



PHYTOCHEMICAL VIRUCIDAL POTENTIAL OF THERAPEUTIC PLANTS INDIGENOUS TO RAJASTHAN: A REVIEW

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AUTHOR'S CONTRIBUTION

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ABSTRACT

Infectious diseases create major unavoidable, devastating and fatal conditions for all mankind. Since ancient times, Indian traditional medicinal system is utilizing the several thousands of plants for treating and to providing protection against various human ailments including various infections and epidemics. Fortunately India is enriched with multiple of plant species proven with their medicinal properties such as antiviral, antibacterial and antimicrobial properties. Researchers concluded phytochemical and pharmacological importance of these precious therapeutic properties of plants. Thorough research and experimentation on the antiviral properties of numerous plants scientifically confirmed the plants potential. The objective of this review is to summarize those plants exploring antiviral compounds activities and their therapeutic actions.

Keywords: Infections; epidemics; phytochemical; antiviral; ailments.

1. INTRODUCTION

As the whole world is passing through the century's most destructive catastrophe namely Corona virus disease (COVID-19), established as a pandemic of century proved to be fatal for millions of lives till now and still remain untreated [1]. Often viral infections show contagiousness and their transmissions rely on incubation period and the phase between contact of a virus and the appearance of its symptoms. Virus transmission may occur just by the direct contact or many other various ways and its counter resistance and remission leads to repeated infections in immune-deficient patients [2]. A large group of viruses with no proficient vaccine or specific therapy, mostly possess RNA genome which is genetically variable with quick resistant ability [3,4].

2. EPIDEMIOLOGY

In global scenario viral infections such as Variola viruses smallpox have taken approximately 300 million lives during 20th century [5] 4.2 million in 2019 due to dengue virus and 300 million from other unobvious infections. Influenza viruses also contain the ability to get mutated and convert into highly virulent new virus strains [6]. SARS-CoV, Severe acute respiratory syndrome or SARS-classic A type of corona virus out broke in 2003 and infected 8,000 people in which ten percent announced dead [7]. Another corona virus (MERS-CoV), Middle East respiratory syndrome (novel coronavirus 2012), spread in September 2012, caused the mortality of approximately 252 persons [8], then Ebola virus (EBOV) West Africa in 2014 and now Corona virus disease 2019 (COVID-19) by severe acute respiratory

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syndrome coronavirus 2 (SARS-CoV-2) Wuhan strain a new strain of Betacoronavirus found 70% genetic similar to SARS-CoV [9].

Mechanism of Antiviral Agents: Antivirals with their complex functioning are of two types

- (i) (DAAs) Directly acting antivirals i.e. they include drugs that directly affect virus-derived components including viral proteins and viral genomes act on viral polymerases and proteases
- (ii) Host acting antivirals (HAAs), are heterogeneous in nature i.e they modify the host pathways thus they affect virus life cycles and also immune response of host including antibodies, interferons and vaccines [10].

Influenza viruses possess three surface proteins including hemagglutinin (HA), neuraminidase (NA), and Matrix-2 (M2) protein. The hemagglutinin binds the influenza A virus to terminal sialic acids on host cell receptors, after which it is endocytosed through the M2 proton channel in the membrane to enter the virus, and cause the release of the virus ribonucleoprotein (RNP) which undergoes replication. The neuraminidase (NA) of virions cleave sialic acid from the cell receptors and from the glycosylated HA, to release progeny virions from the cell. M2 inhibitors block the M2 proton channel and prevent release of the virus RNP to enter in to the nucleus of cell. The NA inhibitors (NAIs) prevent release of newly synthesized virions from the host cell [11] Two major classes of antivirals available for the treatment and prevention of influenza

- 1. M2 inhibitors are active only against influenza A viruses: Except H1N1, H3N2 pandemic A

and H5N1 viruses example amantadine and rimantadine

- 2. Neuraminidase inhibitors (NAIs): zanamivir, oseltamivir, peramivir, and a long-acting NAI, laninamivir [11].

Nucleoside analogues such as acyclovir and ganciclovir have been stronghold for therapy of alphaherpesviruses (herpes simplex virus (HSV) and varicella-zoster virus (VZV)) and cytomegalovirus (CMV) infections, respectively [12].

