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Herbal medicines for sexually transmitted diseases and AIDS

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Abstract

Sexually transmitted diseases (STDs) and acquired immunodeficiency syndrome (AIDS) are gaining significant importance at present due to rapid spread of the diseases, high cost of treatment, and the increased risk of transmission of other STDs and AIDS. Current therapies available for symptomatic treatment of STDs and AIDS are quite expensive beyond the reach of common man and are associated with emergence of drug resistance. Many patients of STDs and AIDS are seeking help from alternative systems of medicines such as Unani, Chinese, Ayurvedic, naturopathy, and homeopathy. Since a long time, medicinal plants have been used for the treatment of many infectious diseases without any scientific evidence. At present there is more emphasis on determining the scientific evidence and rationalization of the use of these preparations. Research is in progress to identify plants and their active principles possessing activity against sexually transmitted pathogens including human immunodeficiency virus (HIV) with an objective of providing an effective approach for prevention of transmission and treatment of these diseases. In the present review, plants reported to possess activity or used in traditional systems of medicine for prevention and treatment of STDs including AIDS, herbal formulations for vaginal application, and topical microbicides from herbal origin, have been discussed. © 2002 Elsevier Science Ireland Ltd. All rights reserved.

Keywords: Sexually transmitted diseases; AIDS; Vagina; Microbicides; Herbal medicine

1. Introduction

In normal healthy women, vaginal cavity is inhabited by a number of microorganisms, existing in a dynamic microenvironment. Any disturbance to this ecosystem leads to a number of infectious conditions and diseases. Sexually transmitted diseases (STDs), also known as venereal diseases are infections caused by a variety of pathogens including bacteria (*Neisseria gonorrhoea*, *Treponema pallidum*, *Haemophilus ducreyi*, *Gardnerella vaginalis*), viruses (human immunodeficiency virus (HIV), herpes simplex virus, human papilloma virus (HPV)), Chlamydia (*Chlamydia trachomatis*), and parasites (*Trichomonas vaginalis*, *Giardia lambia*) (Hardin, 1996). Acquired immunodeficiency syndrome (AIDS), genital herpes, genital warts, chlamydial genital infections, trichomoniasis, vaginitis and vulvovaginitis are some of the sexually transmitted infections (STIs). Sexual contact is the most common but not the only means of transmission of these infections. It is now well established that STDs (both ulcerative and non-ulcerative) increase the risk of transmission of other STIs, including AIDS because of changes in the normal vaginal epithelium (Wasserheit, 1992).

Current therapies for AIDS and other STDs include drug administration by various routes including oral, parenteral, and topical (vaginal and rectal). Since sexual mode of transmission is the most common cause of occurrence of STDs, vaginal and rectal approaches are becoming significant for prevention of their transmission. In the last decade, major advancements have been reported in the field of 'microbicides', i.e. compounds or formulations which when applied topically (vaginal or rectal) can prevent the transmission of STDs including AIDS (Forbes, 2000). These include a few from plant sources such as gossypol derivatives, Praneem polyherbal preparations, and plantibodies.

Medicinal plants have a long history of use and their use is widespread in both developing and developed

Abbreviations: HIV, human immunodeficiency virus; AIDS, acquired immunodeficiency syndrome; STDs, sexually transmitted diseases; HSV, herpes simplex virus; HPV, human papilloma virus.

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countries. Herbal medicines provide rational means for the treatment of many diseases that are obstinate and incurable in other systems of medicine. These are gaining popularity because of several advantages such as often fewer side effects, better patient tolerance, relatively less expensive and acceptance due to long history of use. Medicinal effects of plants tend to normalize physiological function and correct the underlying cause of the disorder (Murray and Pizzorno, 1999). Medicinal plants are renewable in nature unlike the synthetic drugs that are obtained from non-renewable sources of basic raw materials such as fossil sources and petrochemicals (Samanta et al., 2000). Cultivation and processing of plants often is environment friendly unlike the pollution by chemical industry. Cultivation of medicinal plants can also be a source of income for poor families. Many of the medicinal plants are locally available, especially in developing and underdeveloped countries. Also, plants are often less prone to the emergence of drug resistance. Due to all these advantages, plants continue to be a major source of new lead compounds.

A large number of active agents are available for the symptomatic treatment of STDs and AIDS. Emergence of drug resistant strains and dose limiting toxic effects has complicated the treatment of these infectious diseases. These complications have necessitated the search for new antimicrobial substances from various sources. Extracts of plants and phytochemicals have been shown to possess activity against sexually transmitted pathogens and may be a good source of new active agents. Several plants have been screened for activity against STDs on the basis of ethnopharmacological data (Vlietinck and Berghe, 1991; Mekkawy et al., 1995; Matsuse et al., 1999; Kambizi and Afolayan, 2001; Rajbhandari et al., 2001) and some of these screening programs have yielded potential leads.

In Europe, the use of medicinal plants for symptomatic treatment of STDs dates back at least to 1574 when 'sarsaparilla' (*Smilax officinalis*, family Liliaceae) was first introduced for the treatment of syphilis. Sarsaparilla was a better alternative to mercury, the standard medical treatment for syphilis during that period. In clinical studies, sarsaparilla was observed to be effective in about 90% cases of acute syphilis and 50% chronic cases (Murray and Pizzorno, 1999). Since then, medicinal plants have been used for the treatment of STDs and AIDS without any scientific evidence in traditional systems of medicine. In the last century enormous efforts have been made to select the plants, isolate the active principles and screen the crude extract/fractions/compounds for activity against various sexually transmitted pathogens, and elucidate their mechanism of action.

2. Acquired immunodeficiency syndrome

AIDS is a clinical syndrome resulting from infection with HIV that causes profound immunosuppression. It is a complex multifactorial disease associated with immunodeficiency and autoimmune inflammation. HIV produces gradual effects on the body's defense mechanisms thereby leading to cancers and opportunistic infections involving multiple systems of the body such as immune, gastrointestinal, genitourinary, endocrine, dermatologic, and nervous systems. Symptoms associated with AIDS include persistent fever, night sweat, weight loss (wasting syndrome), headache, lymphademopathy, skin rashes, diarrhea, thrush, recurrence of varicella zoster virus infection, Kaposi's sarcoma, *Pneumocystis carinii* pneumonia, cryptococcal meningitis, Candida esophagitis, Toxoplasma encephalitis, and disseminated atypical mycobacterial infection (Kapusnik-Uner, 1996; Murray and Pizzorno, 1999).

