



Herbal Medicine Use In Hiv/Aids Treatment

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ABSTRACT

Acquired Immunodeficiency Syndrome (AIDS), caused by the Human Immunodeficiency Virus (HIV), critically impairs the immune system by reducing CD4+ T-helper cells, leading to increased susceptibility to infections and progression to AIDS. The rising global prevalence of HIV/AIDS presents a significant health challenge. Conventional treatments, while effective, are often prohibitively expensive, particularly in developing countries. As a result, many patients are turning to herbal medicines as viable alternatives, both as primary treatments and in combination with conventional therapies.

Herbal remedies such as Kalmegh, Betel Nut, Turmeric, and Clove show promise due to their potential to enhance immune function, offer antioxidant benefits, and exhibit anti-retroviral activity. These plants contain bioactive compounds like alkaloids, flavonoids, and tannins, which may disrupt HIV at various stages of its lifecycle. Despite their widespread use, concerns remain regarding the safety and efficacy of some herbal treatments. A review of clinical trials from 1995 to 2013 underscores the potential of these herbal medicines in supporting immune health in HIV/AIDS management. However, further comprehensive research is necessary to fully establish their safety and effectiveness as reliable treatments for HIV/AIDS.

KEYWORD

AIDS, HIV, Immune system, CD4+T-helper cells, syndrome, Herbal medicines.

INTRODUCTION

Human Immunodeficiency Virus (HIV) is a virus that targets and severely weakens the body's immune system by specifically attacking CD4 cells (T cells), which are crucial for the immune response against infections. Upon entering the body, HIV integrates into the host's DNA and begins replicating, causing the gradual destruction of these essential immune cells. As CD4 cell counts decline, the body's ability to fend off infections and diseases deteriorates, increasing susceptibility to a range of health complications.

- **Transmission :**

HIV is primarily transmitted through several key routes: unprotected sexual contact with an infected person, sharing needles or syringes, and from mother to child during childbirth or breastfeeding. It is crucial to understand that HIV is not spread through casual contact such as hugging, shaking hands, or sharing food. Awareness of these transmission routes is vital for effective prevention strategies and reducing the spread of the virus.

- **Stages of infection :-**

HIV infection progresses through distinct stages:

- 1) **Acute HIV Infection :-**

This initial stage occurs 2-4 weeks after exposure and is often marked by flu-like symptoms, including fever, sore throat, and rash. This period is sometimes referred to as primary HIV infection or acute retroviral syndrome.

- 2) **Chronic HIV Infection :-**

During this phase, the virus remains active but replicates at lower levels. Individuals might not exhibit noticeable symptoms, but the virus continues to damage the immune system, making regular monitoring essential.

- 3) **AIDS (Acquired Immunodeficiency Syndrome):-**

The final and most severe stage of HIV infection is characterized by a critically weakened immune system. This stage often leads to the development of opportunistic infections and certain cancers that take advantage of the body's compromised defenses.

- **Types of HIV:-**

Two major types of HIV have been identify,

- 1) **HIV 1**

HIV-1 is the most widespread type of HIV globally, responsible for the majority of HIV infections. HIV-1 is more easily transmitted than HIV-2.

- **Subtype of HIV 1**

HIV-1 is further divided into four groups: M (Main), N (Non-M, Non-O), O (Outlier), and P.

-Group M: The most common and has several subtypes (A–K).

- Subtype A:** Found mainly in West and Central Africa.
- Subtype B:** Predominant in North America, Europe, and Australia.
- Subtype C:** The most widespread globally, particularly in Southern Africa and India.
- Subtype D:** Common in East and Central Africa.
- Subtype E:** Mostly found in Southeast Asia.
- Subtype F, G, H, J, K: Less common, found in specific regions in Africa and South America.

Groups N, O, P: Less common, primarily found in West and Central Africa.

2) HIV 2

HIV-2 is less common and mostly found in West Africa.

- HIV-2 is believed to have originated from the Sooty Mangabey monkey, a species native to West Africa. The virus has not spread as widely as HIV-1 due to lower transmission rates.
- HIV-2 generally leads to a slower progression to AIDS compared to HIV-1.
- HIV-1 is global, while HIV-2 is concentrated in West Africa with limited spread to other regions

▪ Subtype of HIV 2

HIV-2 has several subtypes (A to H), but A and B are the most prevalent.

• Mechanism of HIV Infection:-

The mechanism of HIV infection initiates when the virus binds to the CD4 receptor on a host cell, typically a CD4+ T cell, through its gp120 protein. This binding process also involves co-receptors, usually CCR5 or CXCR4, which facilitates the fusion of the viral envelope with the host cell membrane, mediated by the gp41 protein. Following fusion, the viral RNA and associated enzymes are released into the host cell's cytoplasm. Here, the enzyme reverse transcriptase catalyzes the conversion of the viral RNA into double-stranded DNA. This DNA is then transported into the nucleus, where it is integrated into the host genome by the enzyme integrase, forming what is known as a provirus. The proviral DNA is transcribed into RNA, which serves as a template for the synthesis of viral proteins and the viral genome. These newly formed components are then assembled into immature virions, which bud from the host cell and mature into infectious particles through the action of the protease enzyme, ready to propagate the infection in new cells.

• Life Cycle of HIV/AIDS:-

To understand each stage in the HIV life cycle, it helps to first imagine what HIV looks like...

