective activity of ethanolic extract of *Pterocarpus marsupium* Roxb. leaves against paracetamol-induced liver damage via reduction of oxidative stress. *Phytomedicine Plus*, **2022**, *2(3*), 100311.
12. Sevindik, M.; Akgul, H.; Pehlivan, M.; Selamoglu, Z. Determination of therapeutic potential of *Mentha longifolia* ssp. *longifolia*. *Fresen Environ Bull*, **2017**,*26*(*7*), 4757-4763.
13. Shahrajabian, M. H.; Sun, W.; Cheng, Q. The importance of flavonoids and phytochemicals of medicinal plants with antiviral activities. *Mini-Reviews in Organic Chemistry*, **2022**,*19*(*3*), 293-318. http://dx.doi.org/10.2174/1570178618666210707161025
14. Baba, H.; Sevindik, M.; Dogan, M.; Akgül, H. Antioxidant, antimicrobial activities and heavy metal contents of some Myxomycetes. *Fresenius Environmental Bulletin*, **2020**, *29*(*09*), 7840-7846.
15. Bal, C.; Sevindik, M.; Akgul, H.; Selamoglu, Z. Oxidative stress index and antioxidant capacity of *Lepista nuda* collected from Gaziantep/Turkey. *Sigma Journal of Engineering and Natural Sciences*, **2019**, *37*(*1*), 1-5.

16. Selamoglu, Z.; Sevindik, M.; Bal, C.; Ozaltun, B.; Sen, İ.; Pasdaran, A. Antioxidant, antimicrobial and DNA protection activities of phenolic content of *Tricholoma virgatum* (Fr.) P. Kumm. *Biointerface Research in Applied Chemistry*, **2020**, *10*(*3*), 5500-5506.

17. Mohammed, F. S.; Günal, S.; Pehlivan, M.; Doğan, M.; Sevindik, M.; Akgül, H. Phenolic content, antioxidant and antimicrobial potential of endemic *Ferulago platycarpa*. *Gazi University Journal of Science*, **2020**, *33*(*4*), 670-677.

18. Mohammed, F. S.; Kına, E.; Sevindik, M.; Doğan, M.; Pehlivan, M. Antioxidant and antimicrobial activities of ethanol extract of *Helianthemum salicifolium* (Cistaceae). *Indian Journal of Natural Products and Resources (IJNPR) [Formerly Natural Product Radiance (NPR)]*, **2021**, *12*(*3*), 459-462.

19. Saridogan, B. G. O.; Islek, C.; Baba, H.; Akata, I.; Sevindik, M. Antioxidant antimicrobial oxidant and elements contents of *Xylaria polymorpha* and *X. hypoxylon* (Xylariaceae). *Fresenius Environmental Bulletin*, **2021**, *30*(*5*), 5400-5404.

20. Eraslan, E. C.; Altuntas, D.; Baba, H.; Bal, C.; Akgül, H.; Akata, I.; Sevindik, M. Some biological activities and element contents of ethanol extract of wild edible mushroom *Morchella esculenta*. *Sigma Journal of Engineering and Natural Sciences*, **2021**, *39*(*1*), 24-28.

21. Islek, C.; Saridogan, B. G. O.; Sevindik, M.; Akata, I. Biological activities and heavy metal contents of some *Pholiota* species. *Fresenius Environmental Bulletin*, **2021**, *30*(*6*), 6109-6114.

22. Rowe, A. M.; Leger, A. S.; Jeon, S.; Dhaliwal, D. K.; Knickelbein, J. E.; Hendricks, R. L. *Herpes keratitis*. *Progress in retinal and eye research*, **2013**, *32*, 88-101.

23. Balasubramaniam, R.; Kuperstein, A. S.; Stoopler, E. T. Update on oral herpes virus infections. *Dental Clinics*, **2014**, *58*(*2*), 265-280. http://dx.doi.org/10.1016/j.cden.2013.12.001.

24. Katz, J.; Yue, S.; Xue, W. *Herpes simplex* and *Herpes zoster* viruses in COVID-19 patients. *Irish Journal of Medical Science* (1971-), **2022**, *191(3*), 1093-1097.

25. Serkedjieva, J.; Manolova, N.; Zgórniak-Nowosielska, I.; Zawilińska, B.; Grzybek, J. Antiviral activity of the infusion (SHS-174) from flowers of *Sambucus nigra* L., aerial parts of *Hypericum perforatum* L., and roots of *Saponaria officinalis* L. against influenza and *Herpes simplex* viruses. *Phytotherapy Research,***1990**, *4(3)*, 97-100. http://dx.doi.org/10.1002/ptr.2650040305.

26. Pacheco, P.; Sierra, J.; Schmeda-Hirschmann, G.; Potter, C. W.; Jones, B. M.; Moshref, M. Antiviral activity of Chilean medicinal plant extracts. *Phytotherapy Research*, **1993**,*7*(*6*), 415-418. http://dx.doi.org/10.1002/ptr.2650070606.

27. Vlietinck, A. J.; Van Hoof, L.; Totte, J.; Lasure, A.; Berghe, D. V.; Rwangabo, P. C.; Mvukiyumwami, J. Screening of hundred Rwandese medicinal plants for antimicrobial and antiviral properties. *Journal of ethnopharmacology*, **1995**, *46*(*1*), 31-47.

28. Hamidi, J. A.; Ismaili, N. H.; Ahmadi, F. B.; Lajisi, N. H. Antiviral and cytotoxic activities of some plants used in Malaysian indigenous medicine. *Pertanika J. Trop. Agric. Sci*, **1996**, *19(2/3*), 129-136.

29. Taylor, R. S. L.; Manandhar, N. P.; Hudson, J. B.; Towers, G. H. N. Antiviral activities of Nepalese medicinal plants. *Journal of ethnopharmacology*, **1996**, *52*(*3*), 157-163. http://dx.doi.org/10.1016/0378-8741(96)01409-2.