In Europe, herbal treatments have been considered as the most popular complementary medicine used by HIV infected individuals (Ozsoy and Ernst, 1999). Substantial amount of research has been done and a lot more is in progress to isolate the active leads from plants for prevention of transmission of HIV and treatment of AIDS. These active principles may act by different mechanisms, targeting critical steps within the replication cycle of HIV. Recently, a review (Yang et al., 2001) on natural products under development for anti-HIV activity has been published by National Cancer Institute (USA). Several natural products based anti-HIV surface-active agents, reverse transcriptase inhibitors, nonnucleoside reverse transcriptase inhibitors, integrase inhibitors and protease inhibitors have been reported. Vlietinck et al. (1998) have summarized many compounds of plant origin that inhibit HIV during various stages of life cycle. These include several alkaloids, carbohydrates, coumarins, flavonoids, lignans, phenolics, proteins, quinines/xanthones, phospholipids, tannins, and terpenes from various plants. Several studies have been conducted to screen the plants used in folk medicine for anti-HIV activity. These include plants from Panama (Matsuse et al., 1999), Indonesia (Otake et al., 1995), Egyptian folk medicine (Mekkawy et al., 1995), folk medicine of Iberian Peninsula (Bedoya et al., 2001), and Ayurvedic medicine (Kusumoto et al., 1995). Table 1 summarizes the plants that have been shown to possess activity against HIV, their active principles, the models used for anti-HIV testing, and suggested mechanisms of action.

3. Genital herpes

Genital herpes is an acute inflammatory infection caused by herpes simplex virus (HSV-1 and HSV-2).

Table 1
List of plants that possess anti-HIV activity, their active principles/extracts and mechanism of action

Species (family)	Vernacular name and traditional uses	Indigenous to	Active constituents/extracts tested	In vitro/in vivo assay model	Mechanism of action	References
Achillea millefolium	Yarrow	–	Quercetagetin	–	–	Ono et al., 1990
Alexia leiopetala Sandwith (Leguminoseae)	–	Guyana, Venezuala, Brazil, Amazon Basin	Castanospermine, 6,7 diepicastanospermine, australine, alexine	In vitro model for syncytium formation CD4+ cell line H9 infected with HIV, in vivo mice model	Interferes with syncytium formation and viral infectivity, inhibition of α-glucosidase I located in endoplasmic reticulum	Nash et al., 1988
Ancistrocladus abbreviatus (Ancistrocladaceae)	–	Cameroon	Michellamine A and B	In vitro, MT-2 and CEM-SS cell lines	Inhibits HIV-1 during early phases of viral infection of T-lymphocytes	Manfredi et al., 1991
Andrographis paniculata Nees. (Acanthaceae)	Sambiloto, kalmegh	Indonesia, India	Aqueous extract of leaves	Inhibition of HIV-1 induced cytopathogenicity in MT-4 cells	Inhibition of HIV protease and reverse transcriptase	Otake et al., 1995
Anogeissus acuminata Roxb. Ex DC. Guill. and Perr. (Combretaceae)	No known traditional uses	Bangladesh, India, Burma, Thailand, Vietnam	Anolignan A	HIV-1 reverse transcriptase assay	Inhibition of HIV -1 reverse transcriptase	Rimando et al., 1994
Areca catechu Linn. (Palmae)	Betel nut	India, Eastern Archipelago	Seed extract, procyanidins, arecatannin B1	–	HIV protease inhibition	Kusumoto et al., 1995
A. indica A. Juss. (Meliaceae)	Neem, margosa; used for antibacterial, antipyretic, and anti-inflammatory properties	India, Asia	Seed and leaf extracts	–	–	Talwar et al., 1997, 2000
Bersama abyssinica Fresen. (Melianthaceae)	Azamer, bersama, lolchisa; used in rabies, ascariasis, ulcers, diarrhoea, worm infestations, and cholera	Ethiopia	Methanol extract of leaf, methanolic and acetone extract of root bark	In vitro, inhibition of viral cytopathic effect in MT-4 cells	–	Asres et al., 2001
Buchenavia capitata Vahl Eichl. (Combretaceae)	–	Dominican Republic	*O*-dimethyl-buchenavianine	In vitro, cultured human lymphoblastoid CEM-SS cells	Inhibition of reverse transcriptase	Beutler et al., 1992
Callophyllum inophyllum Linn. (Clusiaceae)	–	Malaysia	Inophyllums coumarin derivatives	–	Inhibition of reverse transcription	Patil et al., 1993
Callophyllum lanigerum Miq. (Clusiaceae)	–	Malaysia	Calanolides coumarin derivatives	Inhibition of in vitro replication of HIV-1 and cytopathic effects in T cell lines CEM-SS and MT-2 cells	Inhibition of reverse transcription, inhibition of DNA and RNA dependent DNA polymerase activities of HIV-1 reverse transcriptase	Kashman et al., 1992; Boyer et al., 1993
Camellia sinensis Linn. (Theaceae)	Used as anti-inflammatory agent and cholerectic	China, Japan, India	Epigallocatechin gallate, epicatechin gallate	–	Inhibition of reverse transcriptase HIV-1 and HIV-2 and cellular RNA and DNA	Nakane and Ono, 1990
Canavalia ensiformis	–	–	Concanavalin A	–	Inhibition of syncytium formation	Hansen et al., 1989
Castanospermium australe (Leguminoseae)	–	–	Castanospermine	In vitro model for syncytium formation CD4+ cell line H9 infected with HIV, in vivo mice model	Interferes with syncytium formation and viral infectivity, inhibition of α-glucosidase I located in endoplasmic reticulum	Gruters et al., 1987; Sunkara et al., 1987; Nash et al., 1988; Ruprecht et al., 1989

Table 1 (*Continued*)