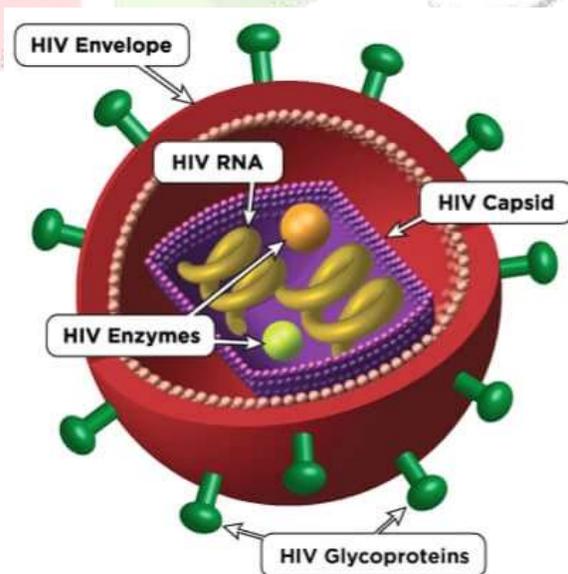


Fig. 1 HIV Virus

- **Key to Terms**

HIV capsid: HIV's core that contains HIV RNA

HIV envelope: Outer surface of HIV

HIV enzymes: Proteins that carry out steps in the HIV life cycle

HIV glycoproteins: Protein "spikes" embedded in the HIV envelope

HIV RNA: HIV's genetic material

- **The seven stages of the HIV life cycle are:**

- I. **Binding:-** HIV binds (attaches itself) to receptors on the surface of a CD4 cell.
 - II. **Fusion:-**The HIV envelope and the CD4 cell membrane fuse (join together), which allows HIV to enter the CD4 cell.
 - III. **Reverse transcription:-**Inside the CD4 cell, HIV releases and uses reverse transcriptase (an HIV enzyme) to convert its genetic material- HIV RNA-into HIV DNA. The conversion of HIV RNA to HIV DNA allows HIV to enter the CD4 cell nucleus and combine with the cell's genetic material-cell DNA.
 - IV. **Integration:-**Inside the CD4 cell nucleus, HIV releases integrase (an HIV enzyme). HIV uses integrase to insert . (integrate) its viral DNA into the DNA of the CD4 cell.
 - V. **Replication:-**Once integrated into the CD4 cell DNA, HIV begins to use the machinery of the CD4 cell to make long chains of HIV proteins. The protein chains are the building blocks for more HIV.
 - VI. **Assembly:-**New HIV proteins and HIV RNA move to the surface of the cell and assemble into immature (noninfectious) HIV.
 - VII. **Budding:-**Newly formed immature (noninfectious) HIV pushes itself out of the host CD4 cell. The new HIV releases protease (an HIV enzyme). Protease breaks up the long protein chains in the immature virus, creating the mature (infectious) virus.
- **Table No. 1** HIV- infected patients that reported the use of medicinal plants and/or phytomedicine

Reasons for the use of the Medicinal Plant/Herbal remedy	N(%)
Gastrointestinal disturbances	24(38.1)
Pleasure or personal satisfaction	18(28.6)
Pain and inflammation control or colds	8(12.7)
Increase on the immunological response	6(9.5)
Sedative and/or sleep inducer	3(4.8)
Gastrointestinal disturbances and personal satisfaction	2(3.2)
Weight reduction	1(1.6)

- **Table No. 2** – Reasons for the use of medicinal plants and/or phytomedicine.

Parameters	Number (%)
Average age (\pm SD)	38.8 (\pm9.49)
Male/Female	44 (65.67)/23 (34.33)
Marital status	
Singles	38 (56.71)
Married or live matrimonially	22 (32.83)
Divorced/widowed	7(10.5)
Educational level	
Illiterate	2 (3.0)
From 1 to 4 years of school	11 (16.24)
From 5 to 8 years of school	26 (38.8)
Graduated from High-School	23 (34.33)
Graduated from College	5 (7.5)
Monthly familiar income	
< 1 minimum wage	1 (1.52)
Between 1 and 5 minimum wages	52 (78.79)
Between 6 and 10 minimum wages	7 (10.61)
> 10 minimum wages	6 (9.1)
Social interaction	
Family	53 (79.09)
Alone	10 (14.93)
Other (s) or in philanthropic institution	4 (6.0)

- **Plants and herbal remedies that can interact with antiretroviral drugs.**

1) *Ilex paraguariensis* (Yerba mate):

Family: Aquifoliaceae

Ilex paraguariensis commonly known as yerba mate, is a plant traditionally used in South America as a stimulant, often consumed as a tea. When considering its use in individuals with HIV, particularly those on antiretroviral therapy (ART), it's important to proceed with caution due to potential interactions between herbal products and HIV medications.

Yerba mate contains caffeine and other active compounds that might interact with HIV medications, especially those metabolized by the liver. This could potentially alter drug levels in the body, either increasing toxicity or reducing effectiveness.

2) *Paullinia cupana* Kunth (Guarana):

Family: Sapindaceae

Paullinia cupana, commonly known as Guarana, is a plant native to the Amazon basin, particularly Brazil. It belongs to the family Sapindaceae. The biological source of *Paullinia cupana* is its seeds, which are rich in caffeine and other stimulants like theobromine and theophylline.

Guarana is not a primary treatment for HIV/AIDS. However, it has been explored for its potential supportive benefits due to its stimulant properties, which might help alleviate some of the fatigue and mental fog associated with HIV/AIDS and its treatment. The high caffeine content in guarana can increase energy levels and improve mental alertness, which could be beneficial for individuals experiencing fatigue.

That said, there is no substantial evidence supporting the direct antiviral effects of guarana against HIV. It is mainly used as a complementary supplement rather than a treatment. As with any supplement, it should be used under the guidance of a healthcare professional, especially in individuals with HIV/AIDS, to avoid potential interactions with prescribed medications.

