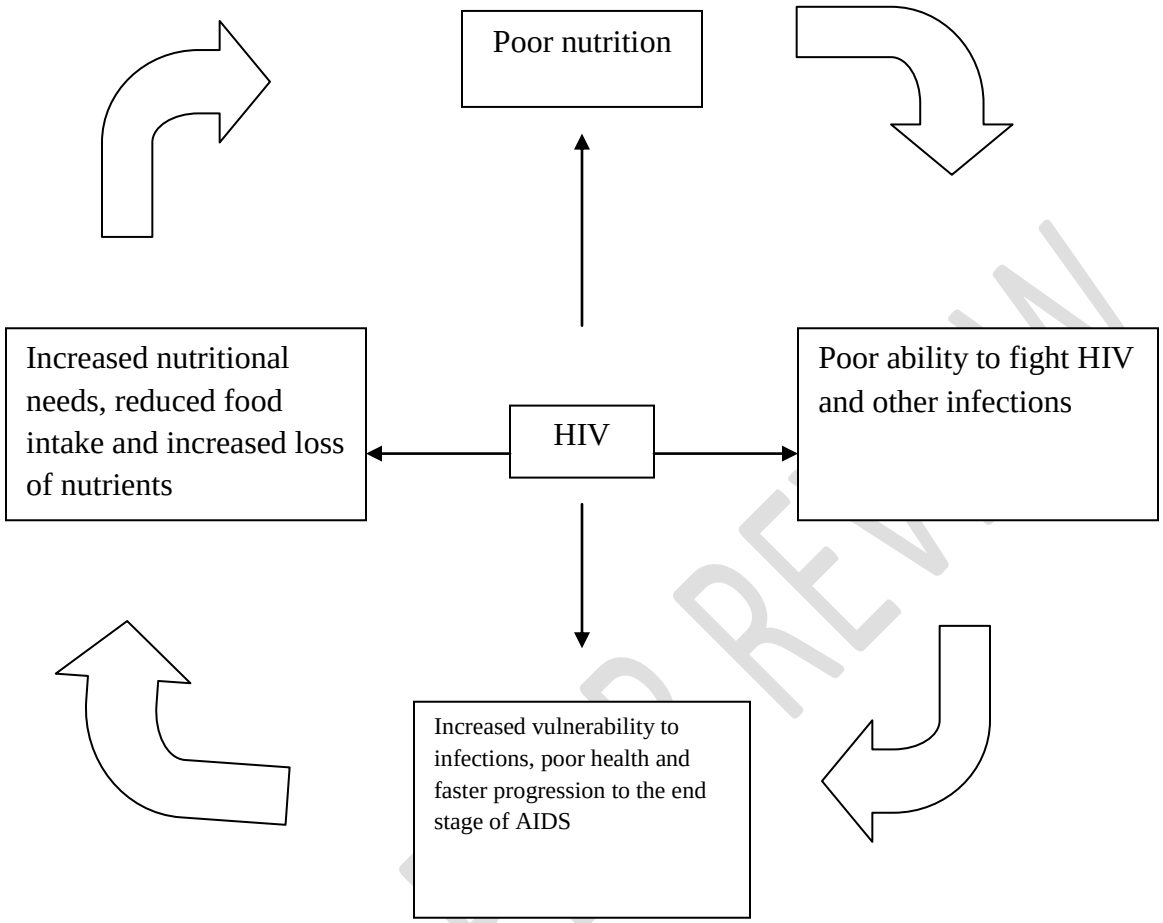
BIOAVAILABILITY OF ANTIOXIDANT VITAMINS IN SELECTED INDIGENEOUS VEGETABLES AND THEIR POTENTIAL USE IN MANAGEMENT OF HIV/AIDS IN BUTULA, BUSIA KENYA