Species (family)	Vernacular name and traditional uses	Indigenous to	Active constituents/extracts tested	In vitro/in vivo assay model	Mechanism of action	References
Cephaelis ipecacuanha Brotero A. Richard (Rubiaceae)	Ipecac; used as emetic, expectorant, amoebicide and for treatment of gout	Brazil	Psychotrine *O*-methylpsychotrine	In vitro	Inhibition of reverse transcriptase	Tan et al., 1991
Chassalia parvifolia (Rubiaceae)	–	–	Circulin A and B	In vitro, XTT based anti-HIV assay	–	Gustafson et al., 1994
Combretum paniculatum Vent. (Combretaceae)	Baye, gabai, shaga; used for tonsillitis, cold, constipation, rheumatism, and as haemostatic	Ethiopia	Ether, dicholoromethane, acetone and methanolic extracts of leaf	In vitro, inhibition of viral cytopathic effect in MT-4 cells	–	Asres et al., 2001
Conospermum incurvum Lindley (Protreaceae)	–	Western Austarlia	Conocurvon, organic extracts of stem, twigs, leaves and flowers	In vitro, T lymphoblastic cell line infected with HIV-1 CEM-SS cells	Mechanism not fully resolved, inhibition of late phases of viral replication cycle	Decosterd et al., 1993; Dai et al., 1994
Curcuma aeruginosa Roxb. (Umbelliferae)	Temu, ireng	Indonesia	Aqueous extract of rhizome	Inhibition of HIV-1 induced cytopathogenicity in MT-4 cells	Inhibition of HIV protease and reverse transcriptase	Otake et al., 1995
C. longa Linn. (Umbelliferae)	Haldi; used as a spice, food colorant and for various medicinal purposes	India	Curcumin	In vitro integrase, *E. coli* integrase assay, HeLa H 12 cells, transactivation assay	Inhibition of HIV-1 integrase, inhibition of Tat-mediated transactivation of HIV-1 long terminal repeat	Barthelemy et al., 1998
Detarium microcarpum	–	–	Epicatechin, epicatechin-3-*O*-gallate	–	Irreversible interaction with glycoprotein gp120	Mahmood et al., 1993
Dianthus caryophyllus	–	–	Antiretroviral proteins (DAP 30 and DAP 32)	–	Ribosome inactivating protein, inhibition of transcription and transactivation	Lee-Huang et al., 1991
Dodonaea angustifolia L.f. (Sapindaceae)	Kitkita, teramin, tasos; used in wound dressing, and for treatment of skin diseases, fever, sore throat, rhinitis, sinusitis, influenza, flu, and piles	Ethiopia	Ether, dicholoromethane, acetone and methanolic extracts of leaf	–	–	Asres et al., 2001
Eugenia caryophyllata Thun. (Myrtaceae)	Clove; used as antiemetic	China	Tannins eugenin, casuarictin, tellimagrandin, chromones biflorin and isobiflorin	–	Inhibition of virus cell fusion, inhibition of syncytium formation	Kim et al., 2001
Eugenia jambolona Lam.	–	–	Extract of bark	–	HIV protease inhibition	Kusumoto et al., 1995
Euodia roxburghiana Benth. (Rutaceae)	–	Thailand, Asia, Australia	Buchapine, 3,-3-methyl-2-butenyl-4-[3-methyl-2-butenyloxy]-21H-quinolinone	In vitro, inhibition of cytopathic effect in cultured human lymphoblastoid CEM-SS cells infected with HIV-1	Inhibition of reverse transcriptase	McCormick et al., 1996
Euphorbia kansui Liou. (Euphorbiaceae)	Kansui; used for edema, asutes, and cancer	China	Ingenol, ingenol triacetate	In vitro, MT-4 and MOLT-4 cells infected with HIV-1 and HTLV-III_B	Inhibition of virus adsorption to host cells	Fujiwara et al., 1996
Euphorbia watanabei (Euphorbiaceae)	–	–	Putranjivain A	–	Inhibition of HIV reverse transcriptase	Mekkawy et al., 1995
Fagara xanthoxyloides Lam.	–	–	Fagaronine	HIV-1 reverse transcriptase inhibition assay	Inhibition of HIV reverse transcriptase	Tan, 1991

Table 1 (*Continued*)

Species (family)	Vernacular name and traditional uses	Indigenous to	Active constituents/extracts tested	In vitro/in vivo assay model	Mechanism of action	References
Galanthus nivalis (Amaryllidaceae)	Snowdrop	–	Mannose-specific agglutinines lectins	In vitro, MT-4 cells infected with HIV-1 and HIV-2	Interference with virus-cell fusion, inhibition of syncytium formation between HIV infected and uninfected cells	Balzarini et al., 1991
Gelonium multiflorum	–	–	Antiretroviral protein (GAP 31)	–	RIP, inhibition of transcription and transactivation	Lee-Huang et al., 1991
G. glabra Linn. (Leguminoseae)	Liquorice; used as demulcent and expectorant	England, Spain	Glycyrrhizin, Licochalcone A, glycocoumarin, licopyranocoumarin	HIV infected OKM-1 and MOLT-4 cells	Inhibition of giant cell formation of HIV-infected cells, interference with viral adsorption and protein kinase C	Ito et al., 1987, 1988; Hatano et al., 1988
G. radix (Leguminoseae)	–	–	Glycyrrhizin, licopyranocoumarin	–	Interference with viral cell binding	Ito et al., 1988; Balzarini et al., 1991
Gossypium spp (Malvaceae)	Cotton seed	India, East Indies, China, Egypt	Gossypol	In vitro	–	Lin et al., 1989; Polsky et al., 1989
Helicteras isora Linn.	Kiules	Indonesia	Aqueous extract of fruit	Inhibition of HIV-1 induced cytopathogenicity in MT-4 cells	Inhibition of HIV protease and reverse transcriptase	Otake et al., 1995
Hippeastrum hybrid (Amaryllidaceae)	Amaryllic	–	Mannose-specific agglutinines lectins	In vitro, MT-4 cells infected with HIV-1 and HIV-2	Interference with virus-cell fusion, inhibition of syncytium formation between HIV infected and uninfected cells	Balzarini et al., 1991
Homoalanthus nutans Forster Pax. (Euphorbiaceae)	Diverse medicinal purposes	Samoa	Prostratin (a phorbol diterpenoid)	In vitro, CEM and MT-2 cells	Mechanism not well understood, possible mechanisms are—down regulation of CD 4 expression in CEM and MT-2 cells, interference in protein kinase C enzyme pathway	Gustafson et al., 1992a
Hypericum perforatum (Hypericeae)	Saint John's wort; used in depression and mental illness	–	Hypericin and pseudohypericin	–	Interference with assembly of virions and secondary spread, interaction with proviral DNA integration, interference with viral infection, prevention of virus spreading and budding	Meruelo et al., 1988; Fanet et al., 1998; Lavie et al., 1989
Jacobinia suberecta	–	–	Moranoline	–	Inhibition of HIV reverse transcriptase	Ratner and Heyden, 1993
Lepidobotrys staudtii Engl. (Lepidobotryaceae)	–	Cameroon	1,3,4,5-tetra-*O*-galloylquinic acid	In vitro, CEM-SS cells	Inhibition of reverse transcriptase	Bokesch et al., 1996
Listera ovata (Orchidaceae)	Twayblade	–	Mannose-specific agglutinins, lectins	In vitro, MT-4 cells infected with HIV-1 and HIV-2	Interference with virus-cell fusion, inhibition of syncytium formation between HIV infected and uninfected cells	Balzarini et al., 1991