Anti-infectious and antiviral activity have been studied in the plant extracts used as folk remedies for different kinds of ailments (Vandan et al., 1986) [13]. Traditional Indian medicinal literature have described clinical effects approximately 50 categories of drugs including anti-diarrhea, anti-haemorrhoid, anti-pyretic, anti-emetic, anti-viral, anti-inflammatory, anti-pruritic, anti-asthmatic, anti-helminthic, haemopoitic, analgesic, sedative, promoter of life (Rasyana), wound healing, destroyer of kidney stones etc [14]. The World Health Organization (WHO) has considered monetary benefits in the development of indigenous medicine and in the utilization of medicinal plants for the treating different diseases. China, India, Nigeria, the United States of America (USA) and WHO have all made substantial research investments in traditional herbal medicines [15]. The following review emphasizing over the Plants, those explore therapeutic actions for antiviral activities which are traditionally used by the people, specifically indigenous to Rajasthan, India. Plants contain a wide variety of phytochemicals, such as alkaloids, phenolic compounds, tannins, saponins, flavonoids, terpenoids, and many other bioactive components [16,17].

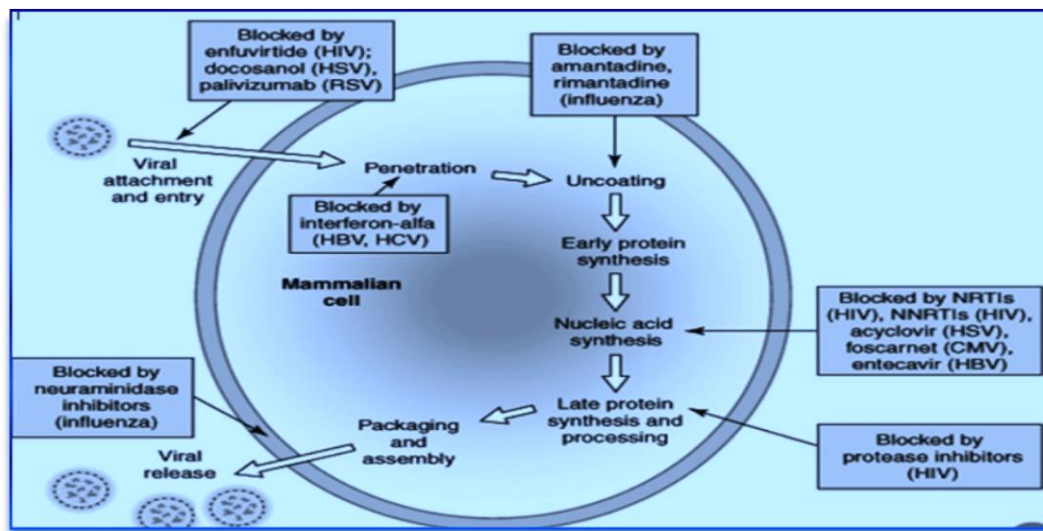
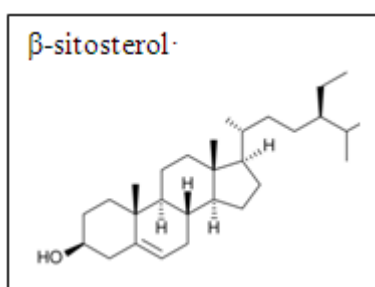


Fig. 1. Mechanism of few antiviral drugs (Saminathan, 2015)

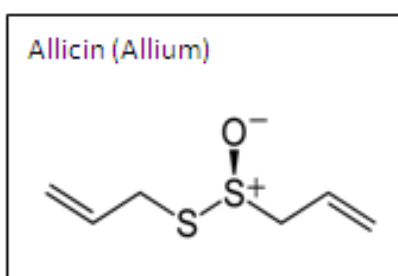
2.1 Phytochemicals for Antiviral Mechanism

***Aegle marmelos*: (Family-Rutaceae):** Indian holy tree, Bael, extract possesses a series of compounds including marmelide in its leaf and stem very efficient in antiviral mechanism against human coxsackieviruses B1-B6 strains. Marmelide, an virucidal compound present *Aegle* shows inhibitory effect at the time of viral mechanism such as adsorption, penetration and during replication [18].

