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(REVIEW ARTICLE)

Medicinal plants with antiviral effect: A review

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Abstract

Several phytochemicals exhibited high level of antiviral activity. Medicinal plant possessed antiviral activity via many mechanisms included inhibition of viral replication, inhibition of the assembly of intracellular infectious virus particles, inhibition of viral infectivity, inhibition of RNA polymerase, DNA polymerase, viral neuraminidase, protease, reverse transcriptase and viral protein expression and many other mechanisms. The current review discuss the medicinal plants with antiviral activity with their mechanisms of action.

Keywords: Medicinal plant; Pharmacology; Antiviral; Mechanisms; Therapeutics

1. Introduction

Human viral infections are significant health problem worldwide. Natural compounds are an important source for the discovery and the development of novel antiviral drugs because of their availability and expected low side effects. Several phytochemicals exhibited high level of antiviral activity [1-5]. Medicinal plant possessed antiviral activity via many mechanisms included inhibition of viral replication, inhibition of the assembly of intracellular infectious virus particles, inhibition of viral infectivity, inhibition of RNA polymerase, DNA polymerase, viral neuraminidase, protease, reverse transcriptase and viral protein expression and many other mechanisms [6-12]. The current review was designed to highlight the medicinal plants with antiviral activity with their mechanisms of action.

2. Medicinal plants with antiviral effects

Table 1 Antiviral spectrum of medicinal plants

Medicinal plants	Active components	Antiviral spectrum	Ref.
Adiantum capillus-veneris	Ethanol extract	Vesicular stomatitis virus	13-14
Agrimonia eupatoria	Ethanolic extract	Hepatitis B virus (HBV)	17-18
Ailanthus altissima	Crude extracts and three neolignan glycosides extracted from the ethanolic extract of the root bark	Tobacco mosaic virus, Human immuno-deficiency virus 1 (HIV1), Epstein-Barr virus, Respiratory syncytial virus (RSV) and Rice stripe virus (RSV)	19-24
Allium sativum	Essential oils	Human immuno-deficiency virus 1 (HIV1) and Influenza virus	26

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	Garlic extract	Human cytomegalovirus, Influenza B, Herpes simplex virus type 1, Herpes simplex virus type 2, Parainfluenza virus type 3, Vaccinia virus, Vesicular stomatitis virus, and Human rhinovirus type 2	27-29
	Ajoene, diallyl thiosulfinate (allicin), allyl methyl thiosulfinate, methyl allyl thiosulfinate, ajoene, alliin, deoxyalliin, diallyl disulfide, and diallyl trisulfide	Herpes simplex virus type 1, Herpes simplex virus type 2, Parainfluenza virus type 3, Vaccinia virus, Vesicular stomatitis virus, and Human rhinovirus type 2	30
	Garlic extract	cytomegalovirus (HCMV)	31-36
Ammi majus	Coumarins	Herpes *simplex* virus type 1 (HSV-1) and Vesicular stomatitis virus (VSV)	37-38
Anchusa italic	Aqueous and alcoholic extract	Influenza virus	39-40
Aristolochia maurorum	Crude extracts	Herpes *simplex* virus type 1 (*HSV*-1) and adenovirus type 5	41
Asclepias curassavica	Ethanolic extract (80%) of freeze dried entire plant	Adeno virus, Coxsackie virus B2, Herpes *simplex* virus type 1, Measles, Poliovirus-1 and Semlicki forest virus	42-43
Astragalus hamosus	emodin and astragalus polysaccharide	Hepatitis B virus (HBV)	44-45
Betula alba	Betulinic acid	HIV-1NL4-3 and HIV-1JRCSF	47
	Three triterpenoids derived from the bark of *Betula alba*, betulin, betulinic acid and oleanolic acid	Vesicular stomatitis virus (VSV) and encephalomyocarditis virus (EMCV)	48
	Betulinic acid and betulin	Human Papilloma Virus (HPV)	49-50
	Bark extract	Hepatitis C virus	51-54
Caesalpinia crista	Ethanolic extract of the root and stem	Vaccinia virus	55-56
Calendula officinalis	Crude extracts of dried flowers	Human immunodeficiency virus type 1 (HIV-1)	57-58
	Chloroform extract	Human immunodeficiency virus type 1 (HIV-1)	59-60
Canna indica	A novel 10 kDa protein	Human immunodeficiency virus type 1 (HIV-1)	61-62
Capparis spinosa	methanolic extract	Herpes simplex virus type 2 (HSV-2)	63-65
Carthamus tinctorius	Hexane and ethanol fractions	Herpes simplex virus and Poliomyelitis virus	66-67
Celosia cristata	Crude leaf extract	Hepatitis B virus (HBC), Tobacco mosaic virus (TMV), Sunnhemp rosette virus (SRV) and potato virus X	69-71

