



Medicinal Plants as Potential Antiviral Agents in HIV Therapy

Mwende Muthoni D.

Faculty of Medicine Kampala International University Uganda

ABSTRACT

Despite the progress in antiretroviral therapy (ART), the emergence of drug resistance and side effects necessitates alternative approaches to HIV treatment. This review examines the potential of medicinal plants as sources of novel anti-HIV agents. Bioactive compounds such as flavonoids, terpenoids, and alkaloids have demonstrated antiviral properties through diverse mechanisms, including inhibition of viral replication and modulation of host immune responses. We discuss preclinical and clinical studies, challenges in standardization, and the synergistic potential of plant-based treatments with conventional therapies. Emphasis is placed on the need for rigorous clinical trials, multidisciplinary research, and ethical considerations to advance the development of plant-derived anti-HIV agents. This work highlights the promising role of traditional medicine in addressing gaps in HIV management.

Keywords: Medicinal plants, HIV therapy, Antiviral agents, Bioactive compounds, Traditional medicine.

INTRODUCTION

Despite the extensive availability of antiretroviral therapies, the prolonged use of these drugs and the development of drug resistance have contributed to the failure of such therapies in a certain population of individuals. In this sense, new approaches are important for the reinstatement of human immunodeficiency virus treatment success. Here, we aim to gather information regarding medicinal plants with anti-HIV activity, describing the main targets of action, the cellular and molecular mechanisms involved, pivotal clinical and preclinical studies that have been performed, ongoing research, and patents granted. We also discuss some misconceptions regarding traditional medicinal use and the incongruence with data resulting from scientific research. The need for new anti-HIV therapies has prompted a search for novel drug candidates in various botanical treatments, and several plant species exhibit promising antiretroviral activities. It is noteworthy that folk medicine still plays a significant role in the healthcare system of about 60% of the world's population. In this regard, some plant species possess a variety of therapeutic uses and represent a resource for the control of viral infections. Several plant species have been used for centuries to suppress or cure various types of diseases, and some are known to possess anti-HIV effects. Additionally, the bioprospection of plant species is supported by the current data regarding the anti-HIV activity of active principles purified from plants *in vitro* and *in vivo*. Some plants are currently being used in HIV-infected patients who have failed standard antiretroviral therapy, and several clinical trials are underway to clarify the effects of such plants [1, 2].

Overview of HIV and Current Treatment Strategies

Human Immunodeficiency Virus (HIV) is a transmittable pathogen belonging to the family Retroviridae. Upon contraction, it can lead to acquired immunodeficiency syndrome (AIDS) and remains one of the primary infections responsible for excess death. HIV primarily attacks immune cells and targets CD4+ cells in particular following transmission. Although AIDS cannot be contracted directly from a patient suffering from the syndrome, other forms of transmission include transfusions and the infancy-to-infant process during lactation. The infection initiates the destruction of CD4+ cells by reverse transcription. HIV acquisition leads to an eventual elevation in viral load, which in turn intensifies malaria, herpes, and tuberculosis associated with concomitant immunity suppression. Patients frequently experience

symptoms secondary to these and other infections such as fatigue, weight loss, and swollen glands. Several treatment strategies are used to manage a patient once diagnosed. Staging and monitoring of the infection are common and typically quantified by measuring the number of T helper cells present as compared to a healthy uninfected person. A high CD4+ cell count presents less risk of a healthcare-associated infection and therefore reduces the chances of hospitalization. HIV immunological consequences include associated decreased CD4+ cells (as it is the target of the virus), thereby limiting the ability of the host to produce an effective immune response. Current treatment strategies in place for HIV have limitations involving drug resistance, in addition to drug side effects. Unfortunately, there is no drug completely effective in treating HIV or eradicating the infection; therefore, a potential anti-HIV agent from medicinal plants might be considered [3, 4].

Antiviral Properties of Medicinal Plants

Emerging revelations suggest that various medicinal plants possess antiviral properties, acting through different mechanisms. These mechanisms depend on the active compounds, such as phenolics, flavonoids, terpenoids, alkaloids, and other bioactive compounds. The antiviral properties of these medicinal plants were identified using *in silico* approaches, *in vitro* assays, and *in vivo* models. Consequently, substantial evidence has been generated through *in vitro* studies identifying specific phytochemicals that possess potential antiviral properties. Of particular importance has been the bioactivity of terpenoids, proanthocyanidins, flavonoids, saponins, alkaloids, and tannins. Due to the synergy and antagonism of some of these plants, it is immensely difficult to classify medicinal plants based on their bioactive compounds that are capable of inhibiting viral replication completely. Nevertheless, we have provided a list of some of the important medicinal plants summarizing their traditional uses as well as evidence of anti-HIV activity [5, 6]. Most of the previous literature and research have reported antiviral compounds derived from medicinal plants in isolation. However, emerging evidence provides information on various bioactive compounds from different classes that can act on different targets for the same pathogenic organism. It is intriguing to observe that the bioactive compounds belonging to different classes, including flavonoids, terpenoids, alkaloids, and proanthocyanidins, possess broad-spectrum activity and demonstrate antiviral potential, targeting both HIV transcriptase and integrase enzymes. In this regard, different targets are being investigated for bioactive compounds derived from medicinal plants, including different viral proteins, viral DNA, viral RNA, and host cell enzymes. Medicinal plants have been used for years in traditional medicine to treat a variety of medical conditions, including viral infections, as a potential source of antiviral compounds due to their ingredients. This modulatory function may stimulate the well-being of patients in one way or another. The use of plant extracts can therefore be suggested as the best modulatory agent for sensitive immune cells to some drugs and serve as an indirect antiviral agent. Therefore, more research is needed to isolate and identify a potential compound based on its traditional use, as well as various properties such as antiretroviral and physiological properties. Furthermore, since they exhibit different levels and targets of antiviral activities, and therapeutic efficacy, and possibly have several immunological functions, bioactive compounds can represent new classes of anti-HIV molecules [7, 8].