30. Abad, M. J.; Bermejo, P.; Gonzales, E.; Iglesias, I.; Irurzun, A.; Carrasco, L. Antiviral activity of Bolivian plant extracts. *General Pharmacology: The Vascular System*, **1999**, *32*(*4*), 499-503. http://dx.doi.org/10.1016/s0306-3623(98)00214-6.

31. Betancur-Galvis, L. A.; Saez, J.; Granados, H.; Salazar, A.; Ossa, J. E. Antitumor and antiviral activity of Colombian medicinal plant extracts. *Memórias do Instituto Oswaldo Cruz*, **1999**, *94*, 531-535. http://dx.doi.org/10.1590/S0074-02761999000400019.

32. Kudi, A. C.; Myint, S. H. Antiviral activity of some Nigerian medicinal plant extracts. *Journal of ethnopharmacology*, **1999**, *68(1-3*), 289-294.

33. Anani, K.; Hudson, J. B.; De Souza, C.; Akpagana, K.; Tower, G. H. N.; Arnason, J. T.; Gbeassor, M. Investigation of medicinal plants of Togo for antiviral and antimicrobial activities. *Pharmaceutical Biology*, **2000,** *38*(*1*), 40-45.

34. Hudson, J. B.; Lee, M. K.; Sener, B.; Erdemoglu, N. Antiviral activities in extracts of Turkish medicinal plants. *Pharmaceutical biology*, **2000**,*38*(*3*), 171-175. http://dx.doi.org/10.1076/1388-0209(200007)3831-SFT171.

35. Mouhajir, F.; Hudson, J. B.; Rejdali, M.; Towers, G. H. N. Multiple antiviral activities of endemic medicinal plants used by Berber peoples of Morocco. *Pharmaceutical biology*, **2001**,*39*(*5*), 364-374. http://dx.doi.org/10.1076/phbi.39.5.364.5892.

36. Rajbhandari, M.; Wegner, U.; Jülich, M.; Schoepke, T.; Mentel, R. Screening of Nepalese medicinal plants for antiviral activity. *Journal of ethnopharmacology*, **2001**, *74*(*3*), 251-255.

37. Betancur-Galvis, L. A.; Morales, G. E.; Forero, J. E.; Roldan, J. Cytotoxic and antiviral activities of Colombian medicinal plant extracts of the *Euphorbia* genus. *Memórias do Instituto Oswaldo Cruz*, **2002**, *97*, 541-546. http://dx.doi.org/10.1590/S0074-02762002000400017.

38. Montanha, J. A.; Moellerke, P.; Bordignon, S. A.; Schenkel, E. P.; Roehe, P. M. Antiviral activity of Brazilian plant extracts. *Acta farmacéutica bonaerense*, **2004**, *23*(*2*), 183-186.

39. Vijayan, P.; Raghu, C.; Ashok, G.; Dhanaraj, S. A.; Suresh, B. Antiviral activity of medicinal plants of Nilgiris. *Indian Journal of medical research*, **2004**, *120*, 24-29.

40. Mothana, R. A.; Mentel, R.; Reiss, C.; Lindequist, U. Phytochemical screening and antiviral activity of some medicinal plants from the island Soqotra. *Phytotherapy Research: an International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product*

Derivatives, **2006**, *20*(*4*), 298-302. http://dx.doi.org/10.1002/ptr.1858.

