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Moringa oleifera has the Potential to Manage HIV-1 and May Enhance the Efficacy of ARVs in Suppressing Viral Loads in HIV/AIDS Patients

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***Abstract*—** *Human immunodeficiency virus (HIV) infection is managed by expensive ARVs, which also have side effects, and lead to drug resistance and failure. The use of nutritional remedies in managing HIV/AIDS is becoming popular. Moringa oleifera is a nutrient-dense plant with medicinal properties resulting from its wide range of biological activities. This study investigated the beneficial effect of Moringa oleifera supplementation on the viral loads of HIV/AIDS patients receiving antiretroviral drugs (ARVs). A Quasi-Experiment of the regression discontinuity type was conducted at the Comprehensive Care Center, Mbagathi County Hospital, Nairobi, Kenya. We recruited 173 HIV seropositive participants undergoing ARV treatment and attending a regular HIV management clinic. The participants were allocated to the intervention group supplemented with Moringa oleifera leaf powder or the control group, which was not supplemented. The HIV-1 viral load measurements were assessed at the end of the third month and the sixth month of the study period. Analysis was then done to compare the two groups. The study observed that the percentage of participants with non-detectable viral load in the intervention group increased by 7.23%. In comparison, that of the control group decreased by 10.29% by the end of the study period. The study concluded that M. oleifera has the potential to inhibit HIV-1 and may enhance the efficacy of ARVs in suppressing viral loads in HIV/AIDS patients.*

***Keywords*—** *ARVs; Kenya; HIV; Moringa oleifera; Viral load.*

I. IINTRODUCTION

Acquired immune deficiency syndrome (AIDS) is caused by the human immunodeficiency virus (HIV) and remains one of the world's most devastating pandemics. It is estimated that 39 million people were living with HIV/AIDS in 2022, with about 630,000 AIDS-related deaths and 1.3 million new infections. Since the beginning of the epidemic, approximately 85.6 million people worldwide have been infected and 40.4 million people have died from AIDS-related diseases (UNAIDS 2023).

Human immunodeficiency virus (HIV) affects the cells of the immune system, including CD4+ T cells, CD8+ T cells, dendritic cells, and macrophages (Cunningham et al., 2010). An adequate response to ART and disease progression is defined as an increase in CD4 count in the range of (50-150) cells/mm3 during the first year of ART (Kaufmann et al., 2003) and a decrease in viral load (Bagnarelli et al., 1995; Kojima et al., 1995; O'Brien et al., 1996). After three to six months, most people who adhere to ARV treatment become virus-free (Oguzhan 2020). Some people, however, are unable to achieve this due to factors such as adherence issues, drug resistance, and other health complications (HIV.gov 2018). Most clinics report viral load as undetectable if it is less than 20-50 RNA copies/ml plasma which standard blood tests cannot detect. All studies that have provided evidence for undetectable viral load (UVL) have used a viral load of less than 200 copies/ml as the cut-off. Increased viral load is associated with CD4 T cell depletion (Coombs et al., 1993; Cunningham et al., 1993).

There is no vaccine or cure for HIV/AIDS. However, antiretrovirals (ARVs) that are currently used to treat the disease help patients live longer lives by providing significant protection against opportunistic infections. Antiretrovirals are drugs that block the replication of HIV, keeping its levels very low in the body. Not all patients adhere to the regimen. Some experience drug resistance and side effects like nausea and vomiting. For such reasons, natural products, particularly those derived from plants, are becoming increasingly popular among HIV/AIDS patients. They are less likely to cause side effects and are excellent sources of new anti-HIV drugs (De Clercq 2005; Esimone et al., 2010; Sabde et al., 2011). Some plant-derived antiretroviral therapies have been shown to inhibit activity on several HIV-1 developmental processes. They have been shown to modulate effects on cellular factors involved in HIV-1 replication (Cos et al., 2004). Some of these compounds have been clinically tested showing remarkable results (Vo and Kim, 2010; Filho et al., 2010).

This study determined the effects of M. oleifera supplement on viral loads and creatinine levels of HIV and AIDS patients.

Alternative traditional remedies conferred significant health improvement, reduced the viral load, and increased CD4+ T cell counts in HIV/AIDS patients in a clinical trial

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conducted in South Africa (Tshibangu et al., 2004). Furthermore, these remedies have been employed in the treatment of this disease as a supplement to the widely used conventional ART.