Table 1 (*Continued*)

Species (family)	Vernacular name and traditional uses	Indigenous to	Active constituents/extracts tested	In vitro/in vivo assay model	Mechanism of action	References
Loranthus parasiticus L. Merr.	Benalu teh	Indonesia	Water extract of stem and bark	HIV-1 infected MT-4 cells	Suppression of syncytium giant cell formation, protease inhibition, reverse transcriptase inhibition	Otake et al., 1995
Macaranga sinensis	–	–	Putranjivain A	–	Inhibition of HIV reverse transcriptase	Mekkawy et al., 1995
Maesa lanceolata Forsskal (Myrsinaceae)	–	–	Maesasaponins (triterpenoid saponins)	Microtray assay, colorimetric assay	–	Apers et al., 2001
Mallotus japonicum (Euphorbiaceae)	–	–	Mallotojaponin, mallatochromene	–	Inhibition of reverse transcriptase	Nakane et al., 1991
Maprounea africana Muell-Arg. (Euphorbiaceae)	–	Central African Republic, Tanzania	Triterpenes of maprounic acid/aleuritolic acid class	HIV-1 and HIV-2 reverse transcriptase inhibition assay	Inhibition of reverse transcriptase	Beutler et al., 1995; Pengsuparp et al., 1994
Momordica charantia Linn. (Cucurbitaceae)	Bitter melon, karela; used for antiviral, antitumor and immunopotentiating purposes and as hypoglycaemic	China, India	Antiretroviral protein (MAP 30)	–	Inhibition of transcription and transactivation, inhibition of viral integrase	Lee-Huang et al., 1990, 1995; Wang et al., 1999
Morus spp. (Moraceae)	–	–	Moranoline	–	Inhibition of HIV reverse transcriptase	Ratner and Heyden, 1993
Myrica rubra and *Myrica nagi* (Myriaceae)	–	–	Myricetin	–	–	Ono et al., 1990
Omphalea diandra Linn. (Euphorbiaceae)	–	Panama	Deoxynojirimicin, α-homojirimicin, 1-deoxymannojirimicin	In vitro, microtiter infection assays using MT-2 cells, syncytium inhibition assay H-9/HTLV-IIIB cell line	Inhibition of HIV infectivity by the enzymes glycosidase and mannosidase, blocks syncytium formation	Kite et al., 1988; Montefiori et al., 1988
Papaver somniferum Linn. (Papaveraceae)	Poppy, opium	India, Asia	Papaverine	–	Interference with expression of HIV proteins especially envelope precursor protein gp 120	Turano et al., 1989
Phyllanthus emblica Linn. (Euphorbiaceae)	Amla; used in jaundice and viral diseases	–	Methanol extract, Putranjivain A	Reverse transcriptase inhibition assay	Inhibition of HIV reverse transcriptase	Mekkawy et al., 1995
Phytolacca americana (Phytolaccaceae)	Poke root	–	Pokeweed antiviral protein	In vitro, acutely and chronically infected lymphocytes and macrophages	Conjugation to antibody specific to cell surface receptors anti-CD 7 which facilitate cellular internalization of antiviral protein	Uckun et al., 1998
Plumeria rubra Linn. (Apocyanaceae)	–	–	Fulvoplumierin	HIV-1 reverse transcriptase assay	Inhibition of HIV reverse transcriptase	Tan, 1991
Pothomorphe peltata L. Miq. (Piperaceae)	–	Dominican Republic	Prenylated catechol dimers, peltatols	–	–	Gustafson et al., 1992b
Psidium guajava L.	–	–	Procyanidin B2	In vitro enzyme reverse transcriptase assay	Inhibition of reverse transcriptase	Kakiuchi et al., 1991
Punica granatum Linn. (Punicaceae)	Pomegranate, anar	–	Punicacortein D, Punicalagin, Punicalin	In vitro, H-9 lymphocyte cells infected with HIV-1	Inhibition of HIV reverse transcriptase	Nonaka et al., 1990

Table 1 (*Continued*)

Species (family)	Vernacular name and traditional uses	Indigenous to	Active constituents/extracts tested	In vitro/in vivo assay model	Mechanism of action	References
Quercus myrsinaefolia, *Q. stenophylla*, *Quercus pedunculata*	–	–	Aqueous and Methanol extracts, 1,3,4-tri-*O*-galloylquinic acid, 3,4,5-Tri-*O*-galloylquinic acid	In vitro, H-9 lymphocyte cells infected with HIV-1	Inhibition of HIV reverse transcriptase and HIV cell growth	Mekkawy et al., 1995
Rauwolfia serpentina (Apocyanaceae)	Sarpgandha	India, Pakistan, Burma, Thailand, Java	Papaverine	–	–	Turano et al., 1989
Rumex cyprius (Polygonaceae)	–	–	Aqueous and Methanol extract	–	Inhibition of HIV reverse transcriptase	Mekkawy et al., 1995
S. indica Linn. (Leguminoseae)	Asoka	–	Extract of bark	–	HIV protease inhibition	Kusumoto et al., 1995
Schumanniophyton magnificum	–	–	Schumannificine	–	Irreversible binding to gp 120	Houghton et al., 1994
Sindora sumatrana Miq.	Supratul	Indonesia	Aqueous extract of fruit	Inhibition of HIV-1 induced cytopathogenicity in MT-4 cells	Inhibition of HIV protease and reverse transcriptase	Otake et al., 1995
Swertia frachetiana	–	–	Swertifrancheside	–	Inhibition of DNA polymerase activity of HIV-1 reverse transcriptase	Pengsuparp et al., 1995
Symphonia globulifera (Clusiaceae)	–	Tanzania	Guttiferone A	In vitro, CEM-SS cells	–	Gustafson et al., 1992b
Syzygium claviflorum (Myrtaceae)	–	–	Betulinic acid, Platanic acid Betulinic acid derivatives	In vitro, CEM-SS and MT-4 cells	Interference with virus-cell fusion, effect on glycoprotein gp41	Nakashima et al., 1992; Fujioka et al., 1994
Terminalia arjuna Wight et Arn. (Combretaceae)	Arjuna	–	Extract of stem bark	–	HIV protease inhibition	Kusumoto et al., 1995
Terminalia bellerica Roxb. (Combretaceae)	Bahera	–	Aqueous and methanol extracts, chebulagic acid, punicalin, punicalagin, and punicacortein	–	Inhibition of HIV reverse transcriptase, inhibition of viral adsorption to cells	Nonaka et al., 1990; Weaver et al., 1992; Mekkawy et al., 1995
T. chebula Ritz (Combretaceae)	Harida, myrobalan	–	Aqueous and methanol extracts, chebulagic acid, punicalin, punicalagin, and punicacortein	–	Inhibition of HIV reverse transcriptase, inhibition of viral adsorption to cells	Nonaka et al., 1990; Weaver et al., 1992; Mekkawy et al., 1995
Terminalia horrida Staud, (Combretaceae)	–	–	Aqueous and methanol extracts, chebulagic acid, punicalin, punicalagin, and punicacortein		Inhibition of HIV reverse transcriptase, inhibition of viral adsorption to cells	Nonaka et al., 1990; Weaver et al., 1992; Mekkawy et al., 1995
Trichosanthes kirilowii Maxim.	Used as anti-inflammatory agent and detoxifier	China	α-trichosanthin	In vitro, VB cell line, macrophage assays cells chronically infected, in vitro with exogenous virus; and cells infected in vivo i.e. culture of macrophages isolated from blood of HIV infected patients	Inhibition of transcription and transactivation	Chow et al., 1990
Urtica diocia (Urticaceae)	Stinging nettle	–	Acetylglucosamine-specific lectin	–	Interference with virus-cell fusion	Balzarini et al., 1991

