**International Journal of Medical Science and Clinical Invention 12(09): 7781-7787, 2025**
**DOI:10.18535/ijmsci/v12i.09.01**
**https://valleyinternational.net/index.php/ijmsci**

# Effects of Dietary Supplementation with *Moringa oleifera* on HIV Viral Load in Adults Receiving Standard Care

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## Abstract

**Background:** Antiretroviral therapy (ART) effectively suppresses HIV viral load. However, people living with HIV (PLWH) fail to achieve optimal viral suppression and especially in resource limited settings. Nutritional supplements such as *Moringa oleifera* have been traditionally used to improve health outcomes in PLWH, yet their effects on viral load remain under researched.

**Objective:** To evaluate the effect of dietary supplementation with *Moringa oleifera* seed flour on HIV viral load among adult women receiving ART in a resource-limited setting.

**Methods:** This was a crossover clinical trial involving 70 HIV-positive women with viral loads ≤1000 copies/mL at Marigat Sub-County Hospital, Kenya. First, Mothers living with HIV, were subjected to a 6-month period of standard care followed by a 6-month period of dietary supplementation with *Moringa oleifera* seeds flour alongside standard care. Viral load assessments were done at baseline, after 6-months of standard care, and after another 6-months of Moringa supplementation. Statistical analyses included paired t-tests and regression models.

**Results:** Both standard care and supplementation phases yielded statistically significant reductions in viral load ($p < 0.001$). Supplementation with *Moringa oleifera* showed a slightly greater reduction in absolute mean viral load than standard care alone, though the difference between the two was not statistically significant ($p = 0.09$). No statistically significant associations were found between viral load and age, education, marital status, employment, or BMI.

**Conclusion:** Supplementation of diet with *Moringa oleifera* seeds flour alongside ART may enhance viral suppression, the observed effects were not statistically significant to standard care alone. Further research is recommended to explore the long-term efficacy and dosage optimization.

**Keywords:** HIV, antiretroviral therapy, *Moringa oleifera*, viral load.

## Introduction

Acquired Immunodeficiency Syndrome (AIDS), caused by the Human Immunodeficiency Virus (HIV), remains a significant global health burden, contributing to substantial morbidity and mortality worldwide. As of the end of 2024, approximately 40.8 million people were living with HIV, with nearly two-thirds (65%) residing in the World Health Organization (WHO) African Region (UNAIDS, 2023). Antiretroviral therapy (ART) has proven effective in suppressing viral replication thus lowering viral load, improving immune function, and reducing HIV-related deaths (WHO, 2023). Despite these advances, it is estimated that approximately 29% of people living with HIV (PLWH) globally fail to achieve viral suppression below the threshold of <200 copies/mL, even while on ART (UNAIDS, 2023).

In many low- and middle-income countries (LMICs), barriers such as the high cost of treatment, geographic inaccessibility and under-resourced health systems delay ART initiation and hinder adherence, particularly when HIV is diagnosed at an advanced stage. These challenges contribute to inadequate viral suppression and increased vulnerability to opportunistic infections (WHO, 2023). To address these gaps, WHO encourages the integration of safe, evidence-based natural adjuvant therapies into HIV care to improve overall patient outcomes (WHO, 2023).

People living with HIV frequently use herbal and traditional remedies to manage HIV symptoms, mitigate the side effects of ART, and manage

opportunistic infections (Kafuko et al., 2019; Lubinga et al., 2023). The use of herbal supplements in HIV management is influenced by factors such as affordability, accessibility, cultural beliefs, and perceived health benefits. However, while these remedies are widely used, their clinical efficacy remain inadequately studied and poorly understood. More rigorous clinical research is needed to evaluate the effects of herbal supplements when used concurrently with ART, particularly in terms of virological outcomes (Lubinga et al., 2023).