41. Monavari, H.; Hamkar, R.; Norooz-Babaei, Z.; Adibi, L.; Noroozi, M.; Ziaei, A. Antiviral effect assay of twenty five species of various medicinal plants families in Iran. *Iranian Journal of Medical Microbiology*, **2007**, *1*(*2*), 49-59.
42. Loizzo, M. R.; Saab, A. M.; Tundis, R.; Statti, G. A.; Menichini, F.; Lampronti, I.; Doerr, H. W. Phytochemical analysis and in vitro antiviral activities of the essential oils of seven Lebanon species. *Chemistry & biodiversity*, **2008**, *5*(*3*), 461-470. http://dx.doi.org/10.1002/cbdv.200890045.
43. Caamal-Herrera; I. O., Muñoz-Rodríguez, D.; Madera-Santana, T.; Azamar-Barrios, J. A. Identification of volatile compounds in essential oil and extracts of *Ocimum micranthum* Willd leaves using GC/MS. *International Journal of Applied Research in Natural Products*, **2016**, *9*(*1*), 31-40.
44. Alim, A.; Ismihan, G.; Hamdi, M. G.; Bektas, T.; Julia, S. In vitro antimicrobial and antiviral activities of the essential oil and various extracts of *Salvia cedronella* Boiss. *Journal of Medicinal Plants Research*, **2009**, *3*(*5*), 413-419. http://dx.doi.org/10.5897/JMPR.9000743.
45. Orhan, I.; Deliorman-Orhan, D.; Özçelik, B. Antiviral activity and cytotoxicity of the lipophilic extracts of various edible plants and their fatty acids. *Food chemistry*, **2009**, *115*(*2*), 701-705. http://dx.doi.org/10.1016/j.foodchem.2009.01.024.
46. Soltan, M. M.; Zaki, A. K. Antiviral screening of forty-two Egyptian medicinal plants. *Journal of ethnopharmacology*, **2009**, *126*(*1*), 102-107.
47. Vimalanathan, S.; Ignacimuthu, S.; Hudson, J. B. Medicinal plants of Tamil Nadu (Southern India) are a rich source of antiviral activities. *Pharmaceutical biology*, **2009**, *47*(*5*), 422-429. http://dx.doi.org/10.1080/13880200902800196.
48. Ahmed, B. B.; Sahar, A. S.; Omar, R. A. Antiviral activity and mode of action of *Dianthus caryophyllus* L. and *Lupinus termes* L. seed extracts against in vitro *Herpes simplex* and hepatitis A viruses infection. *Journal of Microbiology and Antimicrobials*, **2010**, *2*(*3*), 23-29. http://dx.doi.org/10.5897/JMA.9000011.
49. Brandão, G. C.; Kroon, E. G.; Dos Santos, J. R.; Stehmann, J. R.; Lombardi, J. A.; Braga de Oliveira, A. Antiviral activity of Bignoniaceae species occurring in the State of Minas Gerais (Brazil): part 1. *Letters in Applied Microbiology*, **2010**, *51*(*4*), 469-476. http://dx.doi.org/10.1111/j.1472-765X.2010.02924.x.
50. Bagla, V. P.; McGaw, L. J.; Eloff, J. N. The antiviral activity of six South African plants traditionally used against infections in ethnoveterinary medicine. *Veterinary microbiology*, **2012**, *155*(*2-4*), 198-206. http://dx.doi.org/10.1016/j.vetmic.2011.09.015.
51. Faral-Tello, P.; Mirazo, S.; Dutra, C.; Pérez, A.; Geis-Asteggiante, L.; Frabasile, S.; Arbiza, J. Cytotoxic, virucidal, and antiviral activity of South American plant and algae extracts. *The Scientific World Journal*, **2012**, (1), 174837.
52. Fernandes, M. J. B.; Barros, A. V.; Melo, M. S.; Simoni, I. C. Screening of Brazilian plants for antiviral activity against animal herpesviruses. *J Med Plants Res*, **2012**, *6*, 2261-2265. http://dx.doi.org/10.5897/JMPR10.040.
53. Tan, W. C.; Jaganath, I. B.; Manikam, R.; Sekaran, S. D. Evaluation of antiviral activities of four local Malaysian *Phyllanthus* species against *Herpes simplex* viruses and possible antiviral target. *International journal of medical sciences*, **2013**, *10*(*13*), 1817. http://dx.doi.org/10.7150/ijms.6902.
54. Visintini Jaime, M. F.; Redko, F.; Muschietti, L. V.; Campos, R. H.; Martino, V. S.; Cavallaro, L. V. In vitro antiviral activity of plant extracts from *Asteraceae* medicinal plants. *Virology journal*, **2013**, *10*(*1*), 1-10. http://dx.doi.org/10.1186/1743-422X-10-245.
55. Boligon, A. A.; Piana, M.; Kubiça, T. F.; Mario, D. N.; Dalmolin, T. V.; Bonez, P. C.; Athayde, M. L. HPLC analysis and antimicrobial, antimycobacterial and antiviral activities of Tabernaemontana catharinensis A. DC. *Journal of Applied Biomedicine*, **2015**, *13*(*1*), 7-18. http://dx.doi.org/10.1016/j.jab.2014.01.004.
56. Kendir, G.; Köroglu, A.; Özkan, S.; Özgen Özgacar, S.; Karaoglu, T.; Gargari, S. Evaluation of antiviral and antimicrobial activities of *Ribes* species growing in Turkey. *Journal of Biologically Active Products from Nature*, **2016**, *6*(*2*), 136-149. http://dx.doi.org/10.1080/22311866.2016.1202141.
57. Sharifi-Rad, J.; Iriti, M.; Setzer, W. N.; Sharifi-Rad, M.; Roointan, A.; Salehi, B. Antiviral activity of *Veronica persica* Poir. on herpes virus infection. *Cellular and Molecular Biology*, **2018**, *64*(*8*), 11-17. http://dx.doi.org/10.14715/cmb/2018.64.8.2.
58. Kutluk, I.; Aslan, M.; Orhan, I. E.; Özçelik, B. Antibacterial, antifungal and antiviral bioactivities of selected *Helichrysum* species. *South African Journal of Botany*, 2018, *119*, 252-257.
59. Marina, A. P.; Isabela, C. S.; Veronica, M. H. H.; Maria, J. B. F.; Clarice, W. A.; Juliana, R. B.; Joo, H. G. L. In vitro antiviral activity of Brazilian Cerrado plant extracts against animal and human herpesviruses. *Journal of Medicinal Plants Research*, **2018**, *12*(*10*), 106-115. http://dx.doi.org/10.5897/JMPR2018.6567.
60. Ma, L.; Yao, L. Antiviral effects of plant-derived essential oils and their components: an updated review. *Molecules*, **2020**, *25*(*11*), 2627. http://dx.doi.org/10.3390/molecules25112627.
61. Lowe, H.; Steele, B.; Bryant, J.; Fouad, E.; Toyang, N.; Ngwa, W. Antiviral activity of Jamaican medicinal plants and isolated bioactive compounds. *Molecules*, **2021**, *26*(*3*), 607. http://dx.doi.org/ 10.3390/molecules26030607.
62. Douek, D. C.; Roederer, M.; Koup, R. A. Emerging concepts in the immunopathogenesis of AIDS. *Annual review of medicine*, **2009**, *60*, 471. http://dx.doi.org/10.1146/annurev.med.60.041807.123549.

63. Powell, M. K.; Benková, K.; Selinger, P.; Dogoši, M.; Kinkorová Luňáčková, I.; Koutníková, H.; Heneberg, P. Opportunistic infections in HIV-infected patients differ strongly in frequencies and spectra between patients with low CD4+ cell counts examined postmortem and compensated patients examined antemortem irrespective of the HAART era. *PLoS One*, **2016,** *11*(*9*), e0162704.

64. Sharp, P. M.; Hahn, B. H. The evolution of HIV-1 and the origin of AIDS. *Philosophical Transactions of the Royal Society B: Biological Sciences*, **2010**, *365*(*1552*), 2487-2494.

65. Board, N. L.; Moskovljevic, M.; Wu, F.; Siliciano, R. F.; Siliciano, J. D. Engaging innate immunity in HIV-1 cure strategies. *Nature Reviews Immunology*, **2022**, *22*(*8*), 499-512. http://dx.doi.org/s41577-021-00649-1.