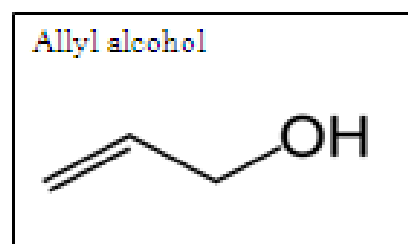
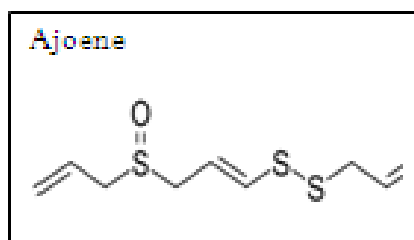
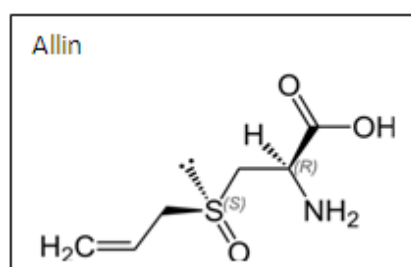
***Aerva lanata* (Family-Amaranthaceae):** *Aerva lanata* (Mountain root) grass known for hepatoprotective activity [19] as well as anti-HIV activity. The phytosterols by lowering LDL cholesterol in the cell-lines infected with HIV-1, human Cytomegalovirus (HCMV) and Herpes simplex virus (HSV) showed significant anti-infective efficacy against HIV-1 and human Cytomegalovirus (HCMV) infections [20]. HIV-1 reverse transcriptase (HIV-1RT) is an essential enzyme for the replication of HIV. The HIV reverse transcriptase inhibitory activity exist in *Aerva lanata* plant extracts [21]. *Aerva lanata* chloroform extract of root contains Phytosterols in highest concentration (91.0%) evidenced with HIV-RT (reverse transcription) inhibition at 2 mg/ml concentration when compared with control drug (AZT) showing 91.7% at 2 mg/ml [22]. Biomarker β -sitosterol is known for its antioxidant and antiviral activities, supported the anti-HBV efficacy via abating the cellular oxidative stress molecules [23].



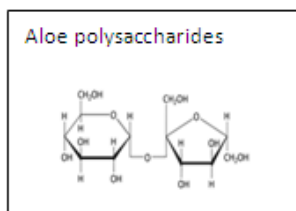
***Allium*: family-Amaryllidaceae:** *Allium* or Garlic possesses 33 sulfur compounds, multiple of enzymes, amino acids and minerals such as selenium [24].



Garlic contains an Active compound Allin sulphur exhibiting its antiviral property against influenza A and B [25]. After incorporation of oil-macerates of garlic, ajoene, allicin, allyl methyl thiosulfinate, methyl allyl thiosulfinate exhibited virucidal activity against few viruses such as herpes simplex virus (HSV) type 1 and 2, vaccinia virus, parainfluenza virus, vesicular stomatitis virus, and human rhinovirus type [26,27]. Compounds Allicin, diallyl trisulfide and ajoene are also effective for treating viral pneumonia, and rotavirus (Hughes et al., 1989), cytomegalovirus [28], HIV, rhinovirus, herpes simplex virus 1 [29], Allyl alcohol and diallyl disulfide also prove to be effective against HIV-infected cells [30]. Garlic extract's exhibits antiviral effect against influenza virus A/H1N1, Allicin diallyl trisulfide [31]. The combination of Garlic and Nilavembu also indicate antiviral property. Antiviral Effects of Garlic and Nilavembu (*Andrographis paniculata*) against Newcastle Disease Velogenic Strain (NDV) belong to poultry and cause a very high mortality [32]. The combination of both onion and garlic extracts indicated virus inactivity after the treatments [33] Infectious bronchitis (IB), disease emerged in U.S. and Iran during 1931 caused by Corona virus or IBV (Infectious bronchitis virus) it was similar to that coronaviruses diseases like SARS and MERS. *Allium sativum* (Garlic) extract on IBV exhibited antiviral activity [34].



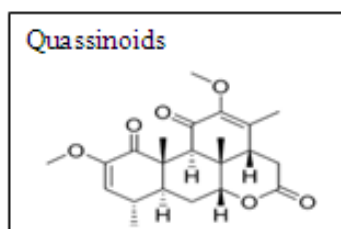
Aloe (family- Asphodelaceae): Aloe is an antimicrobial, fungicidal and antiviral found efficient in wound healing and infection [35].



Thirteen compounds were isolated from both the flowers and flower- peduncles of *A. hijazensis*. *Aloe burbadensis* leaves gel portion possess immunoreactive lectins highly effective as an antiviral agent against human cytomegalo virus (Saoo et al., 2007). Aloe plant preparations reduced MS2 bacteriophage plaque, confirm antiviral activity [36]. Aloe hijazensis flowers, leaves, and roots act against haemagglutinin viruses such as Newcastle disease virus (NDV), avian influenza virus type A (AI-H5N1), avian paramyxovirus type-1 (APMV-1) and egg-drop syndrome virus (EDSV). The extract showed antiviral activity against HSV-2 not only before adsorption but after entry of virus and during viral replications [37]. Transmission electron microscopy indicated the directly interaction of polysaccharides in plant that inhibit adsorption, incubation period, replication of H1N1 influenza and lung damage of the infected mice [38,39]. Aloe polysaccharides. Crude hot glycerine extract of Aloe vera gel act against Herpes Simplex virus type 2 (HSV-2) at the time of attachment and entry of virus and also post attachment stages of replication [40].