In Kenya, the use of *Moringa oleifera*, a commonly available and culturally accepted herbal supplement commonly added to food, is widespread among PLWH. Studies report that up to 80% of HIV-infected individuals in Africa, including Kenya, consume different parts of *M. oleifera* as part of their diet either before or alongside ART (Kasolo et al., 2022). The seeds of *M. oleifera* are rich in proteins, essential vitamins, antioxidants, and bioactive compounds that have been associated with nutritional and antiviral effects (Gambo et al., 2021) hence a possible nutritional supplementation in HIV management.

This study aimed to evaluate the effect of supplementing the normal diet with *M. oleifera* seed flour in HIV-positive women receiving ART with viral loads ≤1000 copies/mL, to generate clinical data into the use of *M. oleifera* as an adjunctive nutritional intervention to optimize HIV treatment outcomes in resource-limited settings.

## Methods

### Study design and setting

The study was a crossover clinical trial conducted at the HIV Clinic of Marigat Sub-County Hospital in Baringo County, Kenya, from August 2022 to December 2023. The hospital provides healthcare services to an estimated population of 128,000, including approximately 660 HIV-positive women of diverse tribal and socio-demographic backgrounds who are managed as outpatients. Marigat Sub-County Hospital was selected as the study site due to its capacity to offer comprehensive HIV care services including diagnostic testing, antiretroviral treatment, and nutritional counselling and its well-established infrastructure staffed by qualified personnel, including nurses, physicians, counselors, pharmacists, nutritionists, and laboratory technicians.

### Recruitment of the study participants

The study included HIV-positive women aged 18 years and above who had been on antiretroviral therapy (ART) for a minimum of one year, demonstrated good adherence to ART and standard care, and had a documented viral load of ≤ 1000 copies/mL, with the most recent viral load assessment conducted within six months prior to recruitment. Eligible participants were also required to express a clear willingness to consume *Moringa oleifera* seed flour supplementation alongside their usual diet consistently for a duration of six months and to provide written informed consent. Exclusion criteria comprised current pregnancy, known hypersensitivity to *Moringa oleifera* or its derivatives, concurrent use of other herbal or natural health products, and the presence of pre-existing opportunistic infections. Informed consent was obtained from all participants by trained research assistants prior to enrollment.

### Study sample size

Among HIV-positive women aged 18 years and above receiving antiretroviral therapy (ART) at Marigat Sub-County Hospital, and maintaining a mean viral load of ≤ 1000 copies/mL for over one year, the baseline mean viral load was 760 ± 110 copies/mL. Based on this mean and standard deviation, a sample size of 70 participants was calculated to be sufficient to detect a minimum clinically meaningful reduction in viral load with 80% statistical power at a 5% level of significance ($\alpha = 0.05$), accounting for an anticipated 10% loss to follow-up.

### Treatments for the study participants

*Moringa oleifera* seed flour underwent quality assurance testing prior to administration to study participants. The study followed a two-phase crossover design. In the initial pre-intervention phase, participants received standard HIV care for six months. Viral load measurements were obtained at the beginning and end of this period to assess the effect of standard care alone. Subsequently, the same participants entered a six-month intervention phase, during which they continued to receive standard care supplemented with *Moringa oleifera* seed flour, consumed alongside their usual diet. The viral load

measurement taken at the end of the pre-intervention phase served as the baseline for evaluating the effect of the *Moringa oleifera* supplementation. A final viral load assessment was conducted at the end of the intervention phase to determine any changes attributable to the combined treatment.

**Preparation of study materials & Study procedures**

*Moringa oleifera* seeds were purchased from Marigat local farmers. The seeds were sorted to remove any undesirable material, and cleaned under running water after which they were dried under the sun for 2 days. Processing, manufacturing and packaging was done at Unga Holdings Limited-Nakuru, Kenya to ensure food processing safety measures were observed. The *Moringa oleifera* seed flour was packaged in individual sachets of 15 grams, representing the recommended daily allowance (Gambo et al., 2021). Thirty sachets, equivalent to a one-month supply, were grouped and sealed in a clear polythene bag. Each bag was labeled with the study abbreviation code and included clear instructions for supplement use. Participants were instructed to consume one sachet per day, aligning with the daily regimen of antiretroviral therapy (ART). To minimize the risk of drug-nutrient interactions, participants were advised to take the supplement eight hours after their ART dose. Additionally, participants were encouraged to monitor and report any side effects experienced during the supplementation period.