Table 1 (*Continued*)

Species (family)	Vernacular name and traditional uses	Indigenous to	Active constituents/extracts tested	In vitro/in vivo assay model	Mechanism of action	References
Ximenia americana L. (Oleaceae)	Enkoi, huda, mellau; used in contagious diseases, stomach complaints, and worm infestations	Ethiopia	Methanol extract of stem bark	–	–	Asres et al., 2001
Xylopia spp. (Annonaceae)	–	Peru	Xylopinic acid	In vitro, CEM-SS cells	–	Fuller et al., 1996

Transmission of virus by direct contact of recipient's mucous membranes or skin with infected sexual partner leads to development of primary genital herpes. The primary symptoms of HSV infection include prodromal flu like syndrome with fever, headache, malaise, diffuse myalgias followed by local symptoms consisting of genital itching, tenderness, dysuria, lesions, painful papules over genital regions and ulceration (Hardin, 1996; Murray and Pizzorno, 1999).

Acyclovir is the most commonly used drug for treatment of HSV infections. A serious problem with acyclovir is the drug resistance in patients. Therefore, there is a need of developing new anti-HSV drugs. Various phytochemicals have been traditionally used for the treatment of viral infections and have been shown to possess in vitro and in vivo antiviral activity against HSV. Some of the plants reported to possess antiviral activity against HSV are summarized in Table 2.

A concentrated extract of *Melissa officinalis* (lemon balm) is one of the most widely used topical preparations in the treatment and prevention of herpes. Melissa cream had been reported to interrupt the infection, promote healing of symptoms, and prevent the recurrence of herpes (Wolbing and Leonhardt, 1994). Another popular topical preparation (Pompei et al., 1980) for preventing and treating herpes outbreaks contains glycyrrhetinic acid, a triterpenoid component of *Glycyrrhiza glabra* (liquorice root). Glycyrrhizin has been found to improve the resistance of thermally injured mice to opportunistic infection of HSV-1 through induction of CD4+ contrasupressor T cells (Utsunomiya et al., 1995).

Inhibitory effects of various Ayurvedic, Panamanian and South American medicinal plants on infection of HSV-1 have been studied (Hattori et al., 1995; Abad et al., 1999). Some of the plants found to be active against HSV-1 are *Eupatorium articulatum*, *Baccharis trinervis*, *Heisteria acuminata*, *Strychnos potatrum*, *Rhus acuminata*, and *Saraca indica*. Traditional herbal medicines such as Kakkon-to, Kanzo-bushi-to, Shigyako-to etc. have been used historically for the treatment of infectious diseases in China. Efficacy of these traditional medicines, in HSV-1 has been studied in vitro and in vivo. Kakkon-to was found to induce strong delayed type hypersensitivity in HSV infected mice, leading to localization of skin lesions and reduction of mortality in mice model (Nagasaka et al., 1995). Kanzo-bushi-to and Shigyako-to (contains medicinal plant extracts from *Zingiberis siccatum* rhizoma, *Aconiti tuber* and *Glycyrrhiza radix*) have been found to increase the resistance of thermally injured mice (infected with HSV-1) through the activation of contrasupressor T cells and CD8+ T cells (Ikemoto et al., 1994; Matsuo et al., 1994). Some of the traditional medicinal plants such as *Rhus javanica* Linn, *Geum japonicum* Thunb, *Syzygium aromaticum* Linn, and *Terminalia chebula* Retuz have been shown to exhibit anti-HSV activity in mice and guinea pig models, and potentiate the activity of acyclovir (Kurokawa et al., 1995; Nakano et al., 1998).

In a study, several compounds were tested in vitro by plaque reduction assay and found active against HSV-2. Among the active compounds, cineole, eugenol, and curcumin prevented the transmission of HSV-2 in a mouse model of intravaginal HSV-2 challenge. Eugenol was also found to provide protection in guinea pig model of HSV (Bourne et al., 1999).

4. Genital warts

HPV causes venereal infections known as genital warts or condylomata acuminata. HPV are easily transmitted during sexual intercourse. Condylomata acuminata is frequently asymptomatic, with occasional clinical symptoms including anogenital pruritis and burning. Penis, anus, vagina, vulva and cervix are common sites of genital warts (Hardin, 1996).

Topical application of small amount of 10–25% solution of plant resin, podophyllotoxin in compound tincture of benzoin has been the most common initial treatment of warts. Podofilox (0.5% solution), the most active component of podophyllotoxin, has been approved by U.S. FDA for treatment of external genital warts (Hardin, 1996). Condylox (Oclassen Pharmaceuticals, Inc.), a gel containing podofilox has been approved by FDA for treatment of anogential warts including external genital warts and perianal warts (http://www.fda.gov/cder/da/da.htm).

5. Chlamydial genital infections

C. trachomatis is also transmitted through sexual contact and leads to diseases such as non-gonooccal urethritis, cervicitis, pelvic inflammatory disease, and lymphogranuloma venereum.

Berberine is effective in treatment of ocular *C. trachomatis* and is expected to be equally effective in genital chlamydia infections. Berberine containing douches and vaginal depletion pack can be used for local application in chlamydial infections. Tinctures, powdered dried root, fluid and solid extracts of *Hydrastis canadensis*, *Berberine vulgaris*, and *Berberis aquifolium* can be used orally for treatment (Murray and Pizzorno, 1999). A polyherbal formulation, Praneem (contains purified extracts from *Azadirachta indica* and saponins from *Sapindus mukerrosi*) has been reported to possess activity against Chlamydia in clinical studies (Garg et al., 1994). Out of 28 patients of chlamydial cervicitis, 22 patients recovered clinically and microbiologically after 7–21 days of application of Praneem cream.