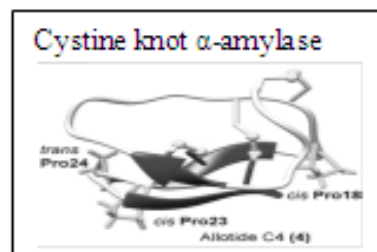
Ailanthus: (family- Simaroubaceae)

Ailanthus excels, tree of heaven bark chloroform and methanol extracts exclaimed antiviral activity against Herpes Simplex virus type 1 (HSV-1). The experiment resulted in to significant virucidal activity of plant [41] compounds such as quassinoids (highly oxygenated triterpenes) and alkaloids and compound, canthin-6-one against the disease against HIV replication in H9 lymphocytic cells., and demonstrated the highest anti-HIV activity shinjulactone C demonstrated the highest anti-HIV activity (Masayoshi et al.,2018)

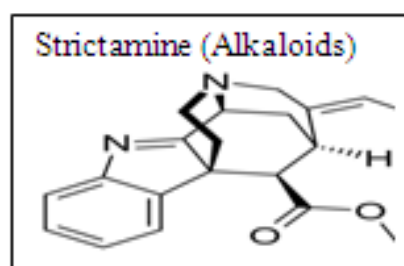


Alstonia venenata (family- Apocynaceae)

Alstonia scholaris or Devil tree dried leaves methanolic Extract showed virucidal activity due to presence of α -glucosidase [42]. Cysteine and proline-rich peptides, Cystine knot α -amylase of family Apocynaceae plants act as inhibitors display its antiviral activity. Alstotides also slow down the early phase of infectious bronchitis virus and Dengue infection due to their ability to inhibit α -amylase [43].



The 17-nor-excelsinidine and strictamine isolated from the twigs and leaves of *Alstonia scholaris* showed significant inhibitory activity against herpes simplex virus (HSV) and adenovirus (ADV) [44]. Mice infected with Coxsackie virus B2 when treated with *Alstonia scholaris* extract survived long than without being treated. The plant extract was also very effective against polio virus and Herpes Simplex pathogenic viruses. Against Hepatitis B virus ethyl acetate fraction of methanol extract of bark decreased the in Relative Fluorescence Value (RFV) value attribute to powerful antiviral activity of *Alstonia scholaris* fractions [45].



Amaranthus tricolor (family-Amaranthaceae)

Amaranthus tricolor (Amarnath), dry leaves possess highly basic glycoprotein of 27 kDa act as antiviral, and impart high level of resistance against sunnhemp rosette virus (SRV). The glycoprotein is characterized for N-glycosidase and RNase activities and N-terminal sequencing [46].

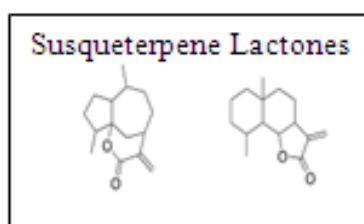
Annona (Family-Annonaceae)

Annona squamosa or srikaya seeds ethanolic extract have antiviral activity against Avian in influenzavirus

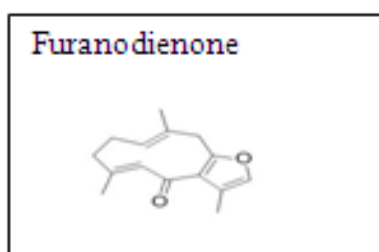
at dose of 0.35 μg / mL. The antiviral mechanism comprises inhibition of adsorption and reduction of viral replication [47].

***Commiphora* (Family-Burseraceae)**

Commiphora swynnertonii, Guggul resin, leaves, stem barks and root barks crude extracts especially that of resin from *C. swynnertonii* have strong antiviral activity against Newcastle disease (NDV) in chickens [48]. Essential oils isolated from *commiphora myrrha* after Gaschromatography-Mass spectrophotometry (GCMS) evidenced the presence of two resins compounds sesquiterpenes and sesquiterpene lactones that possess anti-inflammatory, anti-tumor activity, antibacterial and antifungal and antiviral activity in the myrrha oil [49].



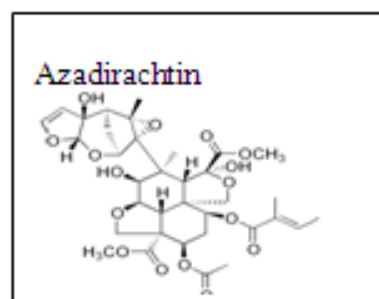
Furanodienone is commonly present in *Commiphora* and *Curcuma* extracts and is known to possess insecticidal, antimicrobial, analgesic and anti-inflammatory activities. Furanosesquiterpenes isolated from *Commiphora erythraea* act as antiviral activity [50].



