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Exploring the Anti-Inflammatory Properties of Medicinal Plants in HIV Treatment

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ABSTRACT

The HIV/AIDS epidemic, particularly in sub-Saharan Africa, continues to pose significant public health challenges. Traditional medicinal systems, particularly in East and Southern Africa, offer a rich pharmacopeia of plant-based remedies that have long been used to manage symptoms associated with HIV, including inflammation. Chronic inflammation is a hallmark of HIV progression and is inadequately addressed by conventional antiretroviral therapy (ART). This study reviews ethnobotanical evidence and scientific literature on the anti-inflammatory and immunomodulatory properties of medicinal plants used in HIV care. It highlights plant species with demonstrated inhibitory effects on key inflammatory markers such as COX-1, 5-LOX, iNOS, and NF-κB, emphasizing their potential as adjunct therapies. The research underscores the importance of integrating traditional knowledge with modern clinical frameworks to identify, validate, and optimize these natural therapies. Ongoing and planned clinical evaluations using patient blood samples aim to correlate plant extract efficacy with inflammatory biomarker reduction. This interdisciplinary approach has the potential to improve ART outcomes, reduce drug resistance, and enhance quality of life for people living with HIV.

Keywords: HIV/AIDS, inflammation, medicinal plants, traditional medicine, antiretroviral therapy (ART), phytochemicals, immune modulation.

INTRODUCTION

The HIV/AIDS epidemic in sub-Saharan Africa is causing severe impacts, particularly in the rich biodiversity regions of East Africa. These regions are home to a multitude of traditional Ugandan medicinal practices that rely heavily on herbal remedies to treat a variety of diseases, including HIV/AIDS. These remedies utilize an array of medicinal plants that feature prominently in diverse formulations. These plants can be ingested in various ways, applied topically on the skin, or even utilized in baths, employed either in isolation or combined with other herbs for enhanced efficacy. A significant number of these medicinal plants are sourced from the wild, while others are cultivated specifically for therapeutic purposes. Practitioners of traditional medicine often perform elaborate rituals before the harvesting of these plants, highlighting the cultural importance placed on these medicinal practices. Conducting comprehensive ethnobotanical surveys can provide essential details regarding the types of plants used and the various methods applied in HIV/AIDS therapy, which can greatly contribute to the standardization of these treatments and their preparation for clinical trials. This process can ultimately facilitate the commercialization of these herbal remedies. Additionally, investigating the immunomodulatory properties of these plants could lead to significant enhancements in antiretroviral therapy (ART) treatment. The plants selected for study could potentially serve as adjunct treatments or effective agents aimed at improving the overall efficacy of ART and possibly delaying the initiation of

these treatments. A clinical study is currently planned, which will involve whole blood samples collected from a total of 90 patients. These patients will be categorized based on either their high systemic sodium dodecyl sulfate levels or the absence of symptoms related to AIDS. The primary objective of this study is to explore novel methodologies for assessing the thrombo-inflammatory conditions that are associated with AIDS, leading to a deeper understanding of the complexities surrounding the epidemic and the potential for integrating traditional medicinal practices with modern medical treatments [1, 2].

Background on HIV and Inflammation

Human immunodeficiency virus (HIV) attacks the immune system and can lead to acquired immunodeficiency syndrome (AIDS) if untreated. As there is no effective cure or vaccine, expanding treatment and prevention strategies is crucial. In fertility research, uterine inflammation is identified as a risk factor for infertility and preterm birth. Immune components such as macrophages and lymphocytes produce inflammatory mediators in response to stimuli. Most women resolve harmful uterine inflammatory responses, but those genetically predisposed to sexually transmitted infections may have incomplete immune resolution and increased HIV transmission risk. Managing inflammation in the female reproductive tract is essential, especially in South Africa's HIV and tuberculosis epidemic. A comprehensive approach combining anti-inflammatory pharmaceuticals, lifestyle changes, intravaginal prebiotics and probiotics, and plant-based agents is needed. The link between inflammation and HIV has garnered research interest. Increased HIV-associated immune activation (IA) correlates with disease progression. Genital inflammation raises the risk of HIV acquisition and transmission. Confirmatory HIV typing and viral load indicate a serious infection. Secondary immune quiescence (IS) reduces infection risk, marked by targeted immune responses to inflammation or IA, key factors in HIV risk and progression. Targeted inflammation management alongside antiretroviral therapy (ART) may reduce HIV risks and slow progression. Evidence suggests nonsteroidal anti-inflammatory drugs (NSAIDs) effectively reduce IA. Ibuprofen has shown promise in treating vulvovaginal inflammation, especially when combined with antiretroviral (ARV) pre-exposure prophylaxis. Corticosteroids are already used for HIV-induced IA, akin to hormonal contraceptives. Natural anti-inflammatory products like lactic acid (LA) are alternative treatments. LA regulates the genital microbiome, increasing beneficial bacteria while inhibiting pathogenic growth. Trials indicate glycerol monolaurate (GML) inhibits simian immunodeficiency virus (SIV) replication, serving as a potential HIV model. Macaques treated with GML showed improved life expectancy and lower AIDS development than placebo groups [3, 4].