Abstract

The study investigated feeding pattern of PLWHA in Butula division, determined vitamin A, C and E content and bioavailability in selected indigenous foods for use in the management of HIV and AIDS. Animal and plants foods accounted for 45.17 %, 21.9 %, 17.48 % and 73 % respectively of total foods consumed. Fresh blanched vegetables, contained high levels of β-carotene; 4000-9700µg/100g and α-tocopherol; 3000-7350µg/100g. Solar dried vegetables contained β-carotene of range 572-854µg/g DW and α-tocopherol of 281-673µg/g DW which is significantly lower ($P<0.05$) than fresh vegetables determined by HPLC. L-ascorbic acid content in fresh vegetables and fruits determined by redox titration ranged from 6 to 65mg/100g. Mean serum retinol, α-tocopherol and β-carotene levels were 0.937, 0.144 and 17.787µmol/l respectively determined using HPLC. CD4+ cell counts in blood determined using flow cytometer were within the normal range of 500-1500 cells/µl while the CD8+ cell count was in the range of 300-3300 cell/µl of blood. Hb was less than 12 g/dL and RDW was less than 15.2 % indicating anaemia. 88.35% of the subjects had a CD4/CD8 ratio of less than 1, 9.71% had a CD4/CD8 ratio range of 2-3 and 1.94% had a ratio greater than 4.77.95% of the subjects had a normal weight, 11.81% were underweight, 8.66% were overweight and 1.57% were obese. Bioavailability in foods estimated using algorithm indicated a +2.17 change in serum β-carotene and +7.776 changes in serum α-tocopherol levels indicating that consumption of the foods would result to improving bioavailability of these nutrients in PLWHA in Butula.

Graphical Abstract



The cycle of malnutrition and HIV infection

Source: Semba and Tang, 1999

Introduction :

Brief historical perspective

HIV remains a major global public health issue, having claimed 40.4 million(WHO,2022) lives so far with ongoing transmission in all countries globally; with some countries reporting

increasing trends in new infections when previously on the decline. There were an estimated 39.0 million (WHO/UNAIDS, 2014) people living with HIV at the end of 2022, two thirds of whom (25.6 million) are in the WHO African Region (UNAIDS, 2021).In 2022, 630 000 people died from HIV-related causes and 1.3 million (WHO, 2022) people acquired HIV.There is no cure for HIV infection (UNAIDS, 2011). However, with access to effective HIV prevention, diagnosis, treatment and care, including for opportunistic infections (KAIS, 2014). HIV infection has become a manageable chronic health condition, enabling people living with HIV to lead long and healthy lives (WHO, 2011).

Globally, 38 million people are living with HIV-68% of these in sub-Saharan Africa (WHO, 2013). Eastern Africa is the second most affected region by HIV and **AIDS** in the world after Southern Africa (UNAIDS, 2013). While the general prevalence has been reducing during the past two decades in the region, with the prevalence in Kenya dropping from 14% to 5%, new areas of concern with regards to infection among the most-at-risk populations are emerging(KAIS,2014). Women and girls comprise 63% of HIV cases, with adolescent girls and young women three times more likely to be infected than men and boys of the same age (KAIS, 2014). Some of the factors cited as contributing to the high HIV/AIDS prevalence in Busia include; poverty, adoption of western lifestyles, socio-cultural practices including wife inheritance, cross border movements, stigma and discrimination (NACC, 2005,NACC,2006).

The management of HIV and AIDS is being done through activities such as awareness creation, condom distribution and provision of **ARV's**. Access to ARV's is increasingly recognized as a key component to comprehensive AIDS management strategies. However, ARV's pose real