Case Studies of Medicinal Plants in HIV Therapy

Wink and Van Wyk propose that if the health effect of a plant in traditional usage needs to be supported, it is necessary to find a plant-based preparation that has already been shown to be effective, safe, and standardized. In this review, various case studies describe the application of medicinal plants in AIDS therapy. This article discusses investigations of the extracts and/or compounds of several plants in cellular *in vitro* systems including St. John's wort, lion's tail, the South African stoebe, pig's ears, and the Chinese flowering ma-chastree. In addition, clinical studies in HIV-positive individuals using St. John's wort and Chinese ma-chastree have also been investigated. Traditional medicine claims several plants to be effective in the treatment of AIDS. The efficacy of some of these plants has already been researched or is under investigation, such as *Sutherlandia frutescens*, *Athrixia phylicoides*, *Hypericum perforatum*, *Leonotis leonurus*, *Combretum microperyum*, *Harinatibia alba*, and *Calluna vulgaris*. Some plant species in this review have a long history of use in treating tuberculosis and syphilis. Their potential in the treatment of AIDS has not yet been investigated. Alternatively, the biochemical properties of these plant species are more relevant to the management of opportunistic infections associated with AIDS. Finally, some plants are included because of anecdotal reports that they are effective in the treatment of AIDS. HIV/AIDS has a debilitating effect on human populations. Individuals identified with the virus will eventually require antiretroviral or other drugs, and even then, disease progression could result in

morbidity and mortality. The high cost of this treatment in developing countries necessitates alternative interventions. Although some research has provided a sound scientific basis for the development of antiretroviral drugs derived from medicinal plant products, the research methodologies used have not been flawless. In this paper, we highlight some serious methodological challenges and attempt to provide more benchmark criteria that will result in developments that could be the most beneficial. The value of traditional medicine lies in three main components: the ethnomedical approach, the psychological effect, and limited population-based clinical research data on anti-HIV activities in rural communities living with HIV/AIDS, as well as the potential for drug development [9, 10].

Challenges and Future Directions

Even though plants have been proposed as a source of new potential antiviral agents for HIV therapy, the composition of bioactive compounds showing antiviral activity in plant extracts is quite complex, as well as the different structures of these compounds. Plant extracts from the same species contain different concentrations of their bioactive compounds, depending on factors such as the ecological conditions of plant growth, botanical parts used, and method of preparation. Another problem is the complex structure of plant material and the massive existence of inactive compounds within extracts. Despite the research efforts of some groups to identify medicinal plants with anti-HIV activity, well-designed and rigorous clinical trials to establish their *in vivo* efficacy and safety, as well as their possible areas of application, are still lacking. The main difficulties associated with the use of traditional and herbal supplies as antiviral agents are as follows: variability of active compound content in the plant material, lack of well-designed clinical trials for most commercially offered herbal products in autoimmune diseases, and opening questions related to the combined use of such preparations with standard antiviral therapy to improve results or reduce the doses of synthetic drugs or increased toxicity levels after joint therapies [11, 12]. The main obstacles to developing herbal agents in treating HIV and other infections include the complexities associated with the compositions of herbal mixtures and their proper analysis, ethical challenges linked to the use of animal models, and their potential limitations, as well as challenges related to the legal or financial commitment to commercialize them as potential drugs. Moreover, related to the potential toxicity, medicinal plants should meet at least three criteria: being tested on cell-based assays, initial determination of the absorption, distribution, metabolism, and excretion profile, and a 28-day study in rats with a single oral dose. Proper evaluations of medicinal plants against HIV must consider these important issues through extensive collaborations such as seminars, workshops, panels, and groups of experts. Furthermore, multidisciplinary research groups such as pharmaceutical, biomedical, phytochemical, and preclinical and clinical pharmacological groups should increase their research in traditional and herbal treatments for AIDS, as a potentially endless source of novel agents in AIDS treatments. However, it is also important to educate health professionals and communities to understand the potential applications of herbal medicine, as well as its limitations, side effects, adverse events, and potential drug interactions. Finally, combinatory treatments of herbal and synthetic antiviral agents should be investigated for possible increased benefits for HIV treatments [13, 3].