66. Locher, C. P.; Witvrouw, M.; De Béthune, M. P.; Burch, M. T.; Mower, H. F.; Davis, H.; Vlietinck, A. J. Antiviral activity of Hawaiian medicinal plants against human immunodeficiency virus type-1 (HIV-1). *Phytomedicine*, **1996**, *2*(*3*), 259-264.

67. Cos, P.; Hermans, N.; De Bruyne, T.; Apers, S.; Sindambiwe, J. B.; Witvrouw, M.; Vlietinck, A. J. Antiviral activity of Rwandan medicinal plants against human immunodeficiency virus type-1 (HIV-1). *Phytomedicine*, **2002**, *9*(*1*), 62-68. http://dx.doi.org/10.1078/0944-7113-00083.

68. Kotwal, G. J.; Kaczmarek, J. N.; Leivers, S.; Ghebremariam, Y. T.; Kulkarni, A. P.; Bauer, G.; Mohamed, A. R. Anti-HIV, Anti-Poxvirus, and Anti-SARS Activity of a Nontoxic, Acidic Plant Extract from the *Trifollium* Species Secomet-V/anti-Vac Suggests That It Contains a Novel Broad-Spectrum Antiviral. *Annals of the New York Academy of Sciences*, **2005**, *1056*(*1*), 293-302. http://dx.doi.org/10.1196/annals.1352.014.

69. Jayakumar, T.; Hsieh, C. Y.; Lee, J. J.; Sheu, J. R. Experimental and Clinical Pharmacology of *Andrographis paniculata* and its Major Bioactive Phytoconstituent Andrographolide. *Evid. Based Complement. Alternat Med.*, **2013**, *5*, 846740.

70. Mukherjee, H.; Ojha, D.; Bag, P.; Chandel, H. S.; Bhattacharyya, S.; Chatterjee, T.K. Anti-herpes Virus Activities of Achyranthes aspera: an Indian Ethnomedicine, and its Triterpene Acid. *Microbiol. Res.*, **2013**, *168,* 238–244.

71. Tong, S.; Zhu, X.; Li, Y.; Shi, M.; Zhang, J.; Bourgeois, M.; Donis, R. O. New world bats harbor diverse influenza A viruses. *PLoS pathogens*, **2013**, *9*(*10*), e1003657. http://dx.doi.org/10.1371/journal.ppat.1003657.

72. Dadonaite, B.; Vijayakrishnan, S.; Fodor, E.; Bhella, D.; Hutchinson, E. C. Filamentous influenza viruses. *The Journal of general virology*, **2016**, *97*(*8*), 1755. http://dx.doi.org/10.1099/jgv.0.000535.

73. Smith, D. J.; Lapedes, A. S.; De Jong, J. C.; Bestebroer, T. M.; Rimmelzwaan, G. F.; Osterhaus, A. D.; Fouchier, R. A. Mapping the antigenic and genetic evolution of influenza virus. *Science*, **2004**, *305*(*5682*), 371-376.

74. Henrickson, K. J. Parainfluenza viruses. *Clinical microbiology reviews*, **2003**, *16*(*2*), 242-264. http://dx.doi.org/10.1128/CMR.16.2.242-264.2003.

75. Tkachenko, K. G. Antiviral activity of the essential oils of some *Heracleum* L. species. *Journal of herbs, spices & medicinal plants*, **2007**, *12*(*3*), 1-12. http://dx.doi.org/10.1300/J044v12n0301.

76. Nikolaeva-Glomb, L.; Mukova, L.; Nikolova, N.; Badjakov, I.; Dincheva, I.; Kondakova, V.; Galabov, A. S. In vitro antiviral activity of a series of wild berry fruit extracts against representatives of Picorna-, Orthomyxo-and Paramyxoviridae. *Natural product communications*, **2014**, *9*(*1*), 51-54. http://dx.doi.org/10.1177/1934578X1400900116.

77. Parhira, S.; Yang, Z. F.; Zhu, G. Y.; Chen, Q. L.; Zhou, B. X.; Wang, Y. T.; Jiang, Z. H. In vitro anti-influenza virus activities of a new lignan glycoside from the latex of *Calotropis gigantea*. *PloS one*, **2014**, *9*(*8*), e104544. http://dx.doi.org/10.1371/journal.pone.0104544.

78. Fatima, M.; Sadaf Zaidi, N. U. S.; Amraiz, D.; Afzal, F. In vitro antiviral activity of *Cinnamomum cassia* and its nanoparticles against H7N3 influenza a virus. *Journal of Microbiology and Biotechnology*, **2016**, *26*(*1*), 151-159.

79. Dorra, N.; El-Berrawy, M.; Sallam, S.; Mahmoud, R. Evaluation of antiviral and antioxidant activity of selected herbal extracts. *Journal of High Institute of Public Health*, **2019**, *49*(*1*), 36-40. http://dx.doi.org/10.21608/JHIPH.2019.29464.

80. Abou Baker, D. H.; Amarowicz, R.; Kandeil, A.; Ali, M. A.; Ibrahim, E. A. Antiviral activity of *Lavandula angustifolia* L. and *Salvia officinalis* L. essential oils against avian influenza H5N1 virus. *Journal of Agriculture and Food Research*, **2021**, *4*, 100135. http://dx.doi.org/10.1016/j.jafr.2021.100135.

81. Thompson, K. M.; Kalkowska, D. A.; Badizadegan, K. Hypothetical emergence of poliovirus in 2020: part 1. Consequences of policy decisions to respond using nonpharmaceutical interventions. *Expert Review of Vaccines*, **2021**, *20*(*4*), 465-481. http://dx.doi.org/10.1080/14760584.2021.1891888.

82. Russo, G. B.; Goyal, T.; Tyler, K.; Thakur, K. T. Re-Emergence of Poliovirus in the United States: Considerations and Implications. *Annals of neurology*, **2022**, *92*(*5*), 725-728. http://dx.doi.org/10.1002/ana.26504.