Moringa oleifera (Moringaceae) is a multipurpose tree with nutritional and medicinal properties that can be used to treat a variety of health problems, including HIV/AIDS. The plant is packed with nutrients such as proteins, minerals, vitamins, fats, and fibers (Rockwood et al., 2013); and minerals like magnesium, copper, sulfur, sodium, phosphorus, zinc, and potassium (Asiedu-Gyekye et al., 2014). These properties can help strengthen the immune system during HIV infection. Moringa may not cure or outperform ARVs, but patients who receive adequate nutrients may experience increased wellness. The purpose of this study was to see how *M. oleifera* supplementation affected the viral load of HIV-positive adults on ARVs in Nairobi, Kenya.

II. Materials and Methods

Study Design

The study was a Quasi-Experiment of the regression discontinuity type involving HIV-positive male and female adults aged 18-55 attending the Comprehensive Care Centre (CCC), Mbagathi County Hospital in Nairobi, Kenya. Patients with gastrointestinal infections, and renal, hepatic, cardiovascular, or endocrine disorders that could interfere with the observation, assimilation, and excretion of the leaf powder were barred from participating. Mentally ill patients as well as expectant and breastfeeding mothers were also excluded from the study. Informed consent was obtained from all participants before participating in the study.

Participants in the study were divided into two groups by the Quasi-experimental design. All participants in the control and intervention groups were taking ARVs. The treatment group received *M. oleifera* supplementation while the control group did not. The viral load of the participants was monitored monthly for six months. The study was approved by the Kenyatta University Ethical Review Board and the Kenya Medical Research Institute (KEMRI) Scientific and Ethics Review Unit (SERU) protocol number KEMRI/SERU/CTMDR/056/3655.

Moringa oleifera Supplementation

Participants in the intervention group were given *Moringa oleifera* leaf powder which was obtained from East Africa Nutraceutical Company, Kenya. The leaf powder was prepared by washing, drying, and grinding the leaves of Moringa. Each study participant in the experimental group received a monthly supply of 300 grams of *Moringa oleifera* leaf powder in the form of teabags weighing 2 grams each. The participants were instructed to use four tea bags (about 8 grams) per day (Kumari 2010), by adding them to hot water (2 tea bags in the morning and 2 tea bags in the evening) in a standard 200 ml mug and steeping for ten minutes.

Viral Load Determination and Toxicity Evaluation

Approximately 5 mL of venous blood was collected at baseline and at three and six months; for quantitative HIV viral load testing using the Abbott RealTime M 2000 HIV-1 (Abbott Molecular Inc.) Viral Load Testing system at the KEMRI HIV laboratory. The aim of measuring creatinine levels in the current study was to determine if *M. oleifera* had toxic effects on the participants in the intervention group. Creatinine tests were carried out on each study subject at baseline, on the third and sixth month of the study. Toxicity on liver and kidney functions was assessed by using the Cock Croft Gault formula (CGF) (Cockcroft and Gault, 1976) to calculate the glomerular filtration rate (GFT) using serum creatinine levels, age, and sex. Low GFRs indicate a decline in renal functional capacity.

GFR= ((140-age) x weight)/(Cr x 85)

Age – in years

Weight – in kilograms

Cr (Creatinine) – mg/Dl

Creatinine levels were measured using the equipment HumaLyzer Primus Chemistry Analyzer (Wiesbaden, Germany).

Data Analysis

Since a large number of participants were virologically suppressed at baseline, the data for viral load was treated as discrete data (detectable or non-detectable). The number of participants with detectable and non-detectable viral load in the two groups was determined and their percentages were calculated. Clustered bar charts representing these percentages at baseline, month three, and month six of the study period were generated. The changes in viral load were depicted by the changes in these percentages over the study period. Analysis of variance (ANOVA) followed by Tukey's post hoc tests compared the mean of the creatinine levels at baseline, month 3, and month 6. Unpaired t-tests compared the mean of the creatinine levels of the intervention and control groups. The results were significantly different if $p < 0.05$.

III. Results

There were 62 males (35.8%) and 111 females (64.2%). The females were more than the males in both of the study groups. The age subset 46 – 55 years had the most participants (54.3%), while the age subset 18 – 25 years had the least (2.3%) (Table 1).

