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An Exploration of Pharmacognosy and its Potential in the Multi-Faceted Solution Required to Address HIV/AIDS in Sub-Saharan Africa

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I). Introduction

Although beget from an inconspicuous particle invisible to the naked eye, the mass murderer known as Acquired Immunodeficiency Syndrome (AIDS) instigated by the Human Immunodeficiency Virus (HIV) has a symbiotic relationship with societal politics, economics, and culture. In the year 2009 alone, the disease took 2.8 million lives. That same year, there were 33.3 million people living with HIV, and 2.6 million of these signified new infections. Of the 7,000 people infected each day, 97% live in low-income countries. Children under age 15 constitute 1,000 of this ill-fated population, and 51% of the adults infected are women (UNAIDS, 2010). As the initial health issue to necessitate and constitute the major concern of a United Nations General Assembly Meeting, it has also been the first disease regarded as a global security threat by the UN Security Council. The quantity of those infected daily is five times the number of people harmed by terrorism and the resulting deaths triggered by this illness are triple the amount of those due to acts of terror. It is estimated that over 95% of people infected with HIV unknowingly transmit the virus before a diagnosis is made (Hunter, 2003).

Although the World Health Organization primarily assesses international disease, the cause and effect relationship of HIV/AIDS exists as a multifaceted matter, one which obliges complex and intricate dealings. This realization brought the establishment of UNAIDS, a coalition of eight United Nations agencies, in 1996 (Hunter, 2003). Considered a global epidemic, the variation in culture and living in the victimized populations presents a multitude of international pandemics, each unique in many aspects. The basis in how the illness uniquely affects each population is related to specific social contexts: a viral disease becomes an epidemic when it influences a particular niche. The 4.4 billion people who live in the developing world so significantly affected by AIDS comprise the poorest 20% of the world and contribute 1.1% of

total global income. Of these people, 3/5 lack sanitation, 1/3 are without clean water, and ¼ are homeless, all contributions to high risk of illness. In countries where 20-40% of the population is HIV+, 60% of those infected are under age 24 (Hunter, 2003). Tainting what would be the most productive inhabitants of struggling nations creates demographic gaps, while depleting those individuals most suitable for overcoming the frequent political, economical, and social challenges faced by unstable countries. The need for such society-specific resolutions has also brought difficulty in prevention and treatment, as most attempts have had broad, international targets without regards to underlying causes due to the exclusive realities of each distinct population. Take, for example, the Copenhagen Consensus of 2004, with its motives in advancing global welfare. Of its $50 billion budget, $27 billion was put towards a goal of preventing 30 million new HIV infections by 2010. By assuming adherence and assimilation by all, the program proved unsuccessful and was terminated (Van Niekerek & Kopelman, 2005).

The geography, history, and culture of sub-Saharan Africa have led to its extreme prevalence and growing distribution of HIV/AIDS. A prominent member of the developing nation assemblage, the region has remained consistent in retaining the highest rates of infection, spread and death caused by the disease.

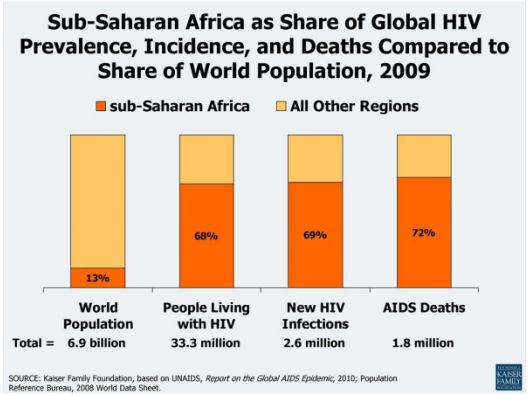


Figure 1: HIV/AIDS data from sub-Saharan Africa compared to world population (UNAIDS, 2010)

Almost all of the social contexts and cultural norms for this area share a main feature in poverty, as it is central to everyday life for the majority of the population. As the many consequences of insufficient living initiate illness, disease is also a principal factor in the manifestation of poverty. As poor living conditions prevent any hopes of accessing or affording treatment, society becomes ill as a whole, which further weakens any ability to conquer incessant challenges.