Table 2
List of plants reported to possess anti-HSV activity

Species (family)	Vernacular name and traditional uses	Indigenous to	Active constituent/fraction/extract	In vitro or in vivo assay model	References
A. catechu Linn. (Palmae)	Betel nut	India, China, Asia	Methanol and aqueous extracts of seed	Plaque inhibition assay of HSV-1 in Vero cells	Hattori et al., 1995
B. trinervis Pers. (Compositae)	–	–	Aqueous extract	In vitro HeLa cells infected with HSV	Abad et al., 1999
Bauhinia vahlii Wight and Arnott	Bhorla; used for treatment of cuts and wounds	Nepal	Methanol extract	In vitro, Vero cells	Taylor et al., 1996a
Camptotheca acuminata (Nyssaceae)	–	China	10-Methoxycamptothecin	Plaque reduction assay	Tafur et al., 1976
Carissa carandus Linn. (Apocyanaceae)	Karondath; used in diarrhea and dysentry	Nepal	Methanol extract	In vitro, Vero cells	Taylor et al., 1996a
D. caryophyllus	–	–	Dianthin 32, ribosome inactivating protein	Plaque reduction assay	Tomasi et al., 1982
E. articulatum	–	–	Aqueous extract	In vitro, HeLa cells infected with HSV	Abad et al., 1999
Gelonium multiforum	–	Himalaya	Antiretroviral protein GAP31	HSV infection assay, Plaque reduction assay	Tomasi et al., 1982; Bourinbaiar and Lee-Huang, 1996
G. japonicum Thunb.	–	–	Eugenin	Plaque reduction assay on Vero cells, murine infection model	Kurokawa et al., 1995, 1998
G. glabra Linn. (Leguminoseae)	Liquorice; used as demulcent, expectorant	England, Spain	Glycyrrhizin, glycyrrhizic acid	Inhibition of viral growth in HSV infected cell cultures, mice model	Pompei et al., 1979; Utsunomiya et al., 1995
Gossypium spp (Malvaceae)	Cotton seed	India, East Indies, Egypt	Gossypol, apogossypol	–	Wichmann et al., 1982
H. acuminata	–	–	Ethanolic extract	In vitro	Abad et al., 1999
Holoptelia integrifolia Plance (Ulmaceae)	Used in rheumatic swellings	–	Methanol extract of bark	In vitro, Vero cells	Rajbhandari et al., 2001
Hypericum cordifolium Choisy (Hypericeae)	Marmhendo; used in fever	Nepal	Methanol extract	In vitro, Vero cells	Taylor et al., 1996b
Limonium sinense Girard Ktze	Used in fever, hemorrhage, and menstrual disorders	China	Ethanolic extract, flavonoids isodihydrosyrengetin, (−)epigallocatechin-3-*O*-gallate, samarangenin, myrecetin, gallic acid, (−)epigallocatechin	Plaque inhibition assay of HSV-1 in Vero cells	Lin et al., 2000
Macaranga pustulata King ex Hook f. (Euphorbiaceae)	Malato, kala; used in topical treatment of skin blemishes	Nepal	Methanol extract	In vitro, Vero cells	Taylor et al., 1996b
M. lanceolata Forsskal (Myrsinaceae)	–	–	Maesasaponins triterpenoid saponins	Microtray assay, colorimetric assay	Apers et al., 2001
Maesa macrophylla Wall. A. DC. (Myrsinaceae)	Bhogati; used in tonsillitis	Nepal	Methanol extract	In vitro, Vero cells	Taylor et al., 1996b
Malotus philippensis Lam. (Euphorbiaceae)	Sindure, Kamala; used in diarrhea and dysentry	India, Pakistan, East Indies, Nepal	Methanol extract	In vitro, Vero cells	Taylor et al., 1996a
M. officinalis (Labiatae)	Lemon mint balm; used as carminative, antispasmodic, sedative	–	–	–	Wolbing and Leonhardt, 1994

Table 2 (*Continued*)

Species (family)	Vernacular name and traditional uses	Indigenous to	Active constituent/fraction/extract	In vitro or in vivo assay model	References
Milettia extensa Bentham Baker (Euphorbiaceae)	Gaujo; used in infected wounds and scabies	Nepal	Methanol extract	In vitro, Vero cells	Taylor et al., 1996a
M. charantia Linn. (Cucurbitaceae)	Bitter melon, karela; used for antiviral, hypoglycaemic, antitumor, and immunopotentiating purposes	China, India	Antiretroviral protein MAP30	HSV infection assay, Plaque reduction assay	Tomasi et al., 1982; Bourinbaiar and Lee-Huang, 1996
Myristica fragrans Van Houtt. (Myristaceae)	Nutmeg	–	Methanol extract of aril	Plaque inhibition assay of HSV-1 in Vero cells	Hattori et al., 1995
Nerium indicum Mill. (Apocyanaceae)	Used in swelling, skin infection	–	Methanol extract	In vitro, Vero cells	Rajbhandari et al., 2001
P. americana (Phytolaccaceae)	Poke root	Tropical America, South Africa	Pokeweed antiviral protein PAP-S	Plaque reduction assay	Tomasi et al., 1982
Pongamia glabra Vent. (Leguminoseae)	–	–	Methanol extract of bark and roots	Plaque inhibition assay of HSV-1 in Vero cells	Hattori et al., 1995
Potamogeton malaianus Miq.	–	–	Potamogetonyde, potamogetonol, and potamogetonin	Vero cell line kidney fibroblast of an African green monkey	Kittakoop et al., 2001
Punica gratum Linn. (Punicaeae)	Pomegranate, anar	–	Methanol extract of pericarp	Plaque inhibition assay of HSV-1 in Vero cells	Hattori et al., 1995
R. acuminata L.f. (Anacardiaceae)	–	–	Aqueous extract of gall	Balb/c mice model	Hattori et al., 1995
R. javanica Linn. (Anacardiaceae)	Used in treatment of chronic diseases such as gastric and duodenal ulcers	China and Japan	Aqueous extract, Moronic acid	Plaque reduction assay, guinea pig model, mouse model	Kurokawa et al., 1995, 1997, 1999; Nakano et al., 1998
Rumex hastatus D. Don (Polygonaceae)	Annile; used in tonsillitis and sore throat	Nepal	Methanol extract	In vitro, Vero cells	Taylor et al., 1996a
S. indica Linn. (Leguminoseae)	Asoka	–	Aqueous extract, Methanol extract of bark	Balb/c mice model, Plaque reduction assay of HSV-1 on Vero cells	Hattori et al., 1995
Sibbaldia micropetala (Rosaceae)	Bhui pasari jhar; used in diarrhea and dysentry	Nepal	Methanol extract	In vitro, Vero cells	Taylor et al., 1996b
Stephania cepharantha	–	–	Methanol extract of root and tubers, 13 bisbenzylisoquinoline 1 protoberberine, 2 morphinamine	In vitro plaque reduction assay on Vero cells, in vivo Balb/c mice model	Nawawi et al., 1999
Streblus asper Loureiro (Moraceae)	Sehor; used in diarrhea and dysentry	Nepal	Methanol extract	In vitro, Vero cells	Taylor et al., 1996a
S. potatrum L.f. (Loganiaceae)	–	–	Methanol extract	Plaque inhibition assay of HSV-1 on Vero cells, Balb/c mice model	Hattori et al., 1995
S. aromaticum L. Merr. et Perry (Myrtaceae)	Clove	Molucca	Eugenin	Plaque reduction assay on Vero cells, Mouse infection model	Kurokawa et al., 1997, 1998
Terminalia alata Heyne ex Roth (Combretaceae)	Saj; used in diarrhea and dysentry	Nepal	Methanol extract	In vitro, Vero cells	Taylor et al., 1996a
T. chebula Retz. (Combretaceae)	Harida, myrobalan	–	Aqueous extract of fruit	Plaque reduction assay, Balb/c mice model	Kurokawa et al., 1995, 1997