TABLE I. Social demographic characteristics of study participants

Characteristic	N	(%)
Age Groups		
18-25	4	2.3
26-35	23	13.3
36-45	52	30.1
46-55	94	54.3
Sex		
Male	62	35.8
Female	111	64.2

Study Process

Fig. 1 shows the parallel flow of participants during the study. Two hundred and sixty-one (261) patients were screened for eligibility out of which only one hundred and seventy-three (173) participated in the study. Seventy-eight (78) declined to participate while ten (10) did not meet the

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inclusion criteria. Out of the one hundred and seventy-three participants enrolled in the study, twenty-two (22) did not complete the study. Two (2) participants were lost to follow-up (one did not respond to phone calls while the other moved out of the country without notice). Fourteen (14) participants refused follow-up after a few weeks of participation despite several attempts to reach them by phone. Four (4) participants were discontinued from the study (one reported menorrhagia, two were admitted to the hospital for fistula correction and dialysis, and one moved out of Nairobi). Two (2) participants succumbed to complications related to cancer.

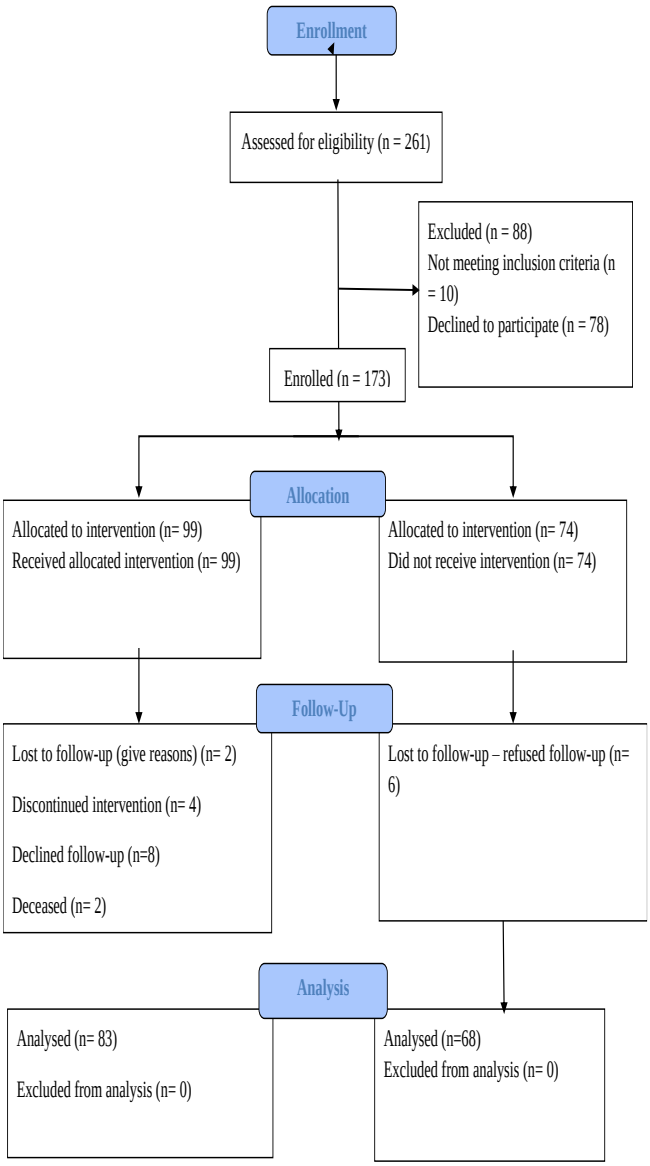

Fig. 1: Participant flow diagram (CONSORT Flow Diagram 2010).

Changes in Viral Load During the Follow-up Period

Fig. 2 shows a clustered bar chart representing the percentage of participants in the intervention and control groups with non-detectable viral load at baseline, month three, and month six of the study period. Of the 83 participants in the control group who completed the study, 69 had a non-detectable viral load at baseline (83.13%). By the end of the third and sixth months, the number of participants with a non-detectable viral load had increased to 72 (86.74%) and 75 (90.36%) consecutively. Out of the 68 participants who had completed the study in the control group, fifty-nine had non-detectable viral load at baseline (86.76%). This number increased to 60 (88.24%) at the end of the third month but decreased to 52 (76.47%) by the end of the sixth month of the study.