3) *Symphytum officinale* L. (Common

Comfrey)

Family: Boraginaceae

Symphytum officinale L., commonly known as

Comfrey, is a perennial herb in the family Boraginaceae. The biological source of *Symphytum officinale* is primarily its roots and leaves, which contain various bioactive compounds, including allantoin, rosmarinic acid, and mucilage.

Comfrey has been traditionally used for its wound-healing and anti-inflammatory properties due to the presence of allantoin, which promotes cell regeneration and tissue repair. However, its use in HIV/AIDS treatment is not well-supported by scientific evidence.

However, it's crucial to note that comfrey contains pyrrolizidine alkaloids (Pas), which are toxic to the liver and can cause severe health issues, including liver damage and even cancer with long-term use. Due to these risks, internal use of comfrey is generally discouraged, especially in individuals with compromised health, such as those with HIV/AIDS.

The metabolism of *Symphytum officinale* L. (comfrey) in the body is complex and is primarily concerned with the processing of its active constituents, especially pyrrolizidine alkaloids (Pas), which are of significant concern due to their potential toxicity.

4) *Andrographis paniculata* (Green chiretta):

Family: Acanthaceae

Andrographis paniculata belongs to the family Acanthaceae. Its biological source is the entire plant, which includes the leaves, stems, and roots, but the leaves are the most commonly used part for medicinal purposes. The plant is a small herb native to South and Southeast Asia, particularly found in countries like India, Sri Lanka, China, and Thailand.

Andrographis paniculata, commonly known as “King of Bitters,” is a medicinal herb that has been traditionally used in various forms of medicine, particularly in Asia. It’s known for its anti-inflammatory, antiviral, and immune-boosting properties.

In the context of HIV/AIDS treatment, *Andrographis paniculata* has been explored for its potential benefits, though it is not a primary treatment. Some studies suggest that compounds in the plant, particularly andrographolide, may have antiviral properties that could help in managing HIV by inhibiting the virus’s replication. Additionally, it may enhance the immune system, which is crucial for individuals with HIV/AIDS, as their immune systems are often compromised.

However, it’s important to note that while *Andrographis paniculata* might offer supportive benefits, it is not a substitute for antiretroviral therapy (ART), which is the standard and most effective treatment for HIV/AIDS. Research is ongoing, and more clinical trials are needed to fully understand its efficacy and safety in this context. Anyone considering using it should do so under the guidance of a healthcare professional.

5) *Sambucus nigra* L (Elder)

Family: Adoxaceae

Sambucus nigra L., commonly known as black elderberry, is a plant that belongs to the Adoxaceae family. The parts of the plant typically used for medicinal purposes are the berries (fruits) and flowers.

When *Sambucus nigra* is consumed, its active components—such as anthocyanins, flavonoids, and various organic acids—are metabolized in the body.

Sambucus nigra L. Is not a primary treatment for HIV/AIDS but has been considered as a complementary therapy due to its potential health benefits. Elderberry is recognized for its immune-boosting properties. It stimulates the production of cytokines, proteins important in immune responses. For people living with HIV, who have compromised immune systems, elderberry may help enhance overall immune function.

Elderberry has demonstrated antiviral activity against several viruses, including influenza. Some of these antiviral properties are attributed to its flavonoids and anthocyanins, which may inhibit viral replication. While there’s no direct evidence that elderberry can inhibit HIV itself, it could help manage secondary infections, which are common in HIV patients.

The high levels of antioxidants in elderberry, such as anthocyanins and flavonoids, can help reduce oxidative stress. Oxidative stress is often elevated in people with HIV due to chronic inflammation and the virus’s effects on the body.

6) *Hymenaea courbaril* L (Stinkingtoe)

Family: Fabaceae

Hymenaea courbaril L., commonly known as Jatobá or Brazilian cherry, is a tree in the Fabaceae family. The biological source of *Hymenaea courbaril* includes its hardwood, fruits, seeds, and resin. The resin, often referred to as copal, and the fruit pulp are particularly valued for their medicinal properties.

The metabolism of *Hymenaea courbaril* involves several active compounds found in its resin and fruit, including terpenes, phenolic compounds, and flavonoids. Terpenes, such as those found in the resin, are absorbed through the gastrointestinal tract after ingestion. These compounds are metabolized primarily in the liver, where they undergo phase I and phase II metabolism, including oxidation and conjugation, which makes them more water-soluble. The metabolites of terpenes are excreted via urine and, to a lesser extent, bile.

However, it has been traditionally used in folk medicine for various purposes, which may provide some complementary benefits for individuals with HIV/AIDS. Here's how it might be considered in the context of HIV/AIDS. The resin and fruit of *Hymenaea courbaril* are rich in antioxidants, particularly phenolic compounds and flavonoids. These antioxidants can help reduce oxidative stress, which is often elevated in individuals with HIV/AIDS due to chronic inflammation and the viral burden. The resin has been traditionally used for its anti-inflammatory properties. Reducing inflammation can be beneficial for people with HIV/AIDS, who often suffer from chronic inflammation due to immune system activation.

7) *Gossypium barbadense* L (Sea Island cotton)

Family: Mallow

Gossypium barbadense L., commonly known as Sea Island cotton or Pima cotton, is a species of cotton in the Malvaceae family. The primary biological sources of *Gossypium barbadense*. These are harvested from the seed pods (bolls) of the cotton plant. The seeds, which contain oil and proteins, are a byproduct of fiber production.

When cottonseed oil is consumed, it is absorbed in the gastrointestinal tract. The fatty acids in cottonseed oil are metabolized in the liver. They undergo beta-oxidation to produce energy and are incorporated into cellular membranes. Cottonseed oil is also rich in linoleic acid (an essential fatty acid) and other components.