Ceratopteris thalictroides	Isolated cyanovirin –N	Human immunodeficiency virus	72-73
Chenopodium album	Two proteins, CAP-I and CAP-II purified from the leaves	Tobacco mosaic virus (TMV) and sunnhemp rosette virus (SRV)	74-75
Chrysanthemum cinerariaefolium	Pyrethrins, complex esters	Herpes simplex virus (HSV)	76
Cicer arietinum	Extracts from the seed, fruit skin and aerial parts	Herpes *simplex* type 1 *(HSV*-1) and *parainfluenza-3* (*PI*-3)	77-78
Cichorium intybus	Protein extracts	Vesicular stomatitis virus	79-80
Citrus species	*Citrus aurantifolia* juice	Human immunodeficiency virus (HIV)	81
	Extracts of peels of *Citrus sinensis*	Coronavirus (CoV)	82-83
Clerodendrom inerme (*Volkameria inermis*)	Crude extracts	Hepatitis B virus	84-85
Cordia myxa	Crude extracts	Human immunodeficiency virus 1 (HIV-1)	86-87
Cuminum cyminum	Essential oils	Herpes simplex virus 1 (HSV-1)	88-89
Cupressus sempervirens	Ethanol extracts	Herpes viruses (HSV-1)	90
	A proanthocyanidin polymer fraction (MW 1500–2000 daltons)	Two retroviruses, HIV and HTLV III B	91-92
Cydonia oblonga	Fruits phenolic extract	Influenza virus	93-94
Cynodon dactylon	Crude extract	White spot syndrome virus (WSSV)	95
	Crude extract	Reproductive and respiratory syndrome virus (PRRSV)	96
	Luteolin and apigenin rich fraction from the ethanolic extract	Chikungunya virus	97-98
Cyperus rotundus	Nine eudesmane-type sesquiterpenoids and two patchoulane-type sesquiterpenoids isolated from the rhizomes	Hepatitis B virus	99-101
Dactyloctenium aegyptiacum	Extract of aerial parts	Herpes Simplex virus 1 and 2, and hepatitis A virus	102-103
Dianthus caryophyllus	Atropine	Herpes Simplex virus, Influenza virus, New Castle Disease virus, Sindbis, Vaccinia, Adenovirus and Japanese encephaitis virus	104-106
Dodonaea viscose	Crude extract	Herpes simplex virus-1 (HSV-1) and hepatitis A virus-27 (HAV-27)	107-108
	Different leaves extracts	Coxackievirus B3 (CVB3) and rotavirus SA-11 (RV SA-11)	109

Dolichos lablab (syn: *Lablab purpureus*)	Petroleum ether, chloroform and methanol 80% extracts of aerial parts	Human immunodeficiency virus-1	110-111
Equisetum arvense	Water extract of aerial parts	Human immunodeficiency virus-1	114-115
Erigeron canadensis (Syn: *Conyza canadensis*)	petroleum ether, chloroform, ethyl acetate and butanol extracts of the of aerial parts	Human cytomegalovirus (HCMV) AD-169 and Cox-B3 viruses	116-117
Erodium cicutarium	Crude extracts	Herpes virus type 1, vesicular stomatitis and vaccinia virus	118-120
Eucalyptus Species	Leaf essential oil	Rotavirus Wa strain, Coxsackievirus B4, and herpes virus type 1	121-122
	Methanolic extracts	Poliovirus type I, Coxsackievirus B and Echovirus 6	123
Euphorbia hirta (syn: *Euphorbia pilulifera*)	Aqueous and 50% methanolic extracts	HIV-1, HIV-2 and SIV (mac251)	124-125
Ficus religiosa	Water and methanol bark extract	RSV and HRV	126-127
Fraxinus ornus	Esculetin (6,7-dihydroxycoumarin)	Newcastle disease virus	128-129
Glycyrrhiza glabra	extracts and glycyrrhizic acid	Epstein-Barr virus, Herpes simplex virus, Hepatitis A virus, Hepatitis B virus, Hepatitis C virus, Human cytomegalovirus, Human immunodeficiency virus, Influenza virus, SARS coronavirus and Varicella zoster virus	130-141
	Two coumarins (glycocoumarin and licopyranocoumarin)	Human immuno-deficiency virus 1 (HIV1)	142-143
	Glycyrrhizin	Human immuno-deficiency virus 1 (HIV1)	144
	Glycyrrhizin	HSV and H5N1	145-146
Gossypium Species	Gossypol	HIV-1, HSV-2, influenza, HTLV-III B and parainfluenza	147-151
	Racemic mixture and both enantiomers of gossypol	Human immunodeficiency virus-type 1 (HIV-l)	152
	Water extracts of leaves	Yellow fever virus	153-154
Hedera helix	Extract contained the highest proportion of hedrasaponin F	Influenza A/PR/8 (PR8) virus	154-155
	Hederasaponin B	EV71 subgenotypes C3 and C4a	155-156
Hibiscus sabdariffa	Aqueous extracts	Feline calicivirus (FCV-F9), murine norovirus (MNV-1) and hepatitis A virus (HAV)	157
	Aqueous extract and its bioactive constituent protocatechuic acid	HSV-2	158
	Leaves extracts	Aichi virus (AiV)	159