**Administration of treatments**

Participants in the first phase adhered to standard care protocols for 6 months. Participants in the second phase adhered to the standard care and self-administered 15 grams of *Moringa oleifera* seed flour daily at 8:00 a.m., incorporated into their regular diet, and taken at least eight hours after their routine antiretroviral (ARV) dosing. This regimen was maintained consistently for a period of six months.

Each participant received a one-month supply of *Moringa oleifera* seed flour, packaged in labeled parcels containing the study identification number, dosing instructions, and safety information, including storage guidelines. Daily SMS reminders were sent to participants between 7:00 and 8:00 a.m. to prompt supplement intake, and participants were encouraged to respond via text message or phone call prompt to confirm compliance.

The study team collaborated closely with the HIV clinic staff to ensure that participants continued to receive standard HIV care, including the regular provision and monitoring of ART. During the informed consent process, participants were clearly informed that the *Moringa oleifera* supplement was not a substitute for ART, and they were advised to continue taking their prescribed antiretroviral medications as directed.

Participants were followed for six months and received monthly reviews by a nutritionist to assess adherence to the supplementation protocol and to address any related concerns.

**Study measurements & outcomes**

Blood samples were collected at three time points: baseline (post-enrollment), six months following standard care, and 6 months after initiation of *Moringa oleifera* supplementation, to assess HIV viral load. The primary outcome of the study was the change in both absolute and relative viral load after six months of supplementation, comparing the intervention phase to the standard care phase.

In addition to clinical data, socio-demographic information and data on the acceptability of *Moringa oleifera* supplementation were collected from participants at enrollment.

**Statistical analysis**

All data were reviewed for completeness prior to entry into the Statistical Package for the Social Sciences (SPSS), version 26, for statistical analysis. Categorical variables were analyzed using the Chi-square test. To evaluate changes in viral load over the study period, a paired samples t-test was performed. Additionally, a one-way analysis of variance (ANOVA) was used to assess the effect of different treatments on viral load. Linear regression analysis was conducted to examine the influence of socio-demographic variables on the outcome. A p-value of less than 0.05 was considered statistically significant for all analyses.

**Ethical approval**

The study received ethical approval from the Kabarak University Institutional Scientific and Ethics Review Committee (ISERC) under reference number

KABU01/KUREC/001/09/06/22 and from the National Commission for Science, Technology and Innovation (NACOSTI) under reference number 582620. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. Informed consent was obtained from all participants, and strict measures were implemented to maintain confidentiality and protect participant identity throughout the study.

**Data safety and monitoring**

The data and safety monitoring committee was constituted to ensure the safety of participating individuals. Safety checks were done on a monthly basis. Participants were advised to report any adverse reactions to the principal investigator using a 24/7 hotline phone number.

**Contraindication**

*Moringa oleifera* use has no known contradictions.

**Results**

**Participants flow**

Out of the 270 HIV-positive women screened for eligibility at the Marigat Sub-County Hospital clinic in Kenya, 80 were eligible. A total of 5 (6.25%) declined participation in the study and 75 were enrolled to receive the supplement after a phase of standard care. A total of 70 (93%) completed all study procedures, 3 (4%) participants were lost-to-follow-up, and 2 (2.6%) participants became pregnant and were discontinued from the study.