Proteins from cottonseed are digested into amino acids in the gastrointestinal tract and absorbed into the bloodstream.

Gossypium barbadense L. Does not have a direct, established role in the treatment of HIV/AIDS. However, its byproducts, such as cottonseed oil and proteins, might offer some indirect benefits

Rich in essential fatty acids, including linoleic acid, cottonseed oil can contribute to overall nutrition. Proper nutrition is crucial for people with HIV/AIDS to maintain their health and support their immune system. Contains proteins that can be a part of a balanced diet, which is important for maintaining muscle mass and overall health in HIV/AIDS patients.

8) *Aloe spp* (Babosa)

Family: Asphodelaceae

Aloe spp commonly known as Aloe vera (though there are many species of Aloe), is a succulent plant in the Asphodelaceae family.

The primary biological sources of *Aloe spp*. Are Leaves. The gel from the inner part of the leaves is widely used for medicinal and cosmetic purposes.

When ingested, the polysaccharides, vitamins, and minerals in aloe gel are absorbed in the gastrointestinal tract. Aloe's key components, such as acemannans (a type of polysaccharide), are thought to have immunomodulatory effects.

Compounds absorbed from aloe gel are metabolized in the liver and excreted through urine or bile.

Aloe vera contains polysaccharides like acemannans, which may have immunomodulatory effects. These compounds are thought to enhance immune response and may help in managing the immune system's function in individuals with HIV/AIDS.

Aloe vera has anti-inflammatory properties that can help reduce inflammation and potentially alleviate some symptoms related to chronic infections and inflammatory conditions associated with HIV/AIDS.

9) Allium cepa (cebola):

Family: Amaryllidaceae

Allium cepa L., commonly known as the onion, is a species in the family Amaryllidaceae. It is cultivated globally and is one of the most widely consumed vegetables. The plant's bulb is the primary edible part, though the leaves and flowers can also be used in culinary applications.

Onions contain various bioactive compounds, including flavonoids (like quercetin), sulfur compounds, and saponins. When consumed, these compounds undergo metabolism primarily in the liver. Quercetin, for instance, is absorbed in the small intestine, where it may be conjugated to glucuronides, sulfates, or methylated forms, increasing its water solubility for excretion. The sulfur compounds are also metabolised to various sulfur-containing compounds that contribute to the onion's characteristic smell.

Allium cepa L. is not a standard treatment for HIV/AIDS, but it has been studied for its potential complementary role due to its antioxidant and anti-inflammatory properties. Some research suggests that the bioactive compounds in onions, particularly quercetin, might inhibit certain stages of the HIV lifecycle or protect against oxidative stress, which is heightened in HIV-infected individuals. However, these findings are preliminary, and Allium cepa L. should not be considered a replacement for antiretroviral therapy (ART), which is the primary treatment for HIV/AIDS. Onions might offer supportive benefits as part of a balanced diet in managing the condition, but their efficacy and safety as a treatment require further clinical validation.

10) Eucalyptus globulus Labill (Tasmanian blue gum)

Family: Myrtaceae

Eucalyptus globulus Labill (commonly known as the blue gum or Tasmanian blue gum) is a species of Eucalyptus native to southeastern Australia. Here's an overview of its biological source, metabolism, and potential role in the treatment of HIV/AIDS

The primary active component of Eucalyptus globulus is eucalyptol, which undergoes metabolic processing in the liver. It is metabolized primarily by cytochrome P450 enzymes (specifically CYP3A4). The metabolites are then excreted via urine. Eucalyptol has moderate bioavailability when administered orally, and its metabolites include hydroxy-eucalyptol and conjugated forms, which are further processed before excretion.

The essential oil from Eucalyptus globulus has been studied for its potential immune-modulating properties. It might help in boosting the immune system, which is crucial for HIV/AIDS patients whose immune systems are compromised.

Eucalyptus oil has demonstrated antimicrobial properties, which can be beneficial for HIV/AIDS patients prone to opportunistic infections due to their weakened immune systems.

Patients with HIV/AIDS often suffer from respiratory issues. Eucalyptus oil can be used as an inhalant to help clear respiratory congestion and improve breathing, thereby providing symptomatic relief.

High doses of eucalyptus oil can be toxic and should be used under medical supervision, particularly in immunocompromised patients.

11) *Serenoa repens* (Saw palmetto)

Family: Arecaceae (Palm)

Serenoa repens (commonly known as saw palmetto) is a small palm native to the southeastern United States, particularly in Florida. It is widely known for its use in treating benign prostatic hyperplasia (BPH) and other conditions. Below is an overview of its biological source, metabolism, and potential role in the treatment of HIV/AIDS.

The active components of *Serenoa repens* include fatty acids (e.g., lauric acid, oleic acid) and phytosterols (e.g., beta-sitosterol). These compounds are absorbed in the gastrointestinal tract, with their metabolites eventually excreted through urine and feces.

The exact metabolic pathways are not fully understood, but it is known that *Serenoa repens* can inhibit 5-alpha-reductase, an enzyme that converts testosterone to dihydrotestosterone (DHT).

Like other plant-based therapies, *Serenoa repens* may possess immune-modulating properties, which could be beneficial in supporting the immune system of HIV/AIDS patients. However, specific evidence in this context is limited. The anti-inflammatory effects of saw palmetto might help in reducing chronic inflammation, which is a common issue in HIV/AIDS due to ongoing immune activation. *Serenoa repens* might provide symptomatic relief for conditions such as urinary tract symptoms, which could affect HIV/AIDS patients, especially older males who might also suffer from BPH.