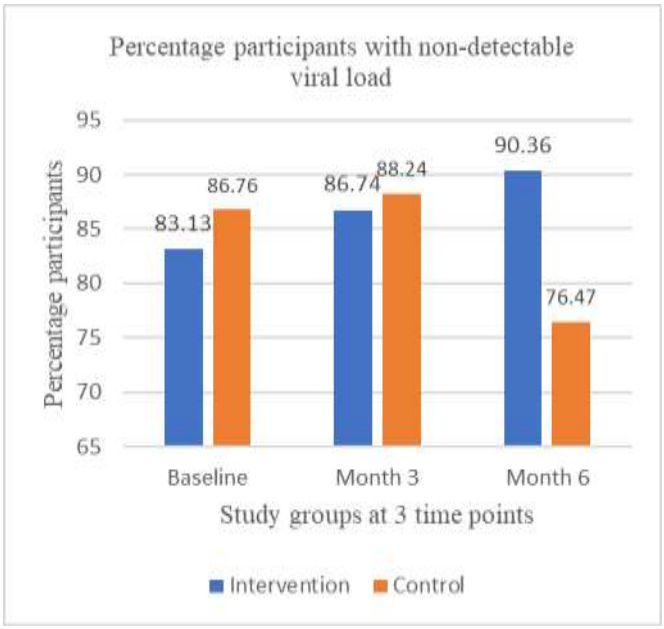

Fig. 2. Percentage of participants with non-detectable viral load.

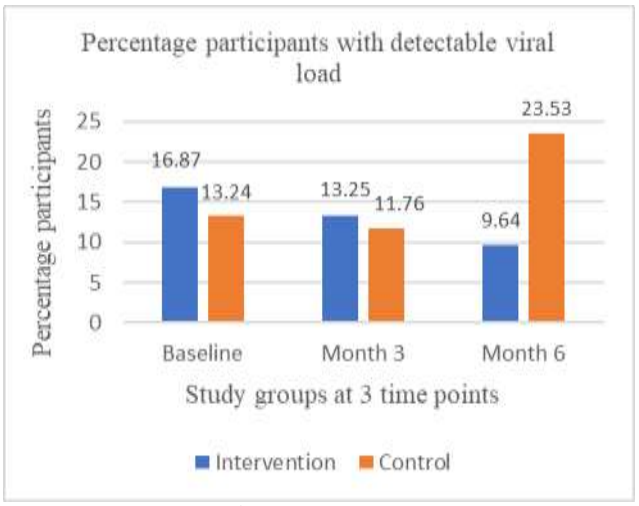

Fig. 3: Percentage of participants with detectable viral load.

Fig. 3 shows a clustered bar chart representing the percentage of participants in the intervention and control groups with detectable viral load at baseline, month three, and month six of the study period. Out of the 83 participants in the intervention group who completed the study, 14 (16.87%) were viremic at baseline. By the end of the third and sixth months, the number of viremic participants had reduced to 11 (13.25%) and 8 (9.64%) consecutively. Out of the 68 participants who had completed the study in the control group,

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nine were viremic at baseline (13.24%). This number was reduced to 8 (11.76%) at the end of the third month but increased to 16 (23.53%) by the end of the sixth month of the study. These values were converted to percentages which were plotted into clustered bar charts.

Toxicity Test

The toxicity was assessed by the kidney's glomerular filtration rate (GFR) calculated from the creatinine levels (Fig. 4). The mean GFR of the control group (108.72 ± 32.09) was significantly higher (p = 0.004) when compared with that of the intervention group (94.21 ± 27.71). At the beginning of the study, the mean GFR of the control group (84.35 ± 22.97) was significantly higher (p = 0.002) when compared to that of the intervention group (72.83 ± 22.57).

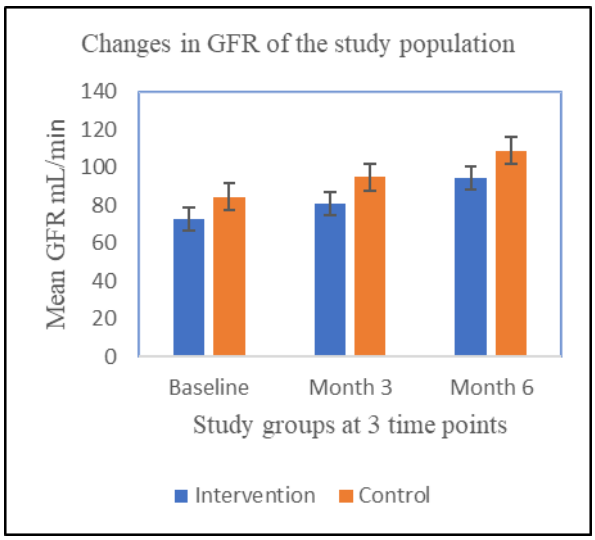

Fig. 4: Changes in glomerular filtration rate (GFR).