**Demographic characteristics of the participants at enrolment**

The majority of participants were found to be married, accounting for 38.1% of the total, with 30.4% being separated, widowed 13%, single 12.2% and a small proportion of 6.3% of the participants being divorced. Additionally, a significant proportion, 35.9%, had discontinued their education at the secondary school level, with those who completed secondary at 33.3%, completed primary at 27%, with higher education level 3.3% and a very small proportion 0.4% having dropped at primary school. A predominant 49.6% were engaged in informal employment, with 37% in formal employment and 13.3% unemployed. Age distribution revealed that the largest segment of participants, 31.9%, fell within the age range of 18 to 25 years with those above 50 coming last at 2.2%. (Table 1).

**Table 1: Sociodemographic characteristics of participants**

| Variable | Category | Frequency | Percentage% |
|---|---|---|---|
| Marital Status | Married | 27 | 38.1 |
| | Separated | 21 | 30.4 |
| | widowed | 9 | 13.0 |
| | Single | 9 | 12.2 |
| | Divorced | 4 | 6.3 |
| Education | University/College | 2 | 3.3 |
| | Completed Secondary | 23 | 33.3 |
| | Dropped Secondary | 25 | 35.9 |
| | Completed Primary | 19 | 27.0 |
| | Dropped from primary | 1 | 0.4 |
| Employment | Formal employment | 26 | 37.0 |
| | Informal employment | 35 | 49.6 |
| | Unemployed | 9 | 13.3 |
| Age | 18 – 25 | 22 | 31.9 |
| | 26 – 30 | 17 | 24.1 |
| | 31 –35 | 10 | 14.1 |
| | 36 – 40 | 10 | 14.1 |
| | 41 – 45 | 7 | 10 |
| | 46 –50 | 3 | 4.4 |
| | > 50 | 1 | 1.4 |

**Anthropometric and Viral load characteristics of the participants at enrollment**

The majority of the participants had a normal BMI of 19–24 kg/m$^2$. The viral load of the majority of the participants was high with a mean of 474 copies/mL, SD = 127.86 yet they had been on ART for at least 12 months before the study. The participants' ART adherence was at 75%.

**Effect of interventional treatments on the viral load**

We noted a statistically significant difference when comparing mean viral load at baseline with those at month 6 for each phase. After standard care phase for 6 months there was a significant absolute mean viral load reduction of 21$\pm$ 12.25 copies/ml, ($p < 0.001$). Equally, second phase of administering *Moringa oleifera* supplement alongside standard care for 6 months produced a

higher absolute mean viral load reduction of 25± 12.45 copies/ml, ($p$ = 0.001). Furthermore, we calculated the relative difference viral load count. At the standard care phase of patient follow-up, the standard care produced a relative mean viral load decrease of 4.4 ±6.12, ($p$ < 0.001), while the administration of *Moringa oleifera* supplement alongside standard care produced a relative mean viral load decrease of 5.5 ± 6.25, ($p$ = 0.001). Further, we noted no statistically difference when comparing the mean differences between standard care phase and *Moringa oleifera* supplementation alongside standard care phase p < 0.09). (Table 2).

**Table 2: Viral load variation of the participants**

| Viral load | Mean difference | Std. Deviation | P-Value | P-Value |
|---|---|---|---|---|
| **Viral load absolute diff at 6 months** | | | | |
| Viral load after six months of standard care | 21 | 12.25 | 0.001* | |
| | | | | 0.09 |
| VL after another six months of standard care plus *Moringa oleifera* seeds supplementation | | | 0.001* | |
| | | | 0.001* | |
| | | | | 0.09 |
| | | 12.45 | | |
| | 25 | | | |
| **Viral load relative diff at 6 months** | | | 0.001* | |
| | | 6.12 | | |
| | 4.4 | | | |
| Viral load after six months of standard care | | | | |
| | 5.5 | | | |
| | | 6.25 | | |
| VL after another six months of standard care plus *Moringa oleifera* seeds supplementation | | | | |

Footnote: *Statistically significant result ($p$ < 0.05)

**Effect of demographic and anthropometric factors on viral load**

The analysis revealed no statistically significant association between baseline viral load and the participants' age (p = 0.070), marital status (p = 0.943), education level (p = 0.842), employment status (p = 0.555) and anthropometric BMI (p = 0.451) characteristics (Table 3).