12) *Sambucus nigra* L (Elder)

Family: Adoxaceae.

Sambucus nigra L. (commonly known as elderberry) is a plant widely recognized for its medicinal properties. The primary bioactive compounds in elderberry include flavonoids (such as quercetin and anthocyanins), phenolic acids, vitamins (like vitamin C), and triterpenes. These compounds are believed to contribute to its antiviral, antioxidant, and immunomodulatory properties.

Upon ingestion, the flavonoids in elderberry are absorbed in the gastrointestinal tract. They are metabolized in the liver, where they undergo phase II detoxification (e.g., glucuronidation and sulfation). The metabolites are then excreted via urine. The bioavailability of elderberry flavonoids is considered moderate, with some degree of metabolism occurring in the gut microbiota before systemic absorption.

Elderberry extracts have been studied for their antiviral effects, particularly against influenza viruses. The flavonoids in elderberry are thought to inhibit viral replication and entry into host cells, potentially offering benefits in viral infections like HIV. Elderberry is known for its immune-boosting properties, which could be beneficial in managing HIV/AIDS by enhancing the immune response. However, it is essential to note that elderberry alone is not sufficient as a treatment for HIV but may serve as a supportive therapy.

13) *Espinheira santa* (*Maytenus ilicifolia*)

Family: Celastraceae

Espinheira-santa is a traditional medicinal plant commonly used in South America, particularly in Brazil. Its scientific name is *Maytenus ilicifolia* or *Maytenus aquifolium*, and it belongs to the Celastraceae family. Here's an overview of its biological source, metabolism, and its potential relevance in the treatment of HIV and AIDS

The plant contains several bioactive compounds, including:

Triterpenes (e.g., friedelin, friedelanol)

Flavonoids (e.g., quercetin, kaempferol)

Tannins

Saponins.

These compounds are responsible for the plant's anti-inflammatory, antioxidant, and anti-ulcerogenic properties.

Upon ingestion, the bioactive compounds from *Espinheira-santa* are metabolized in the liver. The flavonoids and triterpenes undergo phase I and II metabolic processes, including oxidation, reduction, hydrolysis, and conjugation. The metabolites are then excreted primarily via the kidneys.

Espinheira-santa is thought to have immune-boosting properties, which could be beneficial for people with HIV/AIDS by enhancing immune function.

HIV/AIDS patients often suffer from gastrointestinal issues. *Espinheira-santa* is traditionally used to treat stomach ulcers and digestive problems, which could help alleviate some of these symptoms in HIV/AIDS patients.

14) *Camellia sinensis* L. (Tea plant)

Family: Theaceae

Camellia sinensis is the plant species whose leaves and leaf buds are used to produce tea, one of the most widely consumed beverages in the world.

The leaves of *Camellia sinensis* contain a rich array of bioactive compounds

Polyphenols: Catechins (e.g., epigallocatechin gallate, EGCG), flavonoids

Alkaloids: Caffeine, theobromine, theophylline

Amino Acids: L-theanine

Vitamins: Vitamin C, Vitamin E, Vitamin K

Minerals: Manganese, potassium, calcium, magnesium.

After ingestion, catechins and other polyphenols from *Camellia sinensis* are absorbed primarily in the small intestine.

Camellia sinensis, particularly the EGCG found in green tea, has shown potential antiviral activity against various viruses, including HIV, in vitro. EGCG can inhibit HIV-1 replication by interfering with the virus's ability to bind to host cells and by inhibiting the enzyme reverse transcriptase. The polyphenols in tea have been noted for their immune-modulating effects. They can enhance immune responses, which may be beneficial for people living with HIV/AIDS. HIV and antiretroviral therapy (ART) can increase oxidative stress in the body. The antioxidant properties of green tea catechins can help reduce oxidative stress.

15) *Matricaria chamomilla* L (German chamomile)

Family: Asteraceae.

Matricaria chamomilla L. (commonly known as German chamomile) is a plant belonging to the Asteraceae family. It has been widely used in traditional medicine for its anti-inflammatory, antispasmodic, and mild sedative properties.

Upon ingestion, these compounds are absorbed in the gastrointestinal tract. The flavonoids, particularly apigenin, are known to have good bioavailability. The flavonoids undergo Phase II metabolism in the liver, where they are conjugated to glucuronides and sulfates for easier excretion. The metabolites are primarily excreted via urine.

The anti-inflammatory effects of chamomile may help alleviate some symptoms associated with HIV/AIDS, such as chronic inflammation. Chamomile has been shown to have mild immune-modulating effects, which could be beneficial in supporting the immune system of people living with HIV/AIDS. Chamomile can help relieve symptoms such as anxiety, gastrointestinal disturbances, and sleep disorders, which are common in

individuals with HIV/AIDS. While there is some evidence that chamomile extracts exhibit antiviral activity, more research is needed to determine their effectiveness specifically against HIV.

16) *Mentha spp* (mint)

Family: Lamiaceae

The term *Mentha spp.* Refers to various species within the *Mentha* genus, commonly known as mint. Some of the most widely used species include *Mentha piperita* (peppermint), *Mentha spicata* (spearmint), and *Mentha arvensis* (field mint). The biological source of these species is the leaves, which are rich in essential oils, including menthol, menthone, and other volatile compounds.

Mentha species are metabolized in the body primarily through the liver. The main components, such as menthol, undergo phase I and phase II metabolism, where they are oxidized by cytochrome P450 enzymes and conjugated with glucuronic acid, sulfate, or glycine. These metabolites are then excreted through the urine. Menthol, for example, is metabolized into menthol glucuronide, menthone, and other related compounds.