Table 2 (*Continued*)

Species (family)	Vernacular name and traditional uses	Indigenous to	Active constituent/fraction/extract	In vitro or in vivo assay model	References
Tridex procumbens Linn. (Asteraceae)	Kurkure; used in cuts and wounds	Nepal	Methanol extract	In vitro, Vero cells	Taylor et al., 1996a
Tripterygium wilfordii Hook fil.	–	–	Triptofordin C-2	In vitro	Hayashi et al., 1996
Withania somnifera L. (Solanaceae)	Ashwagandha	Israel	Methanol extract	Plaque inhibition assay of HSV-1 in Vero cells	Hattori et al., 1995

6. Trichomoniasis

Trichomoniasis, caused by the flagellated, motile protozoan *T. vaginalis*, is usually transmitted sexually. Clinical symptoms of the disease include malodorous yellowish-green vaginal discharge, vaginal itching, redness of the vulva and/or vagina, painful intercourse, abdominal pain, and painful urination (Hardin, 1996; Murray and Pizzorno, 1999). Up to 50% of the women infected with trichomoniasis are asymptomatic. Trichomonas is known to degrade secretory leukocyte protease inhibitor, a substance that is believed to protect the cells of vaginal mucous membrane from HIV infection, thereby increasing the risk of HIV transmission.

A 0.4% solution of *Melaleuca alternifolia* (tea tree) oil in 1 l of water as daily vaginal douche was found to be an effective treatment for trichomoniasis (Pena, 1962). Dried roots, rhizomes, tincture and fluid extracts of botanicals containing berberine such as *H. canadensis*, *Echinacea angustifolia*, and *Angelica* species are being prescribed for treatment of trichomonal infections (Murray and Pizzorno, 1999). In another study, extracts of bark and leaves of *Mikania cordifolia*, leaves of *Neurolaena lobata* and bark of *Scutia buxifolia* have been reported to inhibit the growth of *T. vaginalis* in vitro. Some essential oils including those obtained from *Mentha piperita* and *Lavandula angustifolia* have also been reported to possess strong antitrichomonal properties (Jankov et al., 1968).

7. Vaginitis and vulvovaginitis

Vaginitis is one of the most common mixed vaginal infections and may reflect symptoms of a more serious underlying STD. Vaginal infections may increase the risk of transmission of HIV and other sexually transmitted pathogens. Bacterial vaginosis had been reported to be associated with increased susceptibility to HIV infection (Murray and Pizzorno, 1999).

Major symptoms of vaginitis are vaginal discharge with a foul odor, itching, burning and inflammation (Murray and Pizzorno, 1999). Vaginitis may be caused by:

a) hormonal changes in postmenopausal women (hormonal vaginitis),
b) physical or chemical agents which cause damage to vaginal membranes (irritant vaginitis), and
c) disturbance of ecology of the healthy vagina (infectious vaginitis).

Infectious vaginitis may be caused by the prevalence of microorganisms such as *Candida albicans* (vaginal candidiasis), *T. vaginalis* (trichomonal vaginitis), and *G. vaginalis* (non-specific vaginitis). Less frequent causes of vaginitis include *N. gonorrhoea*, herpes simplex virus and *C. trachomatis* (Ruggiero, 1996; Murray and Pizzorno, 1999).

Traditionally, herbal preparations have been used for the treatment of various STDs. In Central America and Caribbean, 101 plants are claimed to be used in traditional medicine for treatment of gonorrhoea. In a study, tinctures from 44 plants used for STDs in Guatemala were screened for in vitro activity against *N. gonorrhoeae*. Extracts of bark of *Bixa orellana*, fruits of *Parmentiera edulis*, leaf of *Diphysa robinioides*, *Eupatorium odoratum*, *Gliricidia sepium*, *Physalis angulata*, *Piper aduncum* and *Prosopis juliflora*, root of *Casimiroa edulis*, and whole *Clematis dioica* were found to be active against *N. gonorrhoea* (Caceres et al., 1995). In another study, active substances from medicinal plants of Rwanda (Central Africa) that were indigenously used for gonorrhoea were screened for their antimicrobial activity against *N. gonorrhoea*, *N. meningitidis*, *Streptococcus pyogenes*, and *Staphylococcus aureus*. Plants showing greatest activity against these organisms include *Hygrophila auriculata*, *Vernonia aenulans*, *V. crudia*, *Euphorbia grantii*, *Cajanus cajan*, *Orthosiphon australis*, *Rumex abyssinicus* and *Lanatana trifolia*.

Allium sativum (garlic) possesses antibacterial, antiviral and antifungal properties. Douching solutions and gauze containing garlic may be used as a tampoon/suppository for most of the infectious vaginitis. *G. glabra* contains isoflavonoids that are reported to be effective against Candida. Water-soluble chlorophyll can also be added to the douching solutions to provide relief in vaginitis. Atrophic vaginitis due to lack of estrogens may be treated by the use of phytoestrogens obtained from plants such as *Ribes nigrum*, *Foeniculum vulgare*, *Illicium verum*, *Panax ginseng*, *Medicago sativa*, *Trifolia repens* and *G. glabra* (Murray and Pizzorno, 1999).

