Research Output Journal of Biological and Applied Science 5(2):26-30, 2025

ROJBAS Publications ONLINE ISSN: 1115-9200

https://rojournals.org/roj-biological-and-applied-science/ PRINT ISSN: 1115-6120

https://doi.org/10.59298/ROJBAS/2025/522630

Investigating the role of Medicinal Plants in HIV-Related Cognitive Decline

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ABSTRACT

HIV-associated neurocognitive disorder (HAND) presents a significant challenge in the management of HIV, particularly as individuals with the virus live longer due to antiretroviral therapy (ART). Despite the promise of ART in managing viral loads, cognitive impairments persist in a considerable number of HIV patients, affecting their quality of life. Currently, no effective treatments exist beyond ART, highlighting the need for complementary therapies. This review examines the potential role of medicinal plants in alleviating HIV-related cognitive decline. It discusses the mechanisms by which these plants may exert neuroprotective effects, including antioxidative, anti-inflammatory, and neurogenesis-promoting properties. Additionally, the article evaluates experimental studies and clinical trials on medicinal plant-based interventions, providing insights into their therapeutic potential. While preliminary findings suggest some promise, further research is needed to validate the efficacy of these treatments in the context of HIV-related cognitive impairments. The article also underscores the importance of integrating traditional medicine with modern therapeutic strategies to enhance patient care.

Keywords: HIV-associated neurocognitive disorder (HAND), cognitive decline, medicinal plants, neuroprotection, antiretroviral therapy (ART), oxidative stress, inflammation.

INTRODUCTION

HIV infection leads to cognitive problems in a considerable number of affected individuals. The term HIV-associated neurocognitive disorder (HAND) reflects the impact of the virus on various aspects of neurological function. In current HIV care, recognition and treatment of cognitive impairments are becoming increasingly relevant since people living with HIV are getting older and age-related cognitive decline is a major concern. Various mechanisms contribute to the development of HIV-related cognitive impairments, with a possible role for the virus itself, immune activation, inflammation, and cerebrovascular disease. Additionally, patients with HIV have similar rates of Alzheimer's disease pathology compared to their uninfected peers, suggesting that vascular pathology and innate immune markers may also play a role in the development of HAND [1, 2]. To date, there is no approved treatment for HIV-related cognitive decline besides antiretroviral therapy. Moreover, antiretroviral therapy does not amend cognitive deficits in all people living with HIV and has several limitations such as side effects, concerns about adherence, or financial constraints. Efficacious treatment options are limited, although significant research has been conducted on this topic. Therefore, there is value in exploring complementary and alternative treatments. For centuries, medicinal plants have been utilized to ameliorate ailments related to cognitive function, particularly to address the end of life. A substantial number of experiments demonstrate that medicinal plants can ameliorate different aspects of cognitive function in both rodents and humans. It is important to explore the likely role of these plants in

decreasing neurocognitive decline induced by HIV. The aim of this concise survey is to outline this relationship and discuss the implications of these plants in this context [3, 4].

Understanding The Mechanisms of Cognitive Impairment in HIV Patients

Despite the extensive use of ART and the decrease in new HIV cases, about 35 million people are currently living with HIV worldwide. Middle- and low-income countries have shown a remarkable increase in the average age of people living with HIV. This increase, coupled with increased life expectancy and prolonged life of people living with HIV, has led to an increase in both medical and psychological complications. In light of the significant decline in HIV-related deaths, non-infectious complications are typical of advanced infection occurring nowadays. Cognitive impairments may occur at any time between HIV infection and advanced infection. Defining cognitive abnormalities by obtaining neuropsychological tests is only part of the process for assessing cognitive components affecting HIV patients. Advanced non-invasive imaging techniques and biomarker studies have not only established the underlying mechanisms of cognitive decline but have also opened doors for therapeutic targets that can be accessible to patients. Extensive research has detailed biological and psychological factors that are particularly responsible for impaired cognitive function in people living with HIV. Key changes include inflammation as well as the death or injury of neurons and astrocytes and interconnected changes. The primary infection targets are macrophages and monocytes; their fraction in the CNS is the best predictor of ongoing neurocognitive disorders. Other neuropathological effects are related to viral infection, co-infections, persistent inflammation, substance abuse, and behavioral psychosocial aspects. The extent of inflammation correlates with severe neurocognitive decline. Furthermore, increased age, systemic and CNS viral load, and abnormal immune cell function predict neurocognitive decline. So far, seven cognitive domains: processing speed, attention, learning, memory, language skills, visual-spatial ability, and executive skill deficits have been identified as predictable when compared to healthy controls. Key reported research on the pathogenesis of these regulations and its relationship with HIV is discussed in this paper [5, 6].

Medicinal Plants with Potential Neuroprotective Effects in HIV-Related Cognitive Decline

Several classes of medicinal plants have been shown to produce central nervous system-related protective effects. This paper examines a selection of these plants with potential neuroprotective properties in the context of HIV-related cognitive problems. In the following text, a review is presented of each plant's potential use as an ethnobotanical cognitive or cerebral health aid, as well as the likely chemical compounds within these plants that are active in the protection of cerebral health and could be beneficial for at-risk groups, including HIV patients. These plant materials may be of great use in treating or managing cognitive impairments in HIV populations and could aid in preventing the onset of more severe HIV-related cognitive impairments. Included is an analysis of each plant's mechanism of action assisting in the reduction of oxidative damage, known to significantly aid in the protection of cognitive abilities. These effects may include such mechanisms as free radical scavenging, antioxidant action, certain anti-inflammatory effects, and possibly other mechanisms in further clinical integrative studies. The inclusion of medicinal plant materials with cognition-enhancing and cerebrally protective qualities should help to further mitigate cognitive problems in HIV and complement appropriate clinical and pharmaceutical care [7, 8]. In summarizing the cognitive and cerebral protection effects of these plant materials, it is important to begin the systematic empirical and contemporary clinical validation of the claims made about their traditional use as aids for cerebral health or cognitive performance, as proposed by traditional ethnobotanical and ethnomedical systems. In synthesizing this information and understanding the likely key active compounds responsible in these plants, it may also be possible to consider how to combine these with other conventional antiretroviral therapies used in HIV treatment. This research may also help to determine the likely dosages, forms, adequate preparations, and alternate schedules for the practical consumption of these supplements with the goal of developing an appropriate holistic protocol for better management and treatment of HIV-related neurology [9, 10].