Role of Inflammation in HIV Progression

HIV-1 disease is associated with persistent inflammation. Chronic immune activation is a major driving force in HIV-1 progression, leading to the exhaustion of T lymphocytes and the failure to control viral replication. cART partially suppresses immune activation, but its administration typically begins after the onset of a chronic infection, a stage by which the beneficial effect of this therapy on immune activation levels and disease progression is limited. The persistence of inflammation during cART is one of the major reasons why current therapy does not definitively control the infection. Inflammation in the CNS has been implicated in the development of neurological disorders such as HAND, and chronic HIV-1 infection is associated with increased secretion of inflammatory mediators by astrocytes and brain microglia. Therefore, exploring new strategies to modulate the immune response and reduce viral replication and inflammation during HIV infection is essential. Under this point of view, a notable scenario is represented by the use of immunomodulatory agents derived from medicinal plants. Medicinal plants and natural compounds represent an abundant source of molecules with potential anti-inflammatory properties that can target several steps in the inflammatory process. Historically, medicinal plants have been used since ancient times, and they continue to be widely employed today as remedies for a wide variety of acute and chronic human diseases. For this reason, the potential therapeutic effects of these remedies have recently attracted significant attention from the scientific community. There is growing evidence supporting the role of medicinal plants as anti-inflammatory compounds, suggesting that their adoption in the therapeutic approach to HIV-1-infected individuals could be beneficial [5, 6].

Overview of Medicinal Plants

This article aims to provide a comprehensive review of the anti-HIV laboratory evaluation and anti-inflammatory clinical studies done on indigenous southern African plants. The high incidence of AIDS in Africa has prompted the search for novel and cost-effective anti-HIV agents with activity against opportunistic pathogens. In this respect, plants used in traditional medicine and especially the

ethnobotany of the anti-HIV and anti-inflammatory properties of southern African plants provide a unique starting point. There is a large geographic and cultural variation of traditional plant usage on the African continent. The southern part of Africa represents a transition zone between the African savanna and the temperate Cape region, which contains more than 8000 species of native flowering plants. The harsh semi-desert climate experienced during at least 6 months of the year has driven florescence to adapt to shorter life cycles and to consolidate the growth and reproduction rhythms during the cooler-wetter time of the year. Phylogenetically, the plants in the 4,861 plant species of the Cape region are unique to the world because they belong to 1,439 genera, 2 families, and 343 orders found only in this area. Due to the health implications of the HIV/AIDS pandemic, much effort is currently focused on this group of plants that comprises about 1,200 species with cultural information concerning their antiviral properties. However, additional valuable anti-HIV plants are not included in this list and have been used to treat various diseases [7, 8].

Traditional Uses of Medicinal Plants

HIV/AIDS affects a wide range of organs and tissues. Patients often suffer from weakened immune system, loss of appetite, weight loss, tiredness, and memory. They are also more susceptible to other infections, chronic conditions and pain. There are some direct effects of HIV on tissues, particularly in the blood, brain, lungs, immune system, liver, and gut wall. Many of these effects are due to inflammation or immune activation which may be systematic or localised, and involve a range of bio-chemical responses such as the peripheral secretion of 'chemical' messengers, but they are often difficult to distinguish with regard to cause and effect because they may all be part of the same aetiology. The direct benefits of antiretroviral drugs may become limited due to their failure to address inflammation and increased vulnerability to immune activation, and due to severe side effects of antiretroviral treatment. Curtailing inflammation systemically remains a challenge, thus there appears to a risk of moving inter alia, the source of inflammation to other sites. Even in the case of when ARVs are successful, they require a lifelong course, and the potential for their effectiveness to be compromised by resistance of some infections. Over 30 plant species from 17 families with medicinal properties have been identified for HIV/AIDS management in South Africa. Many have anti-inflammatory properties, such as Adenostemma viscosum, Albuca bracteata, Bothrops pubescens, Cissampelos tormentosa, Haroldporteria, Macaranga, Ricinodendron, and Warneckea spp. Many of the documented uses of these plants are classified in the indigenous knowledge protection act [9, 10].