IV. Discussion and Conclusions

According to this study, the number of participants with non-detectable viral load in the intervention group increased while that in the control group decreased by the end of the study period. On the other hand, the number of participants with detectable viral load in the intervention group reduced while that in the control group increased. Undetectable viral load is an indication of the efficacy of a treatment (Oguzhan 2020). These differences in viral load observed could be due to the phytochemicals present in *M. oleifera* that were consumed by the participants in the intervention group. Several scientists have studied the potential of phytochemicals to inhibit different stages of replication of HIV. Tannins may prevent viral infections like HIV (Serafini et al., 1994; Nonaka et al., 1990). Saponins inhibit HIV infectivity (Yang et al., 1999; Li et al., 2012), while flavonoids inhibit critical steps in the life cycle of HIV, like viral transcriptional activity (Melha et al., 2011), reverse transcriptase (Li et al., 2011), viral entry (Liu et al., 2011), integrase (Lee et al., 2003), and protease inhibitory activities (Lee et al., 2009). The decline in the number of participants in the control group with non-detectable viral load may be due to insufficient nutrients and phytochemicals which are important to the immune system.

According to this study, there was no significant difference in the mean creatinine level between the intervention and the control groups by the end of the study. The best indicator of kidney function is the rate of filtration of blood into the glomerulus, or the Glomerular Filtration Rate (GFR). Chronic kidney disease can be defined as a GFR < 60 mL/min/1.73m2 for three or more months (National Kidney Foundation K/DOQI 2000). Serum creatinine was used to calculate GFR according to Cockcroft and Gault (CGF) (Cockcroft and Gault, 1976). The normal creatinine clearance for healthy women is 88-128 m/min and 97-137 ml/min for males.

Although the mean glomerular filtration rate (GFR) of the control group was significantly higher (p = 0.004) than that of the intervention group, the difference could be because there was already a difference at baseline. However, it was noted that the creatinine levels and the GFR of both the intervention and control groups were within normal ranges. The findings of several animal studies suggest that various preparations of *M. oleifera* leaves may be very safe at the amounts and doses commonly used (Awodele et al., 2012; Asare et al., 2012; Asiedu-Gyekye et al., 2014). 1000 mg/kg body weight of Moringa extracts extrapolates to 800 grams for an average 80 kg human being. This amount is way beyond that consumed under normal circumstances. So far, there has been no documented effect of *M. oleifera* on renal function. It may be concluded that the use of *M. oleifera* is not toxic to the kidneys.

This study did not take into account the nutritional status or lifestyle of the participants. The importance of these factors to overall health and the immune system is well understood. Future trials should assess the average nutritional intake and lifestyle of the participants before recruitment to the study to eliminate any bias.

Although none of the participants reported a challenge in boiling water every morning for making Moringa, this practice may also have challenged some participants, especially those who have to go to work very early in the morning. Different formulations of *M. oleifera* that are tasty and easier to consume (like capsules, tablets, or cookies) should be used in future studies to eliminate this bias. Some participants may not have adhered to the proper use of *M. oleifera* as recommended in the study. Since adherence is a great predictor of any treatment outcome, future studies should reinforce it. This is achievable in an inpatient health rehabilitation center.

Supplementation with *M. oleifera* enhances the efficacy of ARVs in suppressing viral loads of HIV/AIDS patients. The use of *M. oleifera* is not toxic to the kidneys. Therefore, nutritional supplementation with *M. oleifera* should form part of the strategy to improve treatment outcomes. Consumption of *M. oleifera* is safe. The distinguishable taste of *M. oleifera* is likely to have caused some participants to either skip some doses or use less than what was recommended by the study. This study was a one-center study which may not be generalized.

Availability Of Data

The data used to come up with the conclusions of this work will be provided upon request.

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Conflict Of Interest

The authors declare that they have no conflicts of interest.

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REFERENCES

[1] Asare, G.A., Gyan, B., Bugyei, K., Adjei, S., Mohama, R., Addo, P., Out-Nyarko, L., and Wiredu, E.K. (2012). Toxicity potentials of the nutraceutical *Moringa oleifera* at supra-supplementation levels. Journal of Ethnopharmacology, 139: 265–272.