challenges with respect to compliance, resistance and sometimes have adverse side effects (Saitoih *et al.*, 2005; Dybul, 2002). In addition, one of the disappointing aspects of the use of ARVS is that although they reduce the rate of viral replication there is only a small improvement in the immune function (Barter *et al.*, 1993). The role of nutrition in the management of HIV/ AIDS has assumed increasing importance over the past decade (FANTA, 2004). Research has shown that nutritional status may affect the progression of HIV to AIDS and survival of HIV individuals (Piwoz and Preble, 2000). HIV infection is characterized by a high preference of micronutrients deficiencies **(**vitamin C, α-tocopherol and β-carotene) and wasting that may vary considerably among different HIV infected population (Baum *et al.*, 1995). Foods have the nutrients necessary for providing energy, building and repairing tissues and helping in strengthening immunity (Stine, 2005). High intakes of vitamin C, α-tocopherol and β-carotene have been associated with reduced progression of HIV to AIDS and improved survival (Semba *et al.*, 1995). Studies suggest that micronutrients deficiencies still occur due to malabsorption or altered metabolism and habitual consumption of poor diets (Semba, 1995; Baum *et al.*, 1995). Many parts of Butula division in Busia district have indigenous foods such as cowpeas, green grams, soya beans, sweet potatoes and green vegetables rich in immune boosting micronutrients that can be used in the management of HIV and AIDS. Since there is no known cure for AIDS, people living with HIV and AIDS (PLWHA) require care in order to maintain their health so as to remain productive longer. It is therefore important that locally available foods rich in immune boosting vitamins are identified and used to prepare food products that will enhance the bio availability of micronutrients in PLWHA and hence improve their health status and quality of life.

Summary of the established Principles

HIV weakens the immune system thus compromising the body's ability to fight infections (Baum et al., 1995). As a result of prolonged illness there is reduced appetite and interference with the body's absorption of nutrients (Piwoz and Preble, 2003). Infection also increases the body's need for essential nutrients. Clinical outcomes of HIV are poorer for individuals with compromised nutrition (Piwoz and Preble, 2003). Many HIV infected individuals are unable to meet these additional nutritional requirements and thus become weak and malnourished. Nutrients most commonly deficient include zinc, selenium and vitamin A, E, B_{12} and B_6 (Liang *et al.,* 1996). Deficiency of these antioxidant vitamins and minerals contribute to oxidative stress condition that may accelerate immune cell death and increase the rate of HIV replication (Romero-Alvira and Roche, 1998). HIV/AIDS and nutrition are intimately linked. Studies have shown that daily micronutrient (vitamin C, α-tocopherol and β-carotene) supplementation improves body weight, body cell mass, reduces HIV RNA levels, improves CD4+ cell counts and reduces incidences of opportunistic infections (Allard *et al.,* 1998; Tang *et al.,* 1993; Semba, 1995). **Indigenous vegetables** such as pumpkins leaves, cowpea leaves, amaranthus, nightshade and frying spider contain these vitamins, which boost **immunity** (Ihekoronye, 1992). Butula division (the study area) in Busia district has a high HIV prevalence of 7.4% (NACC, 2006) and produces enough of these vegetables during the rainy season but they become scarce during the dry season. The aim of the study was to determine the vitamin A, C and E content in indigenous vegetables with a view of utilizing them to prepare locally acceptable food products that will improve the **bioavailability** of these vitamins in PLWHA and the general population of Busia district.

Current state of the art

HIV infection can be detected in three ways: First, by HIV antibody or antigen testing prior to the signs and symptoms of AIDS, second by detecting the presence of HIV nucleic acid and third by physical examination after symptoms occur (Stine, 2005). The most commonly used detection test is Enzyme Linked Immunosorbent Assay (ELISA). Other tests include: Western Blot, Indirect Immunofluorescent Antibody Assay (IFA), Polymerase Chain Reaction (PCR), Rapid HIV testing kit and HIV gene probes (Anderson *et al*., 1991). Prognostic biological markers related to AIDS progression include P24 antigen levels, P24 antibody levels, and T4 and T8 lymphocyte levels (Stine, 2005). T4 and T8 lymphocyte levels are the most extensively used biological markers for AIDS progression (Anderson *et al*., 1991; Burcham and Joyce, 1991; Philips and Andrew, 1991). Viral load assays are good surrogate markers for virus replication and cell killing (CDC, 1993). There are three commercially available viral load assays; Ampricor ultra-sensitive HIV monitoring test, branched DNA (b DNA) technology and nucleic acid sequence-based amplification (Stine, 2005).