Tea tree oil, an essential oil from Australian plant *M. alternifolia*, has a wide spectrum of antimicrobial activity with a minimal effect on commensal lactobacilli in vagina (Hammer et al., 1999). An alcoholic extract of *M. alternifolia* (tea tree) diluted with water has been used as a douche combined with saturated tampoons in the treatment of vaginitis (Pena, 1962). In addition to extract, its vaginal pessaries have also been reported to treat bacterial vaginosis (Blackwell, 1991). Praneem polyherbal products have been reported to be effective in treating patients with abnormal vaginal discharge due to microbial infections (Mittal et al., 1995).

Ayurveda also prescribes some drugs that can be applied vaginally for the treatment of vaginal disorders. These include Subhakari vati, Somanath rus and Soubhagya vardhana tel (Essential ayurvedic drugs for dispensaries and hospitals, 2000).

8. Vaginal formulations of herbal origin

V-gel and PH 5 are examples of vaginal formulations based on herbal extracts, available in Indian market. V-gel, a polyherbal formulation of The Himalaya Drug Company (Bangalore, India), is indicated for vaginal infections of varied etiology such as vaginitis, cervicitis, vaginal candidiasis and vaginal discharge. It contains the extracts of *Emblica officinalis*, *Terminalia belerica*, *T. chebula*, *Rosa centifolia*, *Elletaria cardamomum*, *Boerhaevia diffusa*, *Parmelia perlata*, *Curcuma longa* and *Vitex negundo.* V-gel has been found effective in treating diseases caused by microorganisms such as *G. vaginalis*, *Moniliasis*, *T. vaginalis*, *Gonococcus vaginalis*, *C. albicans* and other non-specific organisms. In clinical studies, it was found that V-gel provides symptomatic relief within 4–5 days of application and complete cessation of symptoms within 7–14 days of treatment. The formulation was found to be safe and can be used by pregnant women, during pelvic inflammatory disease, and in postnatal cases (Mitra et al., 1997; Umadevi and Swarup, Dec1998–Feb1999; Narmada and Vanitha, 1999).

PH 5 (Zoic Pharmaceuticals, Delhi) has been claimed to restore normal vaginal pH, reduce leucorrhoea and various vaginal discharges, and possess astringent, anti-inflammatory, antiseptic and bacteriostatic effects. The vaginal pessaries consist of herbal extracts enclosed in small bags made of cloth. It contains the extracts of *Quercus infectoria*, *Sausurea lappa* and *Tamarix gallica.*

A vaginal depletion pack ('Vag pack') is regularly used and prescribed by naturopathic physicians for treatment of various vaginal disorders over the last 50 years (Murray and Pizzorno, 1999). Efficacy of this pack has not been studied in controlled clinical trials, but it has a long history of use, which dates back to 19th century. The 'Vag pack' consists of a tampoon containing a mixture of *H. canadensis* tincture, *Thuja occidentalis* oil, *M. alternifolia* oil, bitter orange oil, anhydrous magnesium stearate, vita minerals and glycerin.

Praneem polyherbal cream, tablets and suppositories are under clinical development and possess wide spectrum antibacterial, antifungal and antiviral effects against sexually transmitted pathogens (Talwar et al., 1995, 1997, 2000). Praneem contains purified extract of *A. indica* (neem) and saponins extracted from *Sapindus mukerrossi* (reetha). These have been reported to inhibit the clinical isolates of different species of *Candida* (*C. albicans*, *C. tropicalis* and *C. krusei*), *N. gonorrhoea* (including penicillin resistant strains), *G. vaginalis*, and multi drug resistant *Escherichia coli* and *S. aureus.* Intravaginal inoculation of these formulations prevented lesions and vaginal transmission of HSV-2 and *C. trachomatis* in progestin-sensitized mice. In addition, they have also been found to possess virucidal activity against HIV at doses non-toxic to cells in culture. Praneem polyherbal had completed phase I safety and acceptability trials in India. It was found to be effective in post-coital tests in women and produced a curative effect in women with vaginal discharge as per studies conducted in India, Egypt and Dominican Republic.

Viracea, a proprietary formula of Destiny BioMediX Corporation, is a topical microbicide consisting of benzalkonium chloride and phytochemicals derived from *Echinacea purpurea*. Viracea has been reported to possess antiviral activity against Acyclovir resistant as well as susceptible strains of HSV-1 and HSV-2 (Thompson, 1998).

9. Plantibodies as topical microbicides

An innovative approach to microbicide development is the use of genetically engineered plants to produce human monoclonal antibodies, 'plantibodies', active against a range of STIs. Even though plantibodies are not based on indigenous empirical knowledge, these are briefly mentioned because of their potential activity against STIs. With this technology, it is possible to deliver anti-HIV antibodies directly to the vagina, allowing them to combat pathogens before actual infection occurs (Forbes, 2000). Mass production of human antibodies using genetically engineered plants is relatively inexpensive as compared to those produced by fermentation technology and transgenic animals (Harvesting Monoclonal Antibodies from Plants, 1999).

From a public health perspective, monoclonal antibodies provide a promising approach for preventing reproductive tract infections and are expected to play an important preventive role in future emerging disease epidemics (Zeitlin et al., 1999). Corn has been genetically engineered to produce human antibodies against herpes and sperm. Research is in progress to produce anti-HIV antibodies. Herpes antibody has been found to protect mice against infection, and a sperm antibody has prevented pregnancy in rabbits. Corn has been proposed as a cheap and safe potential source of antibodies for contraceptive antimicrobial activities. Plantibodies are very potent, specific, and have the potential to be used in novel ways such as personal lubricants, gels, or controlled-release devices for vaginal insertion. Topical gels containing plantibodies for HSV-1 and HSV-2 are under preclinical development. Application of these antibodies to the mice vagina has been shown to prevent the infection with genital herpes. A more potent herpes plantibody to prevent mother to child transmission of herpes is under development (Harvesting Monoclonal Antibodies from Plants, 1999).

10. Conclusion

Several plant extracts and their constituents possess activity against sexually transmitted diseases indicating their huge potential as an effective measure for prevention and treatment of STDs including AIDS. Plant derived microbicides and plantibodies are some of the new approaches for prevention of HIV and other sexually transmitted pathogens. Herbal medicines can be developed as a safe, effective and economical alternative to drugs presently approved for symptomatic treatment of STDs and AIDS.

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