[2] Asiedu-Gyekye, I.J., Frimpong-Manso, S., and Awortwe, C. (2014). Micro- and macro-elemental composition and safety evaluation of the nutraceutical *Moringa oleifera* leaves. Journal of Toxicology. 2014:786979.

[3] Awodele, o., Oregbe. L.A., Odoma, S., DaSilva, J.A.T., and Osunkalu, V.O. (2012). Toxicological evaluation of the aqueous extract of *Moringa oleifera* Lam. (Moringaceae). Journal of Ethnopharmacology, 139: 300-306.

[4] Bagnarelli, P., Menzo, S., Valenza, A., Paolucci, S., Petroni, S., Scalise, G., Sampaolesi, R., Manzin, A., Varaldo, P.E., and Clementi, M. (1995). Quantitative molecular monitoring of human immunodeficiency virus type 1 activity during therapy with specific antiretroviral compounds. Journal of Clinical Microbiology., 33: 16–25.

[5] Cockcroft, D.W. and Gault, M.H. (1976). Prediction of creatinine clearance from serum creatinine. Nephron. 16(1):31-41.

[6] Coombs, R.W., Henrard, D.R., Mehaffey, W.F., Gibson, J., Eggert, E., Quin, T.C., and Phillips, J. (1993). Cell-free plasma human immunodeficiency virus type 1 titer assessed by culture and immunocapture-reverse transcription-polymerase chain reaction. Journal of Clinical Microbiology. 31: 1980–1986.

[7] Cos, P., Maes, L., Vanden, B.D., Hermans, N., Pieters, L., and Vlietink, A. (2004). Plant Substances as Anti-HIV Agents Selected According to their Putative Mechanism of Action. Journal of Natural Products, 67 (20): 284-293.

[8] Cunningham, A.L., Donaghy, H., Harman, A.N., and Turville, S. G. (2010). Manipulation of dendritic cell function by viruses. ELSEVIER, 13: 524–529.

[9] Cunningham, A.L., Dwyer, D.E., and Downton, D. N. (1993). Viral markers in HIV infection and AIDS. Journal of Acquired Immune Deficiency Syndromes. 6: S32–S35.

[10] De Clercq, E. (2005). Emerging anti-HIV drugs. Expert Opinion on Emerging Drugs. 10: 241–273.

[11] Esimone, C.O., Eck, G., Nworu, C.S., Hoffman, D., Uberla, K., and Proksh, P. (2010). Dammarenolic acid, a secolammarane triterpenoid from Anglaia sp. Shows potent antiretroviral activity in vitro. Phytomedicine, 17: 540–547.

[12] Filho, J.R.; de Sousa Falcon, H.; Batista, L.M.; Filho, J.M. and Piuvezam, M.R. (2010). Effects of plant extracts on HIV-1 protease. Current HIV Research. 8:531-544.

[13] HIV.gov. (2018). HIV viral suppression and undetectable viral load. February 2023. https://www.hiv.gov/hiv-basics/staying-in-hiv-care/hiv-treatment/viral-suppression./

[14] Kaufmann GR, Perrin L, Pantaleo G, Opravil M, Furrer H, Telenti A, Hirschel B., Ledergerber B, Vernazza P, Bernasconi E, Rickenbach M, Egger M, and Battegay, M. (2003). CD4 T-lymphocyte recovery in individuals with advanced HIV-1 infection receiving potent antiretroviral therapy for 4 years: The Swiss HIV Cohort Study. Archives of Internal Medicine. 163: 2187–2195.

[15] Kojima, E.; Sherasaka, T.; Anderson, B.D.; Chokekichai, S.; Steinberg, S.M.; Broder, S. Sherasaka, T.; Anderson, B.D.; Chokekichai, S.; Steinberg, S.M.; Broder, S.; Yarchoan, R., and Mitsuya, H. (1995). Human immunodeficiency virus type 1 viremia changes and development of drug-related mutations in patients with symptomatic HIV infection receiving alternating or simultaneous zidovudine or didanosine therapy. Journal of Infectious Diseases 171:1152-1158.

[16] Kumari, D.J. (2010). "Hypoglycemic Effect of *Moringa oleifera* and Azadirachta indica in Type-2 Diabetes," Bioscan. 5: 211-214.