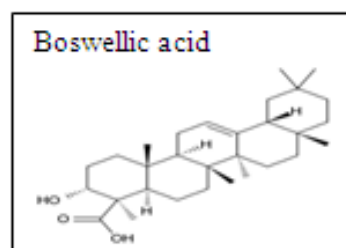
***Azadirachta indica* (family-Meliaceae)**

The antiviral and virucidal effect of methanolic extract fraction of Neem leaves (*Azadirachta indica* A. Juss) (NCL-11) examined against Coxsackie B group of viruses. NCL-11 inhibited plaque formation of Coxsackie virus B at a concentration of 1000 micrograms/ml at 96 hrs [51,52]. Efficacy of NIM-76, a spermicidal fraction from neem oil, was investigated for its antimicrobial action against certain bacteria, fungi and Polio virus as compared to whole neem oil. NIM-76 also exhibited antifungal activity against *Candida albicans* and antiviral activity against Polio virus replication in vero cell lines [53].

Polysaccharides obtained from *Azadirachta indica* act against PV-1 by inhibiting the initial stage of viral replication. Importantly, original polysaccharides showed better virucidal effect than their sulfated derivatives at all tested concentrations. This study provides a scientific basis for the past and present ethnomedical uses of this plant [54,55]. Crude aqueous extract of neem leaves and pure neem compound (Azadirachtin) reduce the replication of Dengue virus type-2 thus proves virus inhibition in dose dependent manner [56]. The pectic arabinogalactan (polysaccharide) isolated from *Azadirachta indica* and its chemically sulfated derivative of 80 kDa and is made up of (1 \rightarrow 5)-/(1 \rightarrow 3,5)-linked α -l-arabinosyl, (1 \rightarrow 3)-/(1 \rightarrow 6)-/(1 \rightarrow 3,6)-linked β -d-galactosyl, and terminal-rhamnosyl and α -l-arabinosyl residues show activity against bovine herpesvirus type-1 proves anti-herpetic activity [57]. An aqueous extract preparation from the barks of neem plant *Azadirachta indica* acts as a potent entry inhibitor against HSV-1 infection into natural target cells. The extract from neem bark significantly blocked HSV-1 entry into cells at concentrations ranging from 50 to 100 $\mu\text{g}/\text{ml}$ [58].

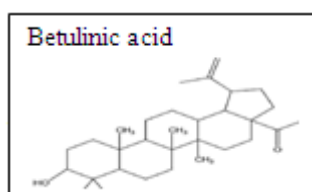


***Boswellia* (Family-Burseraceae)**



Curcumin or *Boswellia serrata* gum resin extract work against Chikungunya virus (CHIKV) causes chikungunya fever. Both compounds blocked entry of CHIKV and vesicular stomatitis virus vector particles indicating wide antiviral activity [59]. *Boswellia serrata* oleo-gum-resin possesses a strong medicinal value for skin ailments including HSV-1. Methanolic extract of *B. serrata* oleo-gum-resin (BSE) and β -boswellic acid (BA) against HSV-1 antiviral activity was assayed by reverse transcriptase-PCR (RT-PCR).

The inhibitory effect of NF- κ B, that is essential for virus replication and p38 MAP-kinase activation, with reduced expression of tumor necrosis factor (TNF)- α , Interleukin (IL)-1 β and IL-6 thus modulate NF- κ B and p38 MAPK pathway [60]. Pentacyclic triterpenoids such as betulinic acid lupeol, (BetA), asiatic acid (AA), boswellic acid (A), glycyrrhizin and 18 β -glycyrrhetic acid (GA), oleanolic acid (OA) important antiviral properties, especially anti-HIV activity thus effective for anti-HIV therapy [61] (Yi et al., 2014). The extracts of *Boswellia serrata* gum resin and its constituents, frankincense resin and boswellic acids exhibit antiviral and cytotoxicity activity [62].



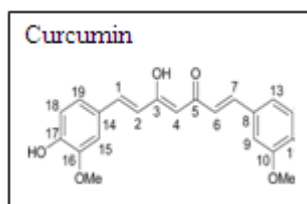
Cassia fistula (family-Fabaceae)

Cassia fistula, Amaltas holds rich medicinal properties including antiviral, antibacterial, antifungal, antineoplastic and anti inflammatory activity. *Cassia fistula* aqueous hot extract of pods and leaves inhibited bovine rhinotracheitis (IBR) virus, a kind of herpes virus in dose dependent manner [63].

Centella asiatica (family Zingiberaceae)

Centella asiatica, *Curcuma longa*, and *Strobilanthes crispus* extract show marked antiviral activity against alpha-herpesvirus (pseudorabies virus). All plant extracts showed marked virucidal ability anti-viral attachment activity. *Centella asiatica* L. and *Strobilanthes crispus* L. were seen most active as anti-viral attachment mechanism [64].