**Table 3: Association between socio-demographic characteristics, BMI and viral load.**

| Socio-demographic variables | p-value |
|---|---|
| age of caregiver | 0.070 |
| marital status | 0.943 |
| Level of education | 0.842 |
| Employment | 0.555 |
| BMI | 0.451 |

**Discussion**

After 6 months of patient follow-up, we observed significant differences in viral load counts in the two phases. When compared to the baseline both standard care phase and *Moringa oleifera* supplement administered alongside standard care phase, exhibited a significant absolute mean viral load reduction. While the standard care absolute mean viral load reduction was smaller than that of the *Moringa oleifera* supplement alongside the standard care, the reduction was still statistically significant. Conversely, the absolute mean difference between standard care phase and *Moringa oleifera* alongside standard care was not statistically significant. The difference in viral load across the two phases implies that, in comparison to standard care alone or conventional care, the combined use of standard care and *Moringa oleifera* may have had a synergistic effect in decreasing viral load. This outcome may arise from the possible enhanced biological activities, such as improved antioxidant properties and antiviral properties. This finding can be

collaborated by a study done by (Rahayu & Timotius, 2022) who concluded that leaf infusion of *Moringa oleifera* has antivirus properties. In addition, *Moringa oleifera* is rich in bioactive substances that have been shown to have positive effects on health (Islam et al., 2021; Su et al., 2023). As such, *Moringa oleifera* may contribute to viral suppression. Reducing viral load is a major treatment objective in the management of HIV/AIDS since it is a crucial indicator of the amount of HIV in the blood. The results also imply that the combined intervention may decrease viral load over the long run, because plant-based medicine has the characteristics of slow onset (Jiménez-Osorio et al., 2022). However, the difference in absolute mean viral load reduction between the standard care alone phase and the combined treatment phase was not statistically significant within the study period despite the combination showing a greater absolute mean reduction. This suggests that while *Moringa oleifera* may have potential benefits, its effects might require a longer duration or a larger amount to become statistically significant (Twinomujuni et al., 2024). This highlights the need for further research with extended study periods and amount to fully understand its impact.

It should also be noted that, as one of the inclusion criteria, this study investigated HIV-positive women who had been on ART for at least a year but had a viral load count below 1000 copies/ml. Studies show that individuals who initiate ART with a viral load count 200 - 1000 often struggle to achieve viral suppression after up to 60 months on ART (Erjino et al., 2023; Suanzes et al., 2023), and this might explain the slow immunological recovery.

We also investigated the effect of demographic and anthropometric factors on the viral load. The study found no evidence of a significant relationship between the absolute viral load count, age, employment, marital status, education or BMI. This suggests that the viral load levels in this patient population may not be directly impacted by these factors. Our results agree with a study carried out by (Plymoth et al., 2020). However the results were contrary to (Bantie et al., 2024) who did a longitudinal study and documented that a change in BMI impacted the viral load. The difference in findings could be attributed to the study design used.

The study utilized dried plant powders and consumed at least 8 hours apart from routine ART dosing to prevent interaction. We also studied *Moringa oleifera* which offer an affordable alternative remedy for managing HIV infection, particularly in low-resource settings. Despite the strengths pointed out, our study had some limitations. We did not evaluate food intakes using methods like 24-hour recall, food frequency or dietary records. We also did not evaluate the ARV interaction with *Moringa oleifera*. Finally, we recruited relatively healthy PLWH, and therefore our results may not be generalizable for individuals with chronic conditions or existing opportunistic infections.

## Conclusion and recommendation

The study found that daily consumption of *Moringa oleifera* improves viral load suppression among PLWH on ART though not statistically significant. We recommend further research to evaluate impact of Moringa supplementation with an increased quantity and duration. Further research is needed to determine the long-term impact of *Moringa oleifera* supplementation on viral load on patients with pre-existing conditions and opportunistic infections among PLWH on ART.

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