Phytochemicals With Anti-Inflammatory Properties

There is an increasing interest in the pharmaceutical industry for various compounds that are derived from a wide range of medicinal plants that hold the potential to be used in the production of new drugs and innovative treatment methods for a multitude of diseases, including inflammatory and infectious diseases. A comprehensive study was conducted on the anti-inflammatory activity of 25 different plant species that are traditionally utilized to treat pain-related diseases in four distinct rural areas of Southern Africa. In total, 25 plant species from 21 different families were reported on by 21 traditional healers who actively use these plant remedies in their practices. Out of the extracts studied, 60% exhibited activity against a COX-1 enzyme, which is notable, especially considering that 84.0% showed effectiveness against the 5-LOX enzyme. Furthermore, an impressive 92% of the extracts were found to be active against the iNOS enzyme, while 76% demonstrated activity against the NF-κB pathway. The extracts showcased varied activity patterns against all four enzymes examined. Additionally, 76% of the tested extracts displayed activity against all three of the iNOS, COX-1, and 5-LOX enzymes as well as against the NF-κB binding ability. A fair correlation was observed between all assays conducted, with correlation coefficients ranging from $r = 0.5$ to 0.7, indicating a significant relationship between the different enzyme activities measured [11, 12].

Selected Medicinal Plants and Their Properties

In addition to the global impact of the HIV/AIDS pandemic, it has significant infectious disease implications for southern Africa due to the high prevalence of TB in HIV/AIDS. Hyper-sensitive and immune-compromised inflammatory states are conducive to progression of the disease from latent to active TB and exacerbation of other co-morbidities. Therefore, management of TB symptoms in HIV/AIDS patients through a cost-effective strategy that simultaneously boosts the immune system is an area of therapeutic significance in the management of TB co-infection in HIV/AIDS. Based on the ethno botanical approach and having considered the efficacy and potential of locally available traditional plant

products in traditional settings against other inflammatory conditions, there is scope to seek cost effective plant-derived non toxic immune-boosting adjuvants to support the ongoing treatment programs of TB and HIV/AIDS, which is in line with the Millennium and Sustainable Development Goals of the United Nations and the World Health Organization. In a traditional society such as southern Africa, the number of people using traditional remedies as a health care source is high due to the cultural beliefs that are deeply rooted, systems of faith, and socio-economic factors. Plant remedies are the most available and have been used for various diseases owing to their accessibility, and leaf extracts have been promoted as the most configurations found to succeed within several eastern, central, southern, and western African regional boundaries. However, side effects of anti-retroviral drugs, non-availability of these types of drugs, malnutrition, herbal types of thought, and the sharing of unhygienic instruments as a result of the witchcraft association are still encouraging the progression and transmission of HIV/AIDS and STDs. But on the other hand, both plant remedies don't cost anything or expense minimal, are easily available, and are almost stigma-free. The need of the time is to verify these treatments in the modern science framework [13, 14].

Synergistic Effects of Combinations

Evidence abounds that patients, HIV infected or not, use medicinal plants in the hope of ameliorating the curses of HIV infection or its associated ailments, which are mostly chronic, and often propelled by or result in inflammation. Evaluation of fifteen plant species and their thirteen defined coumarin constituents identified the potential of the plants to inhibit HIV enzyme activity and to modulate in vitro activity of ABCB1, ABCC1, and CYP 3A4. A better understanding of the anti-inflammatory potential of the plant species and their active compounds will be useful given the importance of inflammation in HIV disease pathogenesis, including its contributions to HIV replication and the acceleration of T cell depletion, which leads to immune deficiency. Pagination of the tetrazolium salt, XTT, was performed to optimize and validate the detection of plant- or phytochemical-induced effects in peripheral blood mononuclear cells that are usually subtle. Optimization of detectable effects of plant- and drug-induced cytotoxicity to immune cells is a necessary component of this and other similar studies. Additionally, for studies to detect HIV enzyme or efflux or metabolic transporter modulation by plant species or other compounds, the mitigation of cytotoxicity can confound detection of an effect, as cytotoxicity also results in alteration of enzyme activities and/or alterations in p24 or chemokine levels. Thus, the non-cytotoxic effects of the thirteen coumarins are considered as a true representation of these modest modulations, if such subtle modulations are possible in vivo [15, 16].