83. Lévêque, N.; Semler, B. L. A. 21st century perspective of poliovirus replication. *PLoS pathogens*, **2015**, *11*(*6*), e1004825. http://dx.doi.org/10.1371/journal.ppat.1004825.

84. Mohamed, I. E. T.; El Nur, E. B. E. S.; Abdelrahman, M. E. N. The antibacterial, antiviral activities and phytochemical screening of some Sudanese medicinal plants. *EurAsian Journal of BioSciences*, **2010**, *4*, 8-16. http://dx.doi.org/10.5053/ejobios.2010.4.0.2.

85. Bertol, J. W.; Santos, P. R.; Rodrigues, J.; Cortez, D. A.; D Filho, B. P.; Nakamura, C. V.; Ueda-Nakamura, T. Antiviral activity of fractions from leaves of *Piper regnelli* var. *pallescens*. *Revista Brasileira de*

Farmacognosia, **2012**, *22*, 1290-1294. http://dx.doi.org/10.1590/S0102-695X2012005000110.

86. Cortez, V.; Meliopoulos, V. A.; Karlsson, E. A.; Hargest, V.; Johnson, C.; Schultz-Cherry, S. Astrovirus biology and pathogenesis. *Annual review of virology*, **2017**, *4*, 327-348. http://dx.doi.org/10.1146/annurev-virology-101416-041742.
87. Wohlgemuth, N.; Honce, R.; Schultz-Cherry, S. Astrovirus evolution and emergence. *Infection, genetics and Evolution*, **2019**,*69*, 30-37. http://dx.doi.org/10.1016/j.meegid.2019.01.009.
88. Ornoy, A.; Ergaz, Z. Parvovirus B19 infection during pregnancy and risks to the fetus. *Birth defects research*, **2017**, *109*(*5*), 311-323. http://dx.doi.org/10.1002/bdra.23588.
89. Adouchief, S.; Smura, T.; Sane, J.; Vapalahti, O.; Kurkela, S. Sindbis virus as a human pathogen—epidemiology, clinical picture and pathogenesis. *Reviews in Medical Virology*, **2016**, *26*(*4*), 221-241. http://dx.doi.org/10.1002/rmv.1876.
90. Fumian, T. M.; Tuipulotu, D. E.; Netzler, N. E.; Lun, J. H.; Russo, A. G.; Yan, G. J.; White, P. A. Potential therapeutic agents for feline calicivirus infection. *Viruses*, **2018**, *10*(*8*), 433. http://dx.doi.org/10.3390/v10080433.
91. Duque-Soto, C.; Borrás-Linares, I.; Quirantes-Piné, R.; Falcó, I.; Sánchez, G.; Segura-Carretero, A.; Lozano-Sánchez, J. Potential antioxidant and antiviral activities of hydroethanolic extracts of selected Lamiaceae species. *Foods*, **2022**, *11*(*13*), 1862. http://dx.doi.org/10.3390/foods11131862.
92. Blaas, D.; Fuchs, R. Mechanism of human rhinovirus infections. *Molecular and cellular pediatrics*, **2016**, *3*(*1*), 1-4. http://dx.doi.org/10.1186/s40348-016-0049-3.
93. To, K. K.; Yip, C. C.; Yuen, K. Y. Rhinovirus–from bench to bedside. *Journal of the Formosan Medical Association*, **2017**, *116*(*7*), 496-504. http://dx.doi.org/10.1016/j.jfma.2017.04.009.
94. Choi, H. J.; Lim, C. H.; Song, J. H.; Baek, S. H.; Kwon, D. H. Antiviral activity of raoulic acid from *Raoulia australis* against Picornaviruses. *Phytomedicine*, **2009**, *16*(*1*), 35-39. http://dx.doi.org/10.1016/j.phymed.2008.10.012.
95. Choi, H. J. Evaluation of antiviral activity of *Zanthoxylum* species against picornaviruses. *Osong Public Health and Research Perspectives*, **2016**, *7*(6), 400-403. http://dx.doi.org/10.1016/j.phrp.2016.11.003.
96. Myllynen, M.; Kazmertsuk, A.; Marjomäki, V. A novel open and infectious form of echovirus 1. Journal of Virology, **2016**, *90*(*15*), 6759-6770. http://dx.doi.org/10.1128/JVI.00342-16.
97. Broberg, E. K.; Simone, B.; Jansa, J. Upsurge in echovirus 30 detections in five EU/EEA countries, April to September, 2018. *Eurosurveillance*, **2018**, *23*(*44*), 1800537. http://dx.doi.org/10.2807/1560-7917.ES.2018.23.44.1800537.
98. Ogbole, O. O.; Akinleye, T. E.; Segun, P. A.; Faleye, T. C.; Adeniji, A. J. In vitro antiviral activity of twenty-seven medicinal plant extracts from Southwest Nigeria against three serotypes of echoviruses. *Virology journal*, **2018**, *15*(*1*), 1-8. http://dx.doi.org/10.1186/s12985-018-1022-7.
99. Crawford, S. E.; Ramani, S.; Tate, J. E.; Parashar, U. D.; Svensson, L.; Hagbom, M.; Estes, M. K. Rotavirus infection. *Nature Reviews Disease Primers*, **2017**, *3*(*1*), 1-16. http://dx.doi.org/10.1038/nrdp.2017.83.
100. Esona, M. D., Gautam, R. Rotavirus. *Clinics in laboratory medicine*, **2015**, *35*(*2*), 363-391. http://dx.doi.org/10.1016/j.cll.2015.02.012.
101. Cecílio, A. B.; de Faria, D. B.; de Carvalho Oliveira, P.; Caldas, S.; de Oliveira, D. A.; Sobral, M. E. G.; de Almeida, V. L. Screening of Brazilian medicinal plants for antiviral activity against rotavirus. *Journal of ethnopharmacology*, **2012**, *141*(*3*), 975-981. http://dx.doi.org/10.1016/j.jep.2012.03.031.
102. Petrini, S.; Iscaro, C.; Righi, C. Antibody responses to bovine alphaherpesvirus 1 (BoHV-1) in passively immunized calves. *Viruses*, **2019**, *11*(*1*), 23. http://dx.doi.org/10.3390/v11010023.
103. Ries, A. S.; Cargnelutti, J. F.; Basso, G.; Acunha, T. V.; Iglesias, B. A.; Flores, E. F.; Weiblen, R. Water-soluble tetra-cationic porphyrins display virucidal activity against *Bovine adenovirus* and *Bovine alphaherpesvirus* 1. *Photodiagnosis and Photodynamic Therapy*, **2020**, *31*, 101947.
104. Simoni, I. C.; Manha, A. P.; Sciessere, L.; Hoe, V. M.; Takinami, V. H.; Fernandes, M. J. B. Evaluation of the antiviral activity of Brazilian cerrado plants against animal viruses. *Virus Reviews & Research*, **2007**, *12*(*1-2*), 5.
105. Müller, L.; Berkeley, R.; Barr, T.; Ilett, E.; Errington-Mais, F. Past, present and future of oncolytic reovirus. *Cancers*, **2020**, *12*(*11*), 3219. http://dx.doi.org/10.3390/cancers12113219.
106. Albarnaz, J. D.; Torres, A. A.; Smith, G. L. Modulating vaccinia virus immunomodulators to improve immunological memory. *Viruses*, **2018**, *10*(*3*), 101. http://dx.doi.org/10.3390/v10030101.
107. Wei, P. H.; Wu, S. Z.; Mu, X. M.; Xu, B.; Su, Q. J.; Wei, J. L.; Xie, Z. C. Effect of alcohol extract of *Acanthus ilicifolius* L. on anti-duck hepatitis B virus and protection of liver. *Journal of ethnopharmacology*, **2015**, *160*, 1-5. http://dx.doi.org/10.1016/j.jep.2014.10.050.
108. Sin, J.; Mangale, V.; Thienphrapa, W.; Gottlieb, R. A.; Feuer, R. Recent progress in understanding coxsackievirus replication, dissemination, and pathogenesis. *Virology*, **2015**, *484*, 288-304.
109. Qian, Q.; Zhou, H.; Shu, T.; Mu, J.; Fang, Y.; Xu, J.; Zhou, X. The capsid protein of Semliki Forest virus antagonizes RNA interference in mammalian cells. *Journal of Virology*, **2020**, *94*(*3*), e01233-19. http://dx.doi.org/10.1128/JVI.01233-19.
110. Aref, S.; Bailey, K.; Fielding, A. Measles to the rescue: a review of oncolytic measles virus. *Viruses*, **2016**, 8(10), 294. http://dx.doi.org/10.3390/v8100294.
111. Mina, M. J.; Kula, T.; Leng, Y.; Li, M.; De Vries, R. D.; Knip, M.; Elledge, S. J. Measles virus infection diminishes preexisting antibodies that offer protection