HIV management for PLWHA is done through activities such as treating the infection with ARVs, nutrition management, treating sexually transmitted diseases, preventing and treating opportunistic infections (NACC, 2002). Since there is no known cure for full-blown AIDS, HIV management is being done through prevention measures such as awareness campaign in the media, voluntary testing and counseling at VCT centers (Stine, 2005). Other approaches used include participatory education, entertainment through drama and puppetry among youth and women group and free distribution of condoms (NACC, 2005). Other strategies used include home based care, prevention of transmission in medical settings including safe blood transfusion and proper infection control and work-based programmes (Stine, 2005). The aim of therapy is to affect the action of HIV and reduce the immune suppression it causes (Stine, 2005). With the

advent of antiretroviral therapies, the treatment and management of HIV/AIDS has changed and created new challenges (Saitoh *et al.,* 2005; Dybul *et al.,* 2002). For this reason, nutrition assessment and education based on the needs of the individual is a critical component of any AIDS treatment program (FANTA, 2004). Enhancing immune function plays an important role in delaying the onset of AIDS (Piwoz and Preble, 2003).

A healthy diet, nutritional supplements, avoiding smoking, alcohol and caffeine, adequate sleep and exercise all play an important role in helping the immune system to work well (Stine, 2005). Research has shown that severe stress increases the risk of early progression of disease in those who are HIV positive (Baum *et al.,* 1995). Many HIV positive people use alternative treatment such as relaxation, spiritual and self-help therapies (Saitoh *et al.,* 2005). Herbal medicine, acupuncture, homeopathy and dietary therapies are also popular (FANTA, 2004).

Highlight of future directions

Nutrition support plays a vital role throughout HIV disease in two basic areas. First it is a vital component of care for the involuntary weight loss and body tissue wasting caused by the disease effects on metabolism (Babemento and Kotler, 1997). Secondly and fundamental, it is an intimate and integral component of care through the specific roles of key nutrients in maintaining the body's immunocompetence (Stine, 2005). Individual nutritional status influences the impact of morbidity and mortality irrespective of the disease process (MOH, 2006).

Good nutrition has the following impacts; which are summarized in (Figure 1)

(i) Prevents **malnutrition** and wasting

(ii) Achieves and maintains optimal body weight and strength

(iii)Enhances the body ability to fight opportunistic infections

(iv)May help delay the progression of HIV

(v) Improves effective treatment (MOH, 2006).