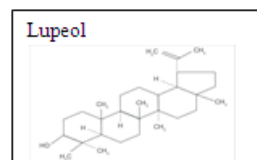
Curcuma longa (family Zingiberaceae)



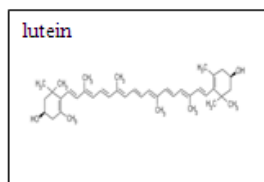
Curcuma longa (Turmeric) has been used for treating various liver diseases caused by hepatitis B virus (HBV) by inhibiting HBV replication in liver cells [65]. Curcuminoids were isolated from methanolic extract of *Curcuma longa* exhibited significant

virucidal activity against the neuraminidases of novel influenza H1N1 and oseltamivir-resistant novel H1N1 (H274Y mutant) found in 293T cells [66]. Curcumin and its new derivatives like gallium-curcumin and Cu-curcumin reduce HSV-1 replication in cell culture. Thus antiviral activity three substances including curcumin, Gallium-curcumin and Cu-curcumin was tested on HSV-1 (Zandi et al., 2007)

Cuscuta (family-Cuscutaceae)

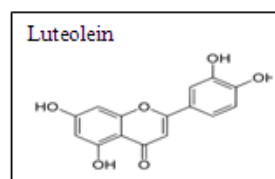


Cuscuta reflexa (Dodder) filaments, aqueous extract hold viral inhibitory response. L. P. Awasthi¹. Dried methanol extract of *O. basilicum* and *Cuscuta campestris* was found to have anti HIV-1 activity [67].

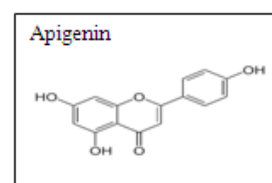


The most active fraction of *C. campestris* compounds Lupeol epoxid showed week anti HIV activity [68].

Cynodon dactylon (Family-Poaceae)

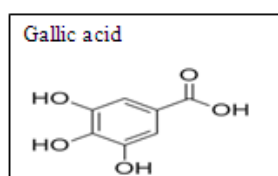


C. dactylon, Bermuda Grass exhibit antiviral activity on white spot syndrome virus (WSSV) in black tiger shrimp *Penaeus monodon* [69]. The ethanolic extract fraction of *Cynodon dactylon* is luteolin and apigenin rich specified for anti-Chikungunya potential. RT-PCR analyses indicated reduction in viral mRNA synthesis and replication in Luteolin and apigeninrich ethanolic fraction treated infected cells [70].

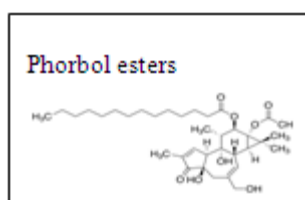


***Diospyros lotus* (Family-Ebenaceae)**

Phenolic compounds isolated from methanolic extract of *Diospyros lotus* fruits act as an important natural source of anti-retrovirals thus support AIDS therapy due to their significant anti-HIV-1 activity and low toxicity. Seven compounds myricetin, ellagic acid, gallic acid, methyl gallate, myricetin-3-O- β -glucuronide, myricetin-3-O- α -rhamnoside, and quercetin were identified. Gallic acid was the most active compound against HIV-1 [71].

***Euphorbia neriifolia* (Family-Euphorbiaceae)**

Euphorbia neriifolia, Indian Spurge leaves ethanolic extract 23 compounds were isolated, including 22 triterpenoids and one flavonoid glycoside. Triterpenoids work against the human coronavirus (HCoV) 3 β -Friedelanol compound also exhibited very potential anti-viral activity even more than the positive control, actinomycin D suggest to be used to develop as HCoV-229E drugs [72]. The Ethanolic extract of plant containing two diterpenoids euphorantins S–T and euphorneroids A–D exhibited moderate anti-HIV-1 activity. Diterpenoids present in the *Euphorbia* such as tetradecanoylphorbol-13-acetate (TPA), phorbol-12,13-didecanoate, and prostratin with anti-CHIKV activity [73].