CONCLUSION

Medicinal plants represent a promising frontier in HIV therapy, offering novel bioactive compounds with unique mechanisms of action. The integration of traditional knowledge with modern scientific research has uncovered several plants with significant anti-HIV potential, supported by preclinical and emerging clinical evidence. However, challenges such as variability in active compound concentration, lack of rigorous trials, and potential safety concerns must be addressed. Collaborative efforts among pharmaceutical, biomedical, and phytochemical disciplines are crucial to overcoming these hurdles. Moreover, education on the benefits and limitations of herbal medicines, alongside the exploration of combinatory therapies with standard ART, could revolutionize HIV treatment strategies. Moving forward, medicinal plants hold the potential to contribute significantly to sustainable and accessible HIV management, especially in resource-limited settings.

REFERENCES

1. Jaisi A, Prema, Madla S, Lee YE, Septama A, Morita H. Investigation of HIV-1 Viral Protein R Inhibitory Activities of Twelve Thai Medicinal Plants and Their Commercially Available Major Constituents. *Chemistry & Biodiversity*. 2021 Dec;18(12):e2100540. [HTML]
2. Attah AF, Fagbemi AA, Olubiyi O, Dada-Adegbola H, Oluwadotun A, Elujoba A, Babalola CP. Therapeutic potentials of antiviral plants used in traditional african medicine with COVID-19 in focus: a Nigerian perspective. *Frontiers in pharmacology*. 2021 Apr 26;12:596855. [frontiersin.org](https://www.frontiersin.org)

3. Alum EU, Uti DE, Ugwu OP, Alum BN. Toward a cure—Advancing HIV/AIDs treatment modalities beyond antiretroviral therapy: A Review. *Medicine*. 2024 Jul 5;103(27):e38768.
4. Ma Y, Frutos-Beltrán E, Kang D, Pannecouque C, De Clercq E, Menéndez-Arias L, Liu X, Zhan P. Medicinal chemistry strategies for discovering antivirals effective against drug-resistant viruses. *Chemical Society Reviews*. 2021;50(7):4514-40. csic.es
5. Denaro M, Smeriglio A, Barreca D, De Francesco C, Occhiuto C, Milano G, Trombetta D. Antiviral activity of plants and their isolated bioactive compounds: An update. *Phytotherapy Research*. 2020 Apr;34(4):742-68. [\[HTML\]](#)
6. Parham S, Kharazi AZ, Bakhsheshi-Rad HR, Nur H, Ismail AF, Sharif S, RamaKrishna S, Berto F. Antioxidant, antimicrobial and antiviral properties of herbal materials. *Antioxidants*. 2020 Dec 21;9(12):1309. mdpi.com
7. Bachar SC, Mazumder K, Bachar R, Aktar A, Al Mahtab M. A review of medicinal plants with antiviral activity available in Bangladesh and mechanistic insight into their bioactive metabolites on SARS-CoV-2, HIV and HBV. *Frontiers in Pharmacology*. 2021 Nov 8;12:732891. frontiersin.org
8. Mandal A, Biswas D, Hazra B. Natural products from plants with prospective anti-HIV activity and relevant mechanisms of action. *Studies in natural products chemistry*. 2020 Jan 1;66:225-71.
9. Owodunni AA, Ismail S. Revolutionary technique for sustainable plant-based green coagulants in industrial wastewater treatment—A review. *Journal of Water Process Engineering*. 2021 Aug 1;42:102096.
10. Alhazmi HA, Najmi A, Javed SA, Sultana S, Al Bratty M, Makeen HA, Meraya AM, Ahsan W, Mohan S, Taha MM, Khalid A. Medicinal plants and isolated molecules demonstrating immunomodulation activity as potential alternative therapies for viral diseases including COVID-19. *Frontiers in immunology*. 2021 May 13;12:637553. frontiersin.org
11. Khan T, Khan MA, Ullah N, Nadhman A. Therapeutic potential of medicinal plants against COVID-19: The role of antiviral medicinal metabolites. *Biocatalysis and agricultural biotechnology*. 2021 Jan 1;31:101890. nih.gov
12. Behl T, Rocchetti G, Chadha S, Zengin G, Bungau S, Kumar A, Mehta V, Uddin MS, Khullar G, Setia D, Arora S. Phytochemicals from plant foods as potential source of antiviral agents: An overview. *Pharmaceuticals*. 2021 Apr 19;14(4):381. mdpi.com
13. Hossain CM, Gera ME, Ali KA. Current status and challenges of herbal drug development and regulatory aspect: a global perspective. *Asian J. Pharm. Clin. Res*. 2022;15:31-41.

CITE AS: Mwende Muthoni D. (2024). Medicinal Plants as Potential Antiviral Agents in HIV Therapy. RESEARCH INVENTION JOURNAL OF SCIENTIFIC AND EXPERIMENTAL SCIENCES 4(3):23-26.
<https://doi.org/10.59298/RIJSES/2024/432326>