	Leaves extracts	Measles virus (MV)	160-161
Hypericum triquetrifolium	essential oils	Coxsakievirus B3	162-163
Jasminum officinale	oleuropein derived from the flowers	Hepatitis B virus (HBV)	164
	8-*epi*-kingiside (8-Epik) derived from the buds	Hepatitis B virus	165-166
Jasminum sambac	hot water extract of flowers	Herpes simplex viruses (HSV-1 and HSV-2) and adenoviruses (ADV-3, ADV-8 and ADV-11)	167-168
Juglans regia	95% ethanol and ethyl acetate leaves extract	Tobacco mosaic virus and Sindbis virus	169-171
Juncus maritimus	Rhizomes extract	Hepatitis C virus	172
Lagerstroemia speciosa	The isolated orobol 7-O-d-glucoside	Human rhinovirus	173
	Quercetin 7-glucoside	Human rhinovirus 2 (HRV2)	174
	Aqueous and 50% ethanolic extracts of the leaves and stems	Human immunodeficiency virus	175
	Tannin ellagic acid	HRV-2, -3, and -4	176
Lallemantia royleana	Essential oils	Herpes simplex virus type 1 (HSV-1)	177
Lithospermum officinale	Shikonin	HIV type 1, AdV3 and HCV	178-182
Luffa cylindriica	Crude extract	Japanese B encephalitis virus	182-183
Lycium barbarum	Four sulfated polysaccharides	Newcastle disease virus	184
	Methanol extract	Hepatitis C virus (HCV)	185
Mangifera indica	Aqueous leaves extracts	Newcastle disease virus (NDV) and IBD (*Birna viridae*)	186
	Mangiferin	Herpes simplex virus type 1 and 2 (HSV 1-2)	188
Matricaria chamomilla	Essential oils	Herpes simplex virus type 2 (HSV-2)	189-191
Mirabilis jalapa	A protein isolated from the roots and leaves	Potato virus X, Potato virus Y, Potato leaf roll virus, and Potato spindle tuber viroid	192-197
	1,2,3,4-tetrahydro-1-methylisoquinoline-7,8-diol compound, isolated from the root	Human immunodeficiency virus type 1 (HIV-1)	198-199
Morus alba	Six compounds (five prenylated compounds and a simple phenolic ester) isolated from the root bark	Herpes simplex virus 1 (HSV-1) and herpes simplex virus 2 (HSV-2)	200
	Leachianone G, isolated from the root bark	Herpes simplex type 1 virus (HSV-1)	201-202
	An alkaloid extract	Avian myeloblastosis virus	203

Narcissus tazetta	A mannose-binding lectin	Human respiratory syncytial virus (RSV) and influenza A (H1N1) virus	204
	A series of Amaryllidaceae isoquinoline alkaloids (Narciclasine, lycoricidine, pancratistatin, 7-deoxy pancratistatin, and acetates 6-8, isonarciclasine, cisdihydronarciclasine, trans-dihydronarciclasine, their 7-deoxy analogues 13b-15b, lycorines and pretazettine)	Flaviviruses (Japanese encephalitis, yellow fever, and dengue viruses), Bunyaviruses (Punta Toro, sandfly fever, and Rift Valley fever viruses), alphavirus (Venezuelan equine encephalomyelitis virus), lentivirus (human immunodeficiency virus-type 1) and the DNA-containing vaccinia virus	205
	Ethanolic extract	Bovine rhinotracheitis and equine rhinopneumonitis viruses	206
	Three lectins isolated from the bulbs	Bovine immunodeficiency virus	207-209
Nerium oleander	Anvirzel™, an aqueous extract of *Nerium oleander*	Herpes simplex virus type 1, polio virus type 1 (Sb-1), vesicular stomatitis virus (VSV), reovirus type-1 (Reo-1), human immunodeficiency virus type-1 (HIV-1), and yellow fever virus (YFV)	209-211
Nicotiana tabacum	Many isolated sesquiterpenes	Tobacco mosaic virus (anti-TMV)	212-216
Ranuculus secleratus	Isolated compounds: apigenin 4'-O- alpha-rhamnopyranoside, apigenin 7- O- beta-glucopyranosyl-4'- O- alpha-rhamnopyranoside, tricin 7- O-beta-glucopyranoside, tricin, and isoscopoletin	Hepatitis B virus (HBV) and Herpes simplex virus type-1 (HSV-1)	217-218

3. Conclusion

Many traditional medicinal plants have been reported to have strong antiviral activity and some of them have already been used to treat animals and people who suffer from viral infection. Analysis of the active ingredients revealed many useful antiviral compounds. The current review was designed to highlight the medicinal plants possessed antiviral effect and their mechanisms of action.

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