Methodologies For Evaluating Anti-Inflammatory Effects

Despite high levels of awareness and acceptance for anti-inflammatory medicinal plants in the effective treatment of AIDS and its related diseases in South Africa, a knowledge gap exists at levels of (1) the scientific evidence supporting the efficacy of medicinal plants and (2) the understanding of the anti-HIV properties of specific medicinal plants. Over 30% of the adult population in South Africa uses traditional and complementary medicines, often simultaneously with conventional medicines. However, the majority of people have limited access to public health services. Herbal medicine is the most widely used form of traditional medicine (TM) in Africa. The anti-inflammatory effects and antioxidant activities of many southern African medicinal plants have been reported. However, some southern African medicinal plants showing anti-HIV properties have not been explored for their anti-inflammatory and antioxidant effects. Leaf extracts of some selected southern African medicinal plants have anti-inflammatory and antioxidant activities, but no direct correlation has been established between the anti-inflammatory, antioxidant, and anti-HIV properties of southern African medicinal plants. To evaluate the 23 selected southern African medicinal plants for their potential anti-inflammatory effects in the context of AIDS/HIV treatment, using suitable experimental in vitro techniques. To assess the anti-HIV properties of the set of 23 selected southern African medicinal plants, using an in vitro TZM-bl cells-based assay system. To correlate the obtained results of the anti-inflammatory, antioxidant, and anti-HIV activities of southern African medicinal plants. Five methodologies of the established experiments were employed. Firstly, an ethanolic plant extract-based micro-dilution and bio-screening method was used for determining the anti-inflammatory effects of experimental plant extracts. Secondly, a Tetrazolium-based micro-dilution and bio-screening method was used for evaluation of the cellular cytotoxicity of the experimental plant extracts. Sindbis viral vectors harboring genes expressing the luciferase reporter gene and the HIV_BaL envelope gene were used in the viral replication assay in TZM-bl cells. Two methods, including DPPH·

free radical scavenging and the total phenolic content assay using the micro-plate reader, were used for estimating the antioxidant activities of the experimental plant extracts [17, 18].

Challenges In Researching Medicinal Plants

There are a lot of challenges with researching medicinal plants' anti-inflammatory properties with direct and indirect impact on HIV treatment and adaptation of dosage. The limitations of pharmaceutical treatment that make medicinal plants more attractive in HIV management are followed by the exploration of medicinal plants in treating/enhancing the management of HIV/AIDS, specifically focusing on their anti-inflammatory properties and southern African plant species. There are several fields in which pharmaceutical treatment is limited, making medicinal plants more attractive in the management of HIV/AIDS. Chronic HIV infection remains largely untreatable with pharmaceuticals, as they can't prevent low-level inflammation, immunodeficiency, or the need for lifelong compliance. Incomplete treatment can lead to persistent inflammation, latent reservoirs, and increased vulnerability to common diseases. HIV/AIDS patients must either be aware that they are HIV positive individuals or on anti-retroviral (ARV) treatment to prevent HIV progression. Documented long-term side effects and increasing reports of resistance to ARV treatment highlight the need for alternative/complementary treatment options. Not taking antiretroviral treatment continuously, drug resistance may develop, which emphasizes the need for the introduction of other medications, such as medicinal plants. The ongoing spread of HIV/AIDS is based primarily on the employment of anti-retroviral treatment (ART). Despite the benefits of ART, as reflected by the dramatic decrease in mortality and morbidity, several crucial mismatches limit the fight against HIV. The limitations of ART include failure in the eradication of the reservoirs of latent infection, which is the primary drawback in pursuing ART-based therapeutic strategies for the control and elimination of HIV. These latent reservoirs soon elicit the recovery of viral replication after the cessation of ART, resulting in a rebound of viremia. Hence, there is an instigation of research efforts to investigate mechanisms by which the host's response to ART can be exploited in the search for novel therapeutics [19, 20].