from other pathogens. Science, **2019**, *366*(*6465*), 599-606. http://dx.doi.org/10.1126/science.aay6485.

112. Laksono, B. M.; de Vries, R. D.; Duprex, W. P.; de Swart, R. L. Measles pathogenesis, immune suppression and animal models. *Current Opinion in Virology*, **2020**, *41*, 31-37.

113. Burman, B.; Pesci, G.; Zamarin, D. Newcastle disease virus at the forefront of cancer immunotherapy. *Cancers*, **2020**, *12*(*12*), 3552. http://dx.doi.org/10.3390/cancers12123552.

114. Brown, V. R.; Bevins, S. N. A review of virulent Newcastle disease viruses in the United States and the role of wild birds in viral persistence and spread. *Veterinary research*, **2017**, *48*(*1*), 1-15. http://dx.doi.org/10.1186/s13567-017-0475-9.

115. Bakari, G. G.; Max, R. A.; Mdegela, R. H.; Phiri, E. C.; Mtambo, M. Antiviral activity of crude extracts from *Commiphora swynnertonii* against Newcastle disease virus in ovo. *Tropical animal health and production*, **2012**, *44*(*7*), 1389-1393. http://dx.doi.org/10.1007/s11250-012-0076-6.

116. Woo, P. C.; Huang, Y.; Lau, S. K.; Yuen, K. Y. Coronavirus genomics and bioinformatics analysis. *Viruses*, 2010, *2*(*8*), 1804-1820. http://dx.doi.org/10.3390/v2081803.

117. Liu, D. X.; Liang, J. Q.; Fung, T. S. Human coronavirus-229E,-OC43,-NL63, and-HKU1 (Coronaviridae). *Encyclopedia of virology*, **2021**, 428. http://dx.doi.org/10.1016/B978-0-12-809633-8.21501-X.

118. Hu, B.; Guo, H.; Zhou, P.; Shi, Z. L. Characteristics of SARS-CoV-2 and COVID-19. *Nature Reviews Microbiology*, **2021**, *19*(*3*), 141-154.

119. Perlman, S. Another decade, another coronavirus. *New England Journal of Medicine*, **2020**, *382*(*8*), 760-762. http://dx.doi.org/10.1056/NEJMe2001126.

120. Lau, K. M.; Lee, K. M.; Koon, C. M.; Cheung, C. S. F.; Lau, C. P.; Ho, H. M.; Fung, K. P. Immunomodulatory and anti-SARS activities of *Houttuynia cordata*. *Journal of ethnopharmacology*, **2008**, *118*(*1*), 79-85.

121. Das, M.; Banerji, A.; Cheemalapati, V. N.; Hazra, J. Antiviral Activity Of Indian Medicinal Plants: Prventive Measures For COVID-19. *Journal of Global Biosciences*, **2020**, *9*(5), 7307-7319.