[17] Lee, J., Oh, W.K., Ahn, J.S., Kim, Y.H., Mbafor, J.T., Wandji, J., and Fomum, Z.T. (2009). Prenyliso flavonoids from *Erythrina senegalensis* as novel HIV-1 protease inhibitors. Planta Medica. 75:268-70.

[18] Lee, J.S., Kim, H.J., and Lee, Y.S. (2003). A new anti-HIV flavonoid glucuronide from Chrysanthemum morifolium. Planta Medica. 69:859-61.

[19] Li, S., Hattori, T., and Kodama, E.N. (2011). Epigallocatechin gallate inhibits the HIV reverse transcription step. Antiviral Chemistry and Chemotherapy. 21(6):239-243.

[20] Li, S.F., Di, Y.T., Luo, R.H., Zheng, Y.T., Wang, Y.H., Fang, X., Zhang. Y., Li, L., He, H.P., Li, S.L., and Hao, X.J. (2012). Cycloartane triterpenoids from Cassia occidentalis. Planta Medica. 78:821-7.

[21] Liu, Y., K.Z., Wu, K.Y., Liu, S., Chen, W.H., Jiang, S., and Jiang, Z.H. (2011). An amphiphilic conjugate approach toward the design and synthesis of betulinic acid-polyphenol conjugates as inhibitors of the HIV-1 gp41 fusion core formation. Chem Med Chem. 6:1654-1664.

[22] Mehla, R., Bivalkar-Mehla, S., and Chauhan, A. (2011). A flavonoid, luteolin, cripples HIV-1 by abrogation of that function. PLoS One 6(11): e27915.

[23] Nonaka, G.I., Nishioka, I., Nishizawa, M., Yamagishi, T., Kashiwada, Y., Dutschman, G.E., Bodner, A.J., Kilkuskie, R.E., Cheng, Y.C., and Lee, K.H. (1990). Anti-AIDS Agents 2: Inhibitory effects of tannins on HIV Reverse transcriptase and HIV Replication in H9 lymphocyte cells. Journal of Natural. Products. 53:587-595.

[24] O'Brien, W.A., Hartigan, P.M., Martin, D., Esinhart, J., Hill, A., Benoit, S., Rubin M., Simberkoff, M.S., and Hamilton, J. D. (1996). Changes in plasma HIV-1 RNA and CD4+ cell counts and the risk of progression to AIDS. English Journal of Medicine, 334: 426–431.

[25] Oguzhan, N. (2020, February 6). What does undetectable mean? Retrieved: 2021 May 14. Aidsmap. https://www.aidsmap.com/about-hiv/faq/what-does-undetectable-mean.

[26] Rockwood, J.L., Anderson, B.G., and Casamatta, D. A. (2013). Potential uses of *Moringa oleifera* and an examination of antibiotic efficacy conferred by *Moringa oleifera* seed and leaf extracts using crude extraction techniques available to under-served indigenous populations. International Journal of Phytotherapy Research., 3: 61–71.

[27] Sabde, S., Bodiwala, H.S., Karmase,A., Deshpande, P.J., Kaur, A., Ahmed, N., Chauthe, S.K., Brahmbhatt, K.G., Phadk, R.U., Mitra, D., Bhutani, K.K., Singh, I.P. (2011). Anti-HIV activity of Indian Medicinal plants. Journal of Natural Medicines, 65(3-40: 662-669.

[28] Serafini, M., Ghiselli, A., and Ferro-Luzz, A. (1994). Red wine, tea, and antioxidants. Lancet 344:626

[29] Tshibangu, K.C.; Worku, Z.B.; De Jongh, M.A.; VanWyk A.E.; Mokwena, S.O., and Peranovic, V. (2004). Assessment of the effectiveness of traditional herbal remedies in managing HIV/AIDS patients in South Africa. East African Medical Journal 81: 499-504.

[30] UNAIDS (2023). Global HIV and AIDS statistics. Fact Sheet 13 July 2023. https://www.unaids.org/sites/default/files/media_asset/UNAIDS_FactSheet_en.pdf.

[31] Vo, T. S. and Kim, S.K. (2010). Potential anti-HIV agents from marine resources: An overview. Marine Drugs 8:2871-2892.

[32] Yang, X.W., Zhao, J., Cui, Y.X., Liu, X.H., Ma C.M., Hattori, M., and Zhang, L. H. (1999). Anti-HIV protease triterpenoid saponins from the seeds of Aesculus chinensis. Journal of Natural Products, 62: 1510–1513.