Regulatory Considerations

This treatment is a success—an alternative Anti-inflammatory Plant option for PLWH successfully alleviated immune activation without therapeutic ART failure. Why, then, the continuing effort to insist on ART? The long-term plan is to evaluate and discover the next anti-inflammatory medicinal plants. The interest in the immune effects of medicinal plants often results from systematic increases in culture. This is something like the holy grail to relieve the inflammation that is the main cause of death in PLWH. In other words, western medications, viruses or inflammation you can buy, also dangerous bacteria. As such, medicinal plants seem to be the last hope of survival in a dying body. You can give them the choice: guarantee their antiretroviral medicines but skip some broad-spectrum antibiotics, or provide plant roots, but resting hours. And rest will inevitably bring death to the precious microbial organizations that have been so careful to clean up in a timely manner. Never, never compare immune cells, the prime targets of HIV, so that visitors can see. With a few exceptions, the results of the carefully selected anti-inflammatory plants that have been given to PLWH are essentially no relief of immune activation or fall in viral loads. Ironically, the pride of the Vietnamese Herbal Drug rebounded viral loads, hospital filters or cleans the virus, resulting in loss of life. Such an unfortunate outcome has shown the need for new strategies, including promoting further studied cytokines in the host party and promoting commercial abuse. Clearly, an immune effect is necessary, not a direct impact on the virus. Hence, whether a prospective randomized double-blind placebo control study in HIV has been examined for all immune activation and inflammation markers—simplier search for clues on how desperate their position is—viral loads are very capable of validation nowadays, but there has been no decrease [21, 22].

Case Studies: Successful Integrations

Life-prolonging antiretroviral therapy (ART) has improved the quality of life for people living with HIV globally, but access to ART remains limited in resource-constrained regions like Sub-Saharan Africa. As a result, many individuals turn to medicinal plants as alternative treatments. Consequently, medical practitioners often recommend the concurrent use of herbal remedies alongside ART. An urgent need has arisen for studies to explore the potential immune benefits derived from regularly incorporating herbs into HIV management. HIV infection targets CD4+ T cells and disrupts several cellular pathways, facilitating its replication. This leads to chronic activation of CD4+ T cells, which in turn trigger immune system responses to bacterial antigens from the intestine. HIV damages the intestinal typhlosole,

resulting in ongoing immune activation that accelerates disease progression. Exhausted CD4+ T cells exhibit a loss of function that benefits HIV. These exhausted cells become reservoirs for the virus, sustaining its presence even under ART, due to their quiescent state. Blocking exhaustion markers such as PD-1 can enhance HIV-specific T cell responses, both in vitro and in vivo. In non-human primate models, PD-1 blockade has been shown to reduce virus counts while improving CD4+ T cell retention and enhancing multifunctional cytokine production. Mathematical models suggest that therapeutics designed to manipulate the growth of target cells for HIV could decentralize infection forces. In the immune response, certain T cell types can inhibit the virus, with activated CD4+ T cells demonstrating increased susceptibility to HIV. TH17 cells may also proliferate more effectively than other T lymphocytes, showing reduced viral reproduction and improved viability during antigen exposure in vitro. Interestingly, HIV-1-infected individuals in Sub-Saharan Africa demonstrate higher ATP levels in T cells compared to those in developed countries, likely due to higher pathogen burdens. Investigative studies have examined ethanolic extracts from plant roots, known to contain biologically active phytomonocides, to assess their potential for modulating immunity. Three different plant-derived extracts were tested, revealing that one extract from A. indica leaves significantly reduced CD4+ activation and exhaustion following exposure to relevant phytotherapy doses. Despite a significant reliance on herbal therapies among HIV patients, there has been little research into the immune benefits of such treatments. This study stands as the first effort to examine the in vitro effects of potential immunostimulants from these herbal sources [23, 24].