122. Thabti, I.; Albert, Q.; Philippot, S.; Dupire, F.; Westerhuis, B.; Fontanay, S.; Varbanov, M. Advances on antiviral activity of *Morus* spp. plant extracts: human coronavirus and virus-related respiratory tract infections in the spotlight. *Molecules*, **2020**, *25*(*8*), 1876. http://dx.doi.org/10.3390/molecules25081876.

123. Pandit, M.; Latha, N. In silico studies reveal potential antiviral activity of phytochemicals from medicinal plants for the treatment of COVID-19 infection. *Research Square*, **2020**, 1-31. http://dx.doi.org/10.21203/rs.3.rs-22687/v1

124. Ghosh, R.; Chakraborty, A.; Biswas, A.; Chowdhuri, S. Identification of alkaloids from Justicia adhatoda as potent SARS CoV-2 main protease inhibitors: An in silico perspective. *Journal of Molecular Structure*, **2021**, *1229*, 129489.

125. Maharjan, P. M.; Cheon, J.; Jung, J.; Kim, H.; Lee, J.; Song, M.; Choe, S. Plant-expressed receptor binding domain of the SARS-CoV-2 spike protein elicits Humoral immunity in mice. *Vaccines*, **2021**, *9*(*9*), 978. http://dx.doi.org/10.3390/vaccines9090978.

126. Bachar, S. C.; Mazumder, K.; Bachar, R.; Aktar, A.; Al Mahtab, M. A review of medicinal plants with antiviral activity available in Bangladesh and mechanistic insight into their bioactive metabolites on SARS-CoV-2, HIV and HBV. *Frontiers in Pharmacology*, **2021**, *12*, 1-20. http://dx.doi.org/10.3389/fphar.2021.732891.

127. Mahmud, M. S.; Hossain, M. S.; Ahmed, A. F.; Islam, M. Z.; Sarker, M. E.; Islam, M. R. Antimicrobial and antiviral (SARS-CoV-2) potential of cannabinoids and *Cannabis sativa*: A comprehensive review. *Molecules*, **2021**, *26*(*23*), 7216. http://dx.doi.org/10.3390/molecules26237216.

128. Imieje, V. O.; Zaki, A. A.; Metwaly, A. M.; Mostafa, A. E.; Elkaeed, E. B.; Falodun, A. Comprehensive In Silico Screening of the Antiviral Potentialities of a New Humulene Glucoside from *Asteriscus hierochunticus* against SARS-CoV-2. *Journal of Chemistry*, **2021**, http://dx.doi.org/10.1155/2021/5541876.

129. Al-Karmalawy, A. A.; Farid, M. M.; Mostafa, A.; Ragheb, A. Y.; H. Mahmoud, S.; Shehata, M.; Marzouk, M. M. Naturally available flavonoid aglycones as potential antiviral drug candidates against SARS-CoV-2. *Molecules*, **2021**, *26*(*21*), 6559. http://dx.doi.org/10.3390/molecules26216559.

130. Nivetha, R.; Bhuvaragavan, S.; Muthu Kumar, T.; Ramanathan, K.; Janarthanan, S. Inhibition of multiple SARS-CoV-2 proteins by an antiviral biomolecule, seselin from Aegle marmelos deciphered using molecular docking analysis. *Journal of Biomolecular Structure and Dynamics*, **2021**, 1-12. http://dx.doi.org/10.1080/07391102.2021.1955009.

131. Fallah, M. S.; Bayati, M.; Najafi, A.; Behmard, E.; Davarpanah, S. J. Molecular docking investigation of antiviral herbal compounds as potential inhibitors of SARS-CoV-2 spike receptor. *Biointerface Research in Applied Chemistry*, **2021**, *11*(*5*), 12916-12924.

132. Zannella, C.; Giugliano, R.; Chianese, A.; Buonocore, C.; Vitale, G. A.; Sanna, G.; Franci, G. Antiviral activity of *Vitis vinifera* leaf extract against SARS-CoV-2 and HSV-1. *Viruses*, **2021**, *13*(*7*), 1263. http://dx.doi.org/10.3390/v13071263.

133. Rehman, M. F. U.; Akhter, S.; Batool, A. I.; Selamoglu, Z.; Sevindik, M.; Eman, R.; Aslam, M. Effectiveness of Natural Antioxidants against SARS-CoV-2? Insights from the In-Silico World. *Antibiotics*, **2021**, *10*(8), 1011. http://dx.doi.org/10.3390/antibiotics10081011.

134. Pattaro-Júnior, J. R.; Araújo, I. G.; Moraes, C. B.; Barbosa, C. G.; Philippsen, G. S.; Freitas-Junior, L. H.; Seixas, F. A. V. Antiviral activity of *Cenostigma pluviosum* var. *peltophoroides* extract and fractions against SARS-CoV-2. *Journal of Biomolecular Structure and Dynamics*,**2022**, 1-12. http://dx.doi.org/10.1080/07391102.2022.2120078.

135. Leka, K.; Hamann, C.; Desdemoustier, P.; Frédérich, M.; Garigliany, M. M.; Ledoux, A. In vitro antiviral

activity against SARS-CoV-2 of common herbal medicinal extracts and their bioactive compounds. *Phytotherapy Research*, **2022**, *36*(*8*), 3013–3015. http://dx.doi.org/10.1002/ptr.7463.