There is limited direct evidence that *Mentha* species are effective in treating HIV/AIDS. However, *Mentha spp.* Have been traditionally used to alleviate some symptoms associated with HIV/AIDS, such as digestive issues, headaches, and respiratory problems. The essential oils from *Mentha* have antimicrobial and anti-inflammatory properties, which may help manage secondary infections and symptoms in HIV/AIDS patients. Additionally, some studies suggest that certain compounds in *Mentha* might have immunomodulating effects, though this is still under investigation and not a substitute for antiretroviral therapy (ART), the standard treatment for HIV/AIDS.

17) *Uncaria tomentosa* (Cat's claw)

Family: Rubiaceae

Uncaria tomentosa, commonly known as cat's claw, is a woody vine native to the Amazon rainforest and other tropical areas of South and Central America. The biological source of *Uncaria tomentosa* includes the bark and roots, which contain the plant's active compounds. The primary bioactive components include oxindole alkaloids, quinovic acid glycosides, flavonoids, and tannins.

The active compounds in *Uncaria tomentosa* are metabolized primarily in the liver. The oxindole alkaloids, which are considered the most significant for their medicinal properties, undergo biotransformation through the liver's enzyme systems. The metabolites are typically conjugated with glucuronic acid or sulfates and are excreted in the urine. However, the exact metabolic pathways of all active compounds are not fully elucidated.

Uncaria tomentosa has been studied for its potential role in supporting the immune system, which is crucial for individuals with HIV/AIDS. The plant's extracts are believed to have immunomodulatory, anti-inflammatory, and antioxidant properties, which can help enhance immune function and reduce the viral load in some cases. Some studies suggest that *Uncaria tomentosa* might help in reducing the number of opportunistic infections that occur due to the compromised immune systems in HIV/AIDS patients. However, while *Uncaria tomentosa* is used as an adjunctive therapy to support overall health and immune function, it is not a replacement for antiretroviral therapy (ART). The evidence for its direct antiviral effects against HIV is still limited, and it is generally used to complement conventional treatments rather than as a primary therapy.

18) *Allium sativum* L. (Garlic)**Family:** Amaryllidaceae

Allium sativum L., commonly known as garlic, is a perennial plant in the Amaryllidaceae family. The biological source of *Allium sativum* is its bulb, which is rich in sulfur-containing compounds like allicin, alliin, and ajoene, as well as vitamins, minerals, and flavonoids. The bulb is the primary part of the plant used for medicinal purposes.

Allium sativum has been studied for its potential benefits in managing HIV/AIDS due to its immune-boosting, antiviral, and antioxidant properties. Garlic is believed to enhance the immune response, which is critical for individuals with HIV/AIDS who have compromised immune systems. It stimulates the activity of natural killer (NK) cells and macrophages, which help fight infections. Garlic's antimicrobial properties can help reduce the risk of opportunistic infections, such as fungal, bacterial, and parasitic infections, which are common in people living with HIV/AIDS. The antioxidant properties of garlic help reduce oxidative stress, which is elevated in HIV-infected individuals and can contribute to disease progression.

19) *Galanthus nivalis* (Snowdrop)**Family:** Amaryllidaceae

Galanthus nivalis is native to Europe and the Middle East. It grows in woodlands and meadows, often in cool, temperate climates. The plant contains several alkaloids, including galantamine, which is its most notable compound. Galantamine is a potent inhibitor of acetylcholinesterase, an enzyme that breaks down acetylcholine, thus enhancing cholinergic neurotransmission.

Galantamine works by increasing acetylcholine levels in the brain, which can improve cognitive function. This mechanism is significant in the treatment of neurodegenerative diseases.

There is limited evidence on the direct use of *Galanthus nivalis* or its extracts in the treatment of HIV/AIDS. However, its derivative, galantamine, is primarily used in the management of Alzheimer's disease and other cognitive impairments rather than HIV/AIDS.

20) *Hippeastrum hybridum* (Amaryllis)**Family:** Amaryllidaceae

Hippeastrum hybridum, commonly known as the Amaryllis, is a hybrid plant of the genus *Hippeastrum*. Its biological source is primarily the bulb of the plant. The plant produces a variety of phytochemicals, including alkaloids, flavonoids, and glycosides. These compounds contribute to its biological activities, although specific metabolic pathways for *Hippeastrum hybridum* are not as well-documented as those for more commonly studied plants. There is limited research on *Hippeastrum hybridum* specifically for HIV/AIDS treatment. However, some studies have explored the antiviral and immunomodulatory properties of various plant extracts. If *Hippeastrum hybridum* has shown any potential, it would likely be due to the presence of bioactive compounds that could influence viral replication or immune function.

21) *Ancistrocladus korupensis* (wine)

Family: Ancistrocladaceae

Ancistrocladus korupensis is a plant species native to the Korup National Park in Cameroon. It has gained attention due to its potential in the treatment of HIV/AIDS, primarily because of the discovery of michellamine B, a compound with anti-HIV properties.

Ancistrocladus korupensis belongs to the family Ancistrocladaceae. It is found in the tropical rainforests of West and Central Africa, particularly in Cameroon.

The metabolism of *Ancistrocladus korupensis* within the human body is not extensively studied. However, michellamine B, an alkaloid isolated from this plant, has been the subject of research. This compound is thought to exert its effects by inhibiting the replication of HIV-1 and HIV-2 in infected cells.