Experimental Studies and Clinical Trials on Medicinal Plants for HIV-Related Cognitive Decline

Several experimental studies have evaluated the effects of individual medicinal plants or their active constituents in vitro, in vivo, and clinical settings. A limited number of clinical trials have investigated the efficacy of individuals or combinations of medicinal plants on cognitive decline in the setting of HIV infection. The rigor of the study design has a large impact on results, with randomized, double-blind clinical trials demonstrating equivocal efficacy, and open-label investigations reporting potential benefits

of selected plant-derived therapies [11, 12, 13, 14]. Manufacturers speculate that medicinal plants might reduce the HAND burden, as well as the parasites, toxins, or infections often held responsible for HAND. Yet we have argued that cautious investigation is warranted. Methodological and practical hurdles could mask the therapeutic potential of plant-derived interventions as tested in studies conducted to date. On the other hand, apparent benefits from early studies, mainly because they use different dosage forms or are based on distinct populations, are still worth pursuing [13, 14, 15, 16]. The included studies demonstrate that although many plants are traditionally used for cognitive benefit, especially in Ethiopia, a few articles do show the negative aspects of traditional remedies. However, clinical studies have been hampered by a lack of validated cognitive testing measures and by the variable staining content of plant extracts [17, 18, 19, 20]. Given standard and effective single- and multi-drug antiretroviral regimens, ARV-related resistance and toxicities are increasingly rare. Scientists and people living with HIV are rightfully looking beyond the antiviral benefits of ARVs to treat associated systemic and central nervous system comorbidities. Antioxidant, neurobiological, anti-apoptotic, neuroplasticity, neurogenesis, or immunomodulatory effects of plant species that comprise comorbidity interventions should be subject to similar or more rigorous standardized experimental exploration. Overall, our evaluation supports a need for incorporating plant-based pharmacological interventions, in addition to addressing systemic causes in the management of HAND in HIV clinical practice [21, 22, 23, 24].

Future Directions and Implications for Healthcare

Understandably, given constraints in the overall body of research, the results and implications presented here are reliant on several assumptions and careful assessments of data. There are numerous avenues for future research to be explored. To gain a more comprehensive understanding of the involvement and role of medicinal plants in curing or mitigating HAND, joint research efforts involving interdisciplinary faculties such as computer scientists, pharmacognosists, virologists, and clinicians are crucial. Research should focus on how modern biophysical assays can be used to unravel the biological effects and pharmacological activities of medicinal plants and their compounds on viral proteins and cognitive function. Further molecular research must be undertaken to investigate the safety, dosage, and preparation methods of medicinal plants and combinations thereof, ultimately targeting specific host cells and protease [23, 24, 25, 26]. This research has allowed for the opportunity to discuss possible implications for healthcare practice when considering the role of medicinal plants in mitigating HIV-related cognitive decline. Integrating traditional medicine with modern therapeutic approaches to enhance patient care requires multifaceted strategies, including education to raise awareness between patients and healthcare providers regarding potential plant-based interventions and effective treatments that can be included in HAART or used as independent complementary therapies. Minimal side effects, a foaming effect, desirable storage properties, low production cost, and ease of administration make the case for joint anti-infective and gel treatment promising. In the near future, a clinical trial involving HIV-positive study groups should be considered; crossover placebo treatment is an option. However, existing ethical concerns and regulatory barriers may limit access to both HIV-positive and healthy study participants. Therefore, integrative pharmacological considerations revolving around traditional medicine must be carefully taken into account to promote the optimal enhancement of drug activity and treatment delivery. It is important to include cognitive health in the therapeutic approaches; such an enhanced approach demands ongoing relevant research, including time-sensitive and innovative studies focusing on HAND and/or HIV and overall cognitive improvement. Therefore, to better understand HAND responses, future integrative as well as complementary studies are highly desirable [17, 18].

CONCLUSION

The growing number of people living with HIV and the prolonged lifespan due to ART has resulted in an increased burden of non-infectious complications, particularly cognitive decline. Although antiretroviral therapy has significantly reduced the incidence of HIV-related deaths, cognitive impairment remains a critical challenge. Medicinal plants, with their neuroprotective properties, present a promising complementary treatment for mitigating HIV-related cognitive decline. While some experimental studies and traditional use indicate potential benefits, rigorous clinical trials are needed to establish their efficacy, optimal dosages, and safety profiles. The integration of plant-based therapies with conventional antiretroviral regimens could pave the way for a holistic approach to managing cognitive impairments in people living with HIV. Future research, incorporating interdisciplinary efforts and advanced biophysical assays, will be crucial in advancing the clinical application of medicinal plants in HIV care.

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CITE AS: Nagm Eldeen Mohamed Abbker Idreis (2025). Investigating the role of Medicinal Plants in HIV-Related Cognitive Decline. Research Output Journal of Biological and Applied Science 5(2):26-30. https://doi.org/10.59298/ROJBAS/2025/522630