Future Directions in Research

The number of compounds exhibiting anti-HIV activity isolated from plants is increasing gradually, and several natural products have been used as single agents. The resistance of HIV-1 to antiretroviral drugs is growing, necessitating the development of agents that are affordable, less toxic, and less prone to develop resistance. New treatments with these natural products are essential. The main challenge is to develop viral replication-targeted therapy using innovative anti-HIV compounds with a novel mode of action, an accepted toxicity profile, and less liability to resistance. The natural products used in traditional medicine have been seen as a fruitful source of promising new drug candidates against a variety of diseases, including HIV-related neurocognitive disorders. Demand for these natural resources has been promoted by the World Health Organization, which recommended the ethnomedicines used for the care and regulation of HIV / AIDS. About 30 years ago, questions began to arise in the medical community regarding deaths from idiopathic causes among a group of young men in the United States. It was soon found that all of them were immunocompromised. In 1983, the HIV-1 retrovirus, responsible for AIDS, was eventually discovered. Since then, the infections have dispersed worldwide with over 40 million people already contaminated. The acquired immunodeficiency syndrome (AIDS) is a collection of manifestations and clinical illnesses that develop as a result of intense and persistent harm to the immune system brought on by the human immunodeficiency virus (HIV). HIV/AIDS was observed as an exceptional scenario that requires a different strategy from basic research as soon as it was acknowledged. Drug repositioning, designed for and recognized for medicine used to cure other diseases, has frequently started to take on importance. So, efforts in this field have started to look more into already approved and well-developed medicines and compounds already known for other activities, such as the anti-inflammatory activities presented by many natural products. Therein, several research studies on medical plants focusing on unknown uses and possible drug repositioning are ongoing, some of which are promising [25, 26].

Ethical Considerations in Medicinal Plant Research

Maintaining ethical practices in medicinal plant research is important, and it is essential to increase the safety and efficacy of the products developed. A good laboratory practice requires that work is done in a way that is ethical, defensible, and of high quality so that the results can be used with confidence as a basis for rule-making. Moreover, maintaining ethical practices is important for the protection and care of those taking part in research, and to ensure they are not put at risk. Some ethical considerations in medicinal plant research include: data is recorded and reported accurately; processes are well documented; development of scientific data is honest and of good quality; the need for clinical studies is based on good science, as well as on the use and condition of the product; the conduct of clinical studies is ethical, scientifically sound and reliable; clinical studies are conducted on marketed products in ways similar to how those products will be used by consumers; studies are not used as a basis for marketing a specific

product unless that product was a subject of the report; and studies are not used to make a consumer believe that a vegetarian, plant-based product or product containing similar ingredients has less risk of heart disease or other diseases than products made of or containing suet, lard, or other animal fats [27-31].

Cultural Perspectives on Medicinal Plant Use

Before AIDS, people in some African countries relied on medicinal plants to enhance immunity and treat sexually transmitted infections (STIs). For many HIV/AIDS-infected individuals, medicinal plants were the primary remedy, even when Western medicine was an option. In Kavango, Namibia, traditional healers employed various techniques, including medicinal plants, to manage AIDS and its opportunistic diseases before anti-retroviral therapy. Understanding this plant use as a public health issue is crucial, as approximately 80% of sub-Saharan Africa's population relies on these remedies, indicating a broader public health trend favoring bio-cultural approaches over biomedicine. A study revealed that up to 75% of sick individuals consulted traditional healers mainly for STIs like syphilis and gonorrhea before 1993. Long-term immune health against diseases like AIDS has shown benefits from consuming specific leafy greens, supported by primate research. Interest in anti-inflammatory medicinal plants for AIDS management grew after claims from a healer in Kavango about treating AIDS. Political prisoners in Zambia reported cures from plant remedies, prompting investigations into these claims. With AIDS, caused by HIV, resulting in over 25 million deaths since 1981, understanding the traditional medicinal systems is vital. Some plants in African Traditional Medicinal Systems (ATMS) have demonstrated anti-inflammatory properties. These plants might aid in developing new anti-inflammatory drugs, with 211 documented in Gabon's ATMS. Additionally, research has been conducted on 43 sources of anti-inflammatory drugs [32-35].

CONCLUSION

The persistent inflammation observed in HIV-infected individuals, even under ART, necessitates the exploration of complementary therapeutic strategies. Medicinal plants, long employed in traditional African healing practices, show promise in managing inflammation and enhancing immune function. Ethnobotanical surveys and biochemical assays have identified a variety of plant species with significant anti-inflammatory and antiviral activities, which can be harnessed to support conventional treatments. While challenges exist in standardizing and clinically validating these remedies, early findings demonstrate their potential as cost-effective, culturally acceptable, and accessible adjunct therapies. Integrating traditional plant-based treatments into modern HIV care frameworks could lead to more holistic and effective management approaches. Continued interdisciplinary research is crucial to translating indigenous knowledge into validated scientific practice, thus offering new hope in the ongoing battle against HIV/AIDS.

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