The compound michellamine B has shown promising anti-HIV activity in laboratory studies. It works by inhibiting the reverse transcriptase enzyme, which is crucial for the replication of HIV. However, its development as a drug has been challenging due to toxicity issues and the difficulty in synthesizing the compound in sufficient quantities. It's important to note that while compounds from plants like *Ancistrocladus korupensis* hold promise, they are not a replacement for established antiretroviral therapies. The best approach to managing HIV/AIDS remains the use of these proven medications under the guidance of healthcare professionals.

22) *Achyrocline satureioides* (Macela):

Family : Asteraceae

Achyrocline satureioides is a medicinal plant commonly known as “marcela” or “macela.” It belongs to the Asteraceae family and is native to South America, particularly in countries like Brazil, Argentina, Uruguay, and Paraguay.

The plant is harvested mainly for its flowers and aerial parts, which are rich in bioactive compounds. These parts are often used in traditional medicine and have been the subject of scientific studies.

Achyrocline satureioides contains various bioactive compounds, including flavonoids, terpenoids, and phenolic acids. Flavonoids, such as quercetin, luteolin, and kaempferol, are particularly abundant and have been studied for their antioxidant, anti-inflammatory, and antiviral properties.

The plant's extracts have shown potential antiviral activity, particularly against the HIV virus. Research has indicated that the flavonoids present in *Achyrocline satureioides* can inhibit the replication of HIV-1 by interfering with the virus's ability to infect host cells. These compounds may work by blocking key enzymes, such as reverse transcriptase, which are crucial for the HIV life cycle.

23) *Arctium lappa* (Greater burdock)

Family: Asteraceae

Arctium lappa, commonly known as burdock, is a biennial plant belonging to the Asteraceae family. It is widely distributed across Europe and Asia and has a long history of use in traditional medicine. *Arctium lappa* is primarily harvested for its roots, though the leaves and seeds are also used medicinally. The root is rich in various bioactive compounds and is the part most commonly used in both traditional and modern herbal medicine.

A type of prebiotic fibre that aids in digestion and helps regulate blood sugar levels. Lignans compounds have antioxidant and anti-inflammatory properties. Polyacetylenes are known for their antibacterial and antifungal effects.

Arctium lappa has suggested potential benefits in managing HIV/AIDS due to its various bioactive compounds. The lignans arctiin and arctigenin, in particular, have shown promise in laboratory studies for

their antiviral activity, including against HIV. These compounds may inhibit the replication of HIV by affecting viral enzymes or by modulating the immune response.

Additionally, *Arctium lappa* is known for its immune-boosting properties, which could be beneficial for people living with HIV/AIDS by supporting the immune system and helping to manage opportunistic infections. Its anti-inflammatory and antioxidant effects can also help in reducing inflammation and oxidative stress, both of which are common in individuals with HIV/AIDS.

24) *Terminalia arjuna* (Arjun tree)

Family: Combretaceae

Terminalia arjuna is a medicinal plant native to India, where it has been used in traditional Ayurvedic medicine for centuries. The primary part used medicinally is the bark, although the leaves, fruits, and seeds may also have medicinal properties. The bark of *Terminalia arjuna* is rich in several bioactive compounds, including triterpenoids (e.g., arjunolic acid, arjunic acid), flavonoids, glycosides (e.g., arjunetin, arjunosides), tannins, and minerals (calcium, magnesium, zinc, copper). *Terminalia arjuna* is metabolised in the liver, where its active compounds undergo biotransformation. The exact metabolic pathways in humans are not fully elucidated, but studies suggest that its flavonoids and triterpenoids undergo phase I and phase II metabolism, including hydroxylation, glucuronidation, and sulfation. The metabolites are primarily excreted through urine and bile.

There is some evidence suggesting that *Terminalia arjuna* exhibits antiviral properties, which could be beneficial in the context of HIV/AIDS. The plant's compounds may help inhibit viral replication, although this is still under investigation. *Terminalia arjuna* is known for its cardioprotective effects, which can be crucial for HIV/AIDS patients, as the virus and certain antiretroviral therapies can lead to cardiovascular complications. Additionally, its antioxidant and anti-inflammatory properties may support the immune system and reduce oxidative stress in these patients. While *Terminalia arjuna* is not a primary treatment for HIV/AIDS, it is sometimes considered as part of an adjunct therapy to support cardiovascular health and overall well-being in patients undergoing conventional antiretroviral therapy.

25) *Humulus Lupulus* (Common hop)

Family: Cannabaceae

Humulus lupulus, commonly known as hops, is a plant primarily known for its use in brewing beer, but it also has medicinal properties. The main parts of the plant used medicinally are the female inflorescences, commonly referred to as hop cones or strobiles.

Hops contain a variety of bioactive compounds, including Humulone, lupulone, and their derivatives, Xanthohumol, isoxanthohumol, and 8-prenylnaringenin Myrcene, humulene, and caryophyllene.

The compounds in hops, particularly flavonoids like xanthohumol, undergo metabolism primarily in the liver. Xanthohumol and its derivatives are metabolized into more active or less active forms through hydroxylation, methylation, and glucuronidation. These metabolites are then excreted through urine and bile.

26) *Calophyllum*

Family: Calophyllaceae

Calophyllum is a genus of flowering plants in the family Clusiaceae, comprising over 180 species. Among these, *Calophyllum inophyllum* is particularly notable due to its medicinal properties. *Calophyllum inophyllum* is the most commonly referenced species when discussing medicinal uses. The leaves, bark, seeds, and oil extracted from the seeds are the primary sources for therapeutic compounds.

These compounds are known for their broad range of biological activities, including anti-inflammatory, antioxidant, and antiviral effects. These are specific coumarins isolated from *Calophyllum inophyllum* that

have shown promising anti-HIV activity by inhibiting the replication of the virus. The metabolism of these compounds involves their interaction with viral enzymes, which can inhibit viral replication. However, the detailed metabolic pathways are still under investigation, and much of the activity is attributed to the inhibition of reverse transcriptase, an enzyme crucial for HIV replication.