***Ficus religiosa* (Family: Moraceae)**

Ficus religiosa leaves and fruit extracts holds anti-asthmatic potential. *Ficus religiosa* bark extracts is useful to inhibit human rhinovirus and respiratory syncytial virus infection secondary metabolites (i.e. Alkaloids, flavonoids, saponins etc.) medicinal plant products and showed its antiviral properties. Roots of *Ficus benghalensis* and *Ficus racemosa* aqueous extract exhibited in vitro antiviral activity for New castle Disease Virus (NDV) and Infectious Bursal Disease (IBD) poultry virus new effective and safe antiviral agents [74]. *Ficus religiosa* Water and

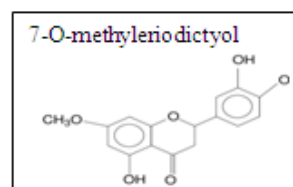
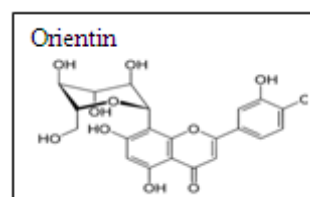
chloroform bark extracts act against herpes simplex virus type 2 (HSV-2) and also against an acyclovir drug resistant strain. Chloroform extract inhibits viral attachment, entry and the production of viral progeny (Ghosh et al.,2016).

***Mangifera indica* (family-Anacardiaceae)**

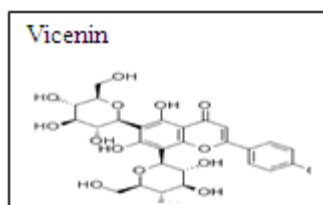
Mango possess mangiferin, a tetrahydroxy pyrrolidone saponin extracted from the leaves of (*Mangifera indica*) efficient against herpes simplex virus type 2 (HSV-2) plaque formation in HeLa cells (Zhu et al., 1993)

***Heliotropium sinuatum* (family-Heliotropiaceae)**

The natural flavonoids isolated from the resinous exudates of the plant *Heliotropium sinuatum* act against infectious salmon anemia virus (ISAV).The results show that 7-O-methylepigenetin isolated from plant inhibit (Modak et al., 2013).

***Ocimum sanctum* (family-Lamiaceae)**

Ocimum sanctum (Holy basil) is very popular for its antimicrobial properties including antiviral effects. Hot aqueous extract of *O. sanctum* leaves at 10mg/ml prevented the cytopathic effects and growth of NCD virus in chicken fibroblast monolayer infected with New Castle Disease virus [75]. *Ocimum sanctum* and *Acacia arabica* antiviral resistance was established, against endemic avian influenza H9N2 infection found in poultry [76]. Flavonoids in Methanolic extracts of *Ocimum sanctum* were assayed for the presence of Orientin and vicenin and to have scavenging activity while luteolin is known to be anti-inflammatory agent and have anti dengue activity [77]. Assessment of in vitro and in vivo activity against herpes simplex virus and other Antiviral activities of extracts and pure constituents of *Ocimum basilicum*, oleanolic acid in black (Krishna Tulasi) and green (Sri Tulasi) varieties of *Ocimum sanctum* was seen [78].



***Piper longum* (family-Piperaceae)**

A systematic bioassay of *P. nigrum* (Pipli) isolated active compounds, such as pipataline, pellitorine, sesamin, brachystamide B and guineensine. Sesamin was present in maximum quantities and brachystamide B in minimum quantity (Srinivas et al., 2006) which is supposed to be antiviral compound in many virucidal activities.

Piper longum seeds extract work against Vesicular stomatitis virus and human para influenza virus on HeLa cell lines. *Piper longum* in methanolic extract showed higher anti-viral activity than in chloroform extract against both viruses. These results suggest that piperidine present in both *Piper longum* and *Piper nigrum* have significant anti-viral and anti-cancer activity in HeLa cells [79].

***Psidium guajava* (family-Myrtaceae)**

Gas chromatography- mass spectrophotometry analysis of *P. guajava* (Guava) revealed the active elution contains active compounds such as phenol, 2,5-bis(1,1-dimethylethyl), diethyl phthalate, asarone, phthalic acid, butyldodecyl ester, phytol and 1,2-benzenedicarboxylic acid, mono(2-ethylhexyl) ester. The study revealed the possibility of developing new antiviral drugs from *P. guajava* against White spots syndrome virus (WSSV) infection (Velmurugan et al., 2012) Tea prepared from Dried leaves of green tea (*Camellia sonensis*) and of guava (*Psidium guajava* Linn.) evidenced for antiviral activity against influenza infections [80].

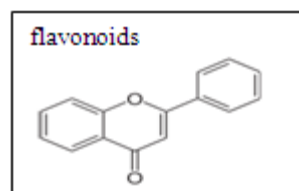
***Sterculia urens* (family-Malvaceae)**

Sterculia urens polysaccharides evaluated as virucidal and immuno-enhancement natural compound protect mice from murine cytomegalovirus and encephalomyocarditis viral infection. D. F. Smee . The antiviral activity of the effective gums was observed in dextran sulfate present in Karaya gum *Sterculia urens* exudate [81].