136. Chiamenti, L.; Silva, F. P. D.; Schallemberger, K.; Demoliner, M.; Rigotto, C.; Fleck, J. D. Cytotoxicity and antiviral activity evaluation of *Cymbopogon* spp hydroethanolic extracts. *Brazilian Journal of Pharmaceutical Sciences*, **2019**, *55*. http://dx.doi.org/10.1590/s2175-97902019000118063.
137. Amber, R.; Adnan, M.; Tariq, A.; Mussarat, S. A review on antiviral activity of the Himalayan medicinal plants traditionally used to treat bronchitis and related symptoms. *Journal of pharmacy and pharmacology*, **2017**, *69*(*2*), 109-122. http://dx.doi.org/10.1111/jphp.12669.
138. Costa, V. G. D.; Saivish, M. V.; Rodrigues, R. L.; Lima Silva, R. F. D.; Moreli, M. L.; Krüger, R. H. Molecular and serological surveys of canine distemper virus: A meta-analysis of cross-sectional studies. *PloS one*, **2019**, *14*(*5*), e0217594. http://dx.doi.org/10.1371/journal.pone.0217594.
139. Mulatu, E.; Feyisa, A. Review: Lumpy skin disease. *J. Vet. Sci. Technol.*, **2018**, *9*(*535*), 1-8. http://dx.doi.org/10.4172/2157-7579.1000535.
140. Gupta, T.; Patial, V.; Bali, D.; Angaria, S.; Sharma, M.; Chahota, R. A review: Lumpy skin disease and its emergence in India. *Veterinary research communications*, **2020**, *44*(*3*), 111-118.
141. Yi, E. J.; Shin, Y. J.; Kim, J. H.; Kim, T. G.; Chang, S. Y. Enterovirus 71 infection and vaccines. *Clinical and experimental vaccine research*, **2017**, *6*(*1*), 4-14. http://dx.doi.org/10.7774/cevr.2017.6.1.4.
142. Lin, J. Y.; Kung, Y. A.; Shih, S. R. Antivirals and vaccines for Enterovirus A71. *Journal of biomedical science*, **2019**, *26*(*1*), 1-10.
143. Chen, B. S.; Lee, H. C.; Lee, K. M.; Gong, Y. N.; Shih, S. R. Enterovirus and encephalitis. *Frontiers in microbiology*, **2020**, *11*, 261. http://dx.doi.org/10.3389/fmicb.2020.00261.
144. Panda, S. K.; Padhi, L.; Leyssen, P.; Liu, M.; Neyts, J.; Luyten, W. Antimicrobial, anthelmintic, and antiviral activity of plants traditionally used for treating infectious disease in the Similipal Biosphere Reserve, Odisha, India. *Frontiers in pharmacology*, **2017**, *8*, 658. http://dx.doi.org/10.3389/fphar.2017.00658.
145. Lingala, S.; Ghany, M. G. Natural history of hepatitis C. *Gastroenterology Clinics*, **2015**, *44*(*4*), 717-734.
146. Thomas, D. L. Global elimination of chronic hepatitis. *New England Journal of Medicine*, **2019,** *380*(21), 2041-2050. http://dx.doi.org/10.1056/NEJMra1810477.
147. Langer, B. C. A.; Frösner, G. G.; Von Brunn, A. Epidemiological study of viral hepatitis types A, B, C, D and E among Inuits in West Greenland. Journal of viral hepatitis, **1997**, *4*(*5*), 339-349. http://dx.doi.org/10.1046/j.1365-2893.1997.00063.x.
148. Basra, S.; Anand, B. S. Definition, epidemiology and magnitude of alcoholic hepatitis. *World journal of hepatology*, **2011**, *3*(*5*), 108. http://dx.doi.org/10.4254/wjh.v3.i5.108.
149. Alter, J.; Mast, E. E. The epidemiology of viral hepatitis in the United States. *Gastroenterology Clinics of North America*, **1994**, *23*(*3*), 437-455. http://dx.doi.org/10.1016/S0889-8553(21)00146-1.
150. Thomas, D. L.; Seeff, L. B. Natural history of hepatitis C. *Clinics in liver disease*, **2005**, *9*(3), 383-398. http://dx.doi.org/10.1016/j.cld.2005.05.003.
151. Terziroli Beretta-Piccoli, B.; Mieli-Vergani, G.; Vergani, D. Autoimmmune hepatitis. *Cellular & molecular immunology*, **2022**, *19*(*2*), 158-176. http://dx.doi.org/s41423-021-00768-8.
152. Li, H.; Zhou, C.; Zhou, L.; Chen, Z.; Yang, L.; Bai, H.; Zhao, Y. In vitro antiviral activity of three enantiomeric sesquiterpene lactones from *Senecio* species against hepatitis B virus. Antiviral Chemistry and Chemotherapy, **2005**, *16*(*4*), 277-282.
153. Lee, S. J.; Lee, H. K.; Jung, M. K.; Mar, W. In vitro antiviral activity of 1, 2, 3, 4, 6-penta-O-galloyl-β-D-glucose against hepatitis B virus. *Biological and Pharmaceutical Bulletin*, **2006**, *29*(*10*), 2131-2134. http://dx.doi.org/10.1248/bpb.29.2131.
154. Rehman, S.; Ashfaq, U. A.; Riaz, S.; Javed, T.; Riazuddin, S. Antiviral activity of *Acacia nilotica* against Hepatitis C Virus in liver infected cells. *Virology journal*, **2011**, *8*(*1*), 1-6.
155. Wahyuni, T. S.; Tumewu, L.; Permanasari, A. A.; Apriani, E.; Adianti, M.; Rahman, A.; Hotta, H. Antiviral activities of Indonesian medicinal plants in the East Java region against hepatitis C virus. *Virology journal*, **2013**, *10*(*1*), 1-9. http://dx.doi.org/10.1186/1743-422X-10-259.
156. Wei, N.; Xiong, J.; Ma, J.; Ye, J.; Si, Y.; Cao, S. Development of efficient, sensitive, and specific detection method for Encephalomyocarditis virus based on CRISPR/Cas13a. *Journal of Virological Methods*, **2022**, *309*, 114592. http://dx.doi.org/10.1016/j.jviromet.2022.114592.
157. Arbab, A. H.; Parvez, M. K.; Al-Dosari, M. S.; Al-Rehaily, A. J. In vitro evaluation of novel antiviral activities of 60 medicinal plants extracts against hepatitis B virus. *Experimental and therapeutic medicine*, **2017**, *14*(*1*), 626-634. http://dx.doi.org/10.3892/etm.2017.4530.