The primary use of *Calophyllum inophyllum* in the context of HIV/AIDS is due to its antiviral properties. Research has shown that certain compounds extracted from the plant, such as inophyllum B and P, can inhibit HIV-1 reverse transcriptase, which is crucial for the replication of the virus. While not a mainstream treatment, extracts from *Calophyllum inophyllum* have been considered for potential complementary therapies in managing HIV/AIDS. However, it is essential to note that while the plant has shown in vitro efficacy, clinical studies are required to confirm its safety and effectiveness in humans. In some regions, the plant has been used in traditional medicine to treat skin infections, wounds, and other conditions, which indirectly supports the immune system in individuals with HIV/AIDS.

27) *Homalanthus nutan*

Family: Euphorbiaceae

Homalanthus nutans, also known as the mamala tree, is a plant species native to the Pacific Islands, particularly Samoa. It has gained significant attention due to its potential use in the treatment of HIV/AIDS. The key active compound isolated from *Homalanthus nutans* is prostratin. Prostratin is a phorbol ester, a type of diterpene compound. It is known for its ability to activate protein kinase C (PKC), which plays a role in various cellular processes.

Prostratin can activate latent HIV reservoirs, making the virus visible to the immune system or susceptible to antiretroviral drugs. This is crucial because one of the major challenges in curing HIV is the persistence of latent virus in the body.

It also downregulates the expression of the HIV receptor (CD4) and co-receptors (CCR5 and CXCR4) on the surface of host cells, reducing the ability of the virus to enter these cells.

Prostratin is not a standalone cure but is being studied as an adjuvant to current antiretroviral therapy (ART). By activating latent HIV, it could help to eliminate reservoirs of the virus, potentially contributing to strategies aimed at eradicating HIV from the body. While prostratin has shown significant promise in laboratory settings, clinical trials are still needed to determine its safety and effectiveness in humans. The goal is to use prostratin in combination with other therapies to purge latent HIV reservoirs, a key hurdle in curing HIV.

28) *Peltophorum africanum*

Family: Fabacea

Peltophorum africanum is a tree species found in tropical Africa. *Peltophorum africanum* is a member of the Fabaceae family. It's commonly found in countries like South Africa, Botswana, and Zimbabwe.

The tree's biological activity comes from various secondary metabolites, including flavonoids, saponins, and alkaloids. These compounds are thought to contribute to its medicinal properties through their effects on various biological pathways. *Peltophorum africanum* has been traditionally used in African medicine for various ailments. Some research indicates that extracts from the plant have antiviral properties, which could be relevant for HIV/AIDS treatment. Specific studies have shown that it may have some inhibitory effects on HIV, but more research is needed to establish its efficacy and safety as a treatment. It is not currently a mainstream treatment for HIV/AIDS, but it holds potential for further investigation.

29) *Melissa officinalis* (Lemon balm)

Family: Lamiaceae

Melissa officinalis, commonly known as lemon balm, is a herbaceous plant from the mint family (Lamiaceae). Its biological source is the leaves of the plant.

The primary bioactive compounds in *Melissa officinalis* include essential oils (such as citronellal, citronellol, and geraniol), flavonoids (such as luteolin and apigenin), and phenolic acids. These compounds are metabolised through various pathways in the body, potentially contributing to their therapeutic effects.

While *Melissa officinalis* is not a primary treatment for HIV/AIDS, it has been explored for its potential benefits in supporting overall health. Its antiviral properties, particularly against herpes simplex virus (HSV), suggest it might have some benefit in managing symptoms or supporting immune function. However, more research is needed to establish its effectiveness specifically for HIV/AIDS. It's essential to use such herbs as complementary to conventional treatments under medical supervision.

30) *Magnolia*

Family: Magnoliaceae

Magnolia is a genus of flowering plants in the Magnoliaceae family. The medicinally used parts of *Magnolia* are typically the bark and leaves of *Magnolia officinalis* (Houpu magnolia) and *Magnolia liliflora*.

The primary bioactive compounds in *Magnolia* include magnolol and honokiol, which are polyphenolic compounds. These compounds are metabolised in the liver, where they undergo various enzymatic transformations before being excreted.

Magnolia extracts, particularly magnolol and honokiol, have demonstrated antiviral, anti-inflammatory, and immune-modulatory properties in some studies. These properties might offer supportive benefits in managing HIV/AIDS, such as reducing inflammation or enhancing immune function. However, there is limited direct evidence supporting their use specifically for treating HIV/AIDS, and they should be used as complementary to conventional therapies rather than as a primary treatment. Always consult with a healthcare professional before using such supplements in the management of HIV/AIDS.

CONCLUSION

Given the widespread and increasing use of medicinal plants and herbal medicines, research should prioritise the identification of phytochemicals, with a focus on understanding their pharmacological effects, mechanisms of action, efficacy, and safety. Both physicians and patients must carefully assess the potential risks before commencing phytotherapy. Herbal drugs may provide supportive benefits in the management of HIV, such as boosting the immune system or alleviating symptoms. However, there is limited scientific evidence to support their efficacy in treating HIV directly. Importantly, some herbal remedies can interact with antiretroviral medications, potentially reducing their effectiveness or causing harmful side effects. Therefore, patients considering the use of herbal drugs should always consult with their healthcare provider to ensure safe and effective treatment. Integrating herbal remedies should be done under professional guidance, and they should never replace conventional ART, which remains the cornerstone of HIV treatment.

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