***Tephrosia* (family: Fabaceae)**

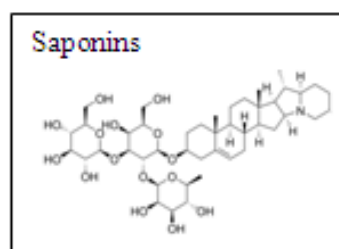
T. purpurea flowers methanol flowers extract indicate good antiviral activity due to flavonoids in HeLa cell

cultures [82]. The flavonoids compounds glabranine and 7-O-methyl-glabranine extracted from *Tephrosia* species were found effective for dengue virus inhibition [83].

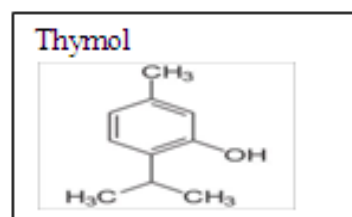


***Tribulus* (family-Zygophyllaceae)**

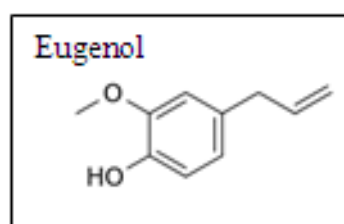
The *T. terrestris* (Gokhru) and *Y. schidigera* saponin were incorporated prior, at the time and post-infection to establish the antiviral activity. Saponin present in extract from the *T. terrestris* validated inhibition of reovirus and rotavirus infection in rhesus monkey [84].



***Syzygium aromaticum* (family- Myrtaceae)**

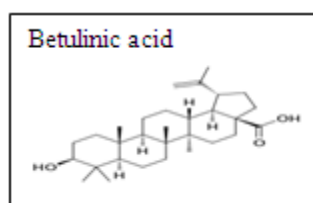


Syzygium aromaticum (clove), dried Flower buds are used as spices [85]. The main chemical constituents essential oil found in flower bud, contains phenylpropanoids such as carvacrol, thymol and eugenol. The presence of Thymol and eugenol in clove essential oil proven to be virucidal on Herpes simplex and hepatitis C viruses (Kamel et al., 2005)



Zinger officinale (family-Zingiberaceae)

Zinger officinale, Ginger Rhizomes are used as a common spices and medicine possess antiviral activity against Human respiratory syncytial virus (HRSV) infection. Fresh ginger decreased the plaque formation when given before viral inoculation and stimulated mucosal cells to secrete IFN- β to fight with viral infection [86]. It is indicated that ginger active compounds have anti- Avian influenza virus H9N2 potential [87].

Zizyphus jujube (family-Rhamnaceae)

Zizyphus jujube, (Jujube) tree is specific for its wide range of medicinal importance such as anti-inflammatory, antimalarial, antibacterial and anticancerous activities Betulinic acid, a pentacyclic triterpene present in plant showed anti-influenza activity in influenza A/PR/8 virus infected A549 cells and also significantly affected increased pulmonary necrosis and edema due to A/PR/8 virus infection in mice [88].

3. DISCUSSION

In this review, the antiviral activities from several natural products and medicines are summarized against remarkable viral pathogens including Coronavirus (CoV), Human immunodeficiency virus (HIV), hepatitis B virus (HBV), hepatitis C virus (HCV), coxsackievirus (CV), dengue virus (DENV), Herpes simplex virus (HSV), Influenza virus and Respiratory virus (RSV). Saponins, natural triterpene glycosides isolated from medicinal plants such as effectively inhibit the SARS-CoV infection, including viral attachment and penetration. Natural medicines such as *Tribulus terrestris* has been observed to exhibit several antiviral mechanisms against SARS-CoV, such as inhibiting the viral papain-like protease (P₁pro) and blocking the viral RNA-dependent RNA polymerase activity. Compounds such as apigenin, orientin and vicenin isolated from *Ocimum basilicum* have been observed for many antiviral activity against.

4. CONCLUSION

Numerous of viruses including SARS, MERS and COVID-19 still exist with no preventive cures such as

vaccines and any efficient treatment. Together with those viruses with Drug-resistant characteristics are continuously creating havoc for the society. Many natural products are pragmatically hold dynamic virucidal action and they can breakthrough to develop therapeutic derivatives for instance Allin sulphur derivatives work against influenza A and B, Allicin derivative from *Allium tuberosum* act as inhibitor for HIV, HSV-1, CMV, Triterpenoids from *Euphorbia neriifolia*, act as inhibitor of coronavirus (HCoV) Curcuminoids from *Curcuma longa* inhibit novel influenza H1N1 and its resistant virus. Several of phytochemical data are only prelude thus need to be experimented and explored to its underlying mechanisms for further authenticity of bioactive components and to develop effective antiviral treatments because various natural products combinational therapies proved to be very supportive to antiviral drug development.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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