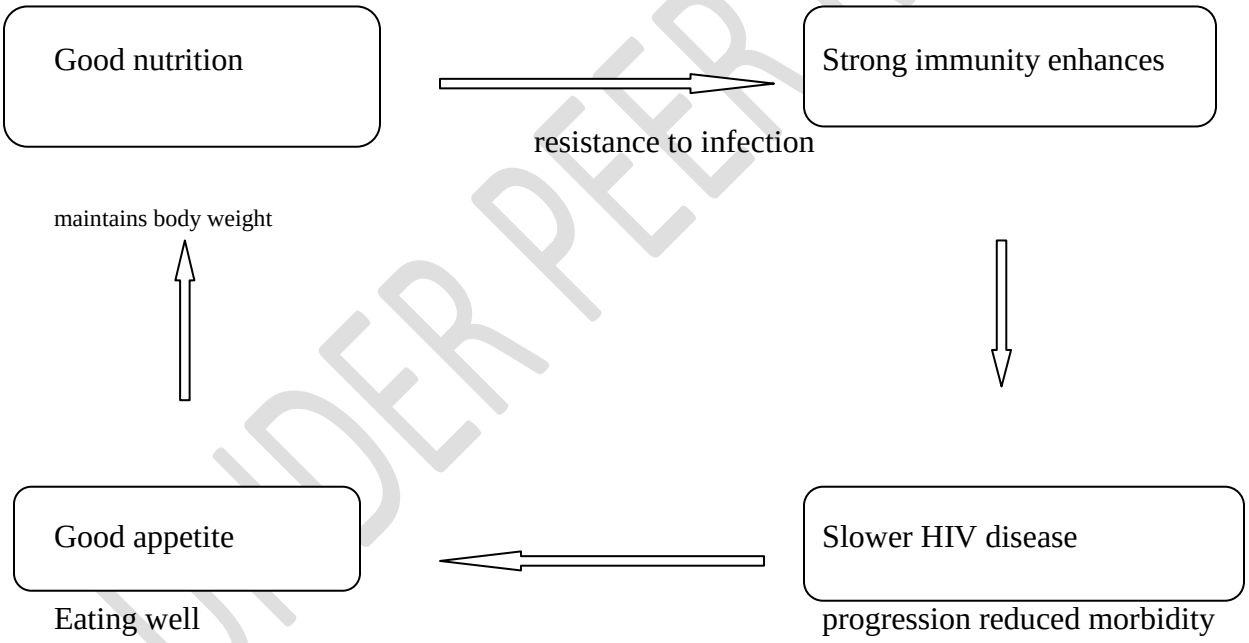


Figure 1: Benefits of good nutrition

Source: MOH, 2006

The current focus on increased access to ARV's in low and middle income earners should not obscure the fact that for much of the world's population living with HIV need for food remains an overwhelming priority (UNAIDS, 2021). Clinical outcome has been shown to be poor and risk of death higher for HIV positive adults with micronutrient deficiencies (Baum *et al.,* 1995; Semba and Tang, 1999). A preliminary study on the use of nutritional preparation with enhanced **antioxidant** properties in Kenya has shown that HIV/AIDS patients experience reduced clinical signs and symptoms, viral load and improved immune status (Mbakaya *et al*., 2003). Similar studies have shown that daily micronutrient (antioxidant vitamins, vitamin C, tocopherol, β-carotene) supplementation improves body weight, body cell mass, reduces HIV RNA levels, improves CD4+ cell counts and reduces incidences of opportunistic infections (Allard *et al.,* 1998). Daily multivitamin supplements were found to reduce HIV disease progression among men, women and children in several longitudinal observational studies and randomized trials. They were also found to provide an important low cost intervention that could be provided to adults in early stages of HIV disease to prolong the time before antiretroviral therapy is recommended.

Studies have shown that nutritional supplements especially micronutrient consumption, can be increased through eating specific foods or through special supplements (FANTA, 2004). Establishing home and community gardens to grow local foods and vegetables is important to improve intake of mineral rich foods (Ihekoronye, 1992). Raising of small animals may help improve protein, fat and micronutrients consumption such as iron (FAO, 2002). Nutrition education at an early stage of HIV infection gives a person a chance to build up healthy eating habits (FAO, 2002). Inclusion of nutrition as a core part in any HIV-care package is essential. Among the nutrients required are **vitamins**.

Key concepts

AIDS: A combination of illnesses caused by the Human Immunodeficiency Virus (HIV) that weaken the immune system.

Antioxidant: Compounds that scavenge free radicals (oxygen molecules) in the body.

Antiretroviral: Drugs that specifically deal with treatment of viruses including the HIV virus.

Bio availability: The degree and rate at which a substance is absorbed into the body at the site of physiological activity and absorption.

HIV: The Human Immunodeficiency Virus that causes AIDS.

Malnutrition: A condition in the body brought about by inadequate or excess intake of required nutrients, or malabsorption.

Immunity: Resistance to a disease because of a functioning immune system.

Indigenous foods: Local native foods grown in a community.

Nutrition: Process of food ingested, digested and absorbed to provide the body with required nutrients.

Vitamin: Nutrients whose main function is to protect the body against infection.

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