The increasing emergence and escalating severity of AIDS experienced globally, significantly in sub-Saharan Africa, demands a quick solution, as the human health clock is ticking and time is running out. Aside from social interventions, antiretroviral therapy (ART) has presented a bio-medicinal approach. After twenty years of research and attempts at implementation, however, antiretroviral treatments have been deemed expensive, inaccessible to those whom need it most, and neither curative nor considerably effective. Such conditions have initiated a prompt, widespread turn to the potential of botanical medicine. Used in multiple practices of traditional and indigenous medicine for over a thousand years, the utilization of plants and herbs as treatment for HIV/AIDS may be an inexpensive, simple, and resourceful alternative in resolving the global AIDS crisis, starting with the large population residing in third world countries.

This purpose of this paper is to defend my idea that botanical medicine shows promise in alleviating the conditions which exist in sub-Saharan Africa due to HIV/AIDS, based on its potential scientific and social contributions. Because of the cost and unavailability of conventional medicine, over 80% of people living in this region rely on traditional medicine for all forms of health care. Beliefs and tradition also contribute to this statistic, as traditional medicine requires no science or evidence, but is highly regarded due to its spiritual foundations.

Practitioners are at the top of societal hierarchy, and there exists a pervasive mistrust of the white man and his medicine, thus elucidating the effect of culture. Within traditional African medicine practices, the main mode of action in treating sickness is through herbalism. I suggest that findings in pharmacognosy can be implemented into traditional practices, prioritizing the health and culture of the people. Plants will be easier and less expensive to attain, assessing the economical and geographical implications of the given population. Such developments may reveal the hidden potential of local resources, and initiate the rebuilding of infrastructures. Information on recent discoveries in botanical medicine has provided a useful basis of comparison to past and present plant usage by traditional medicine, as well as insights into new treatment options. I find it imperative that clinical findings be adapted to local needs and resources, which may cause tension but will most importantly generate synergy between science and the cultural context of AIDS in sub-Saharan Africa.

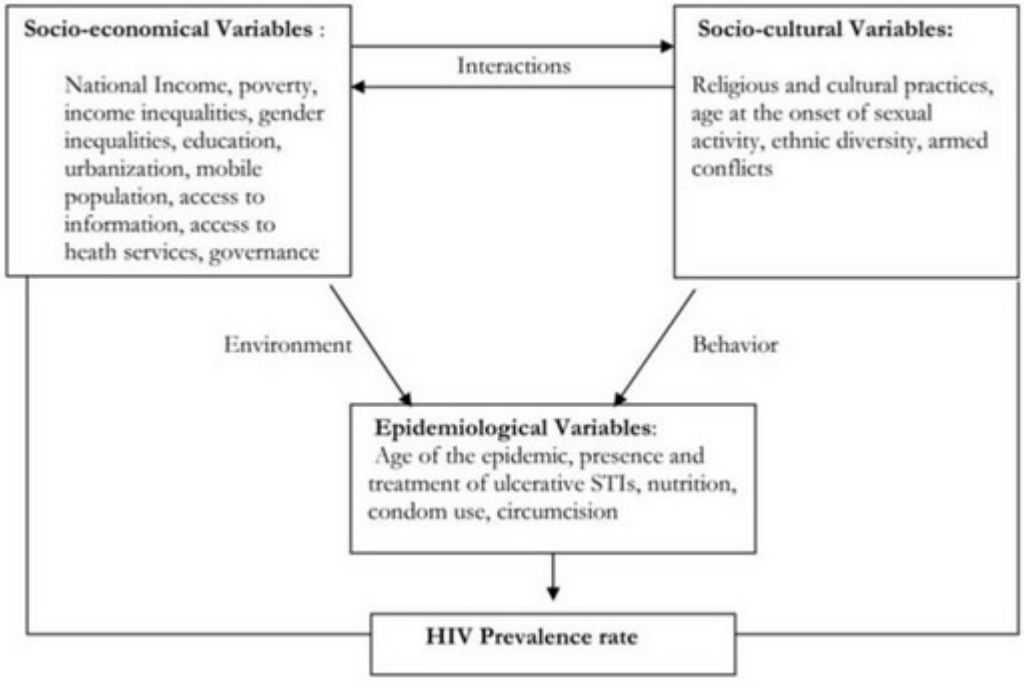


Figure 2: Societal economics, culture, and epidemiology in relation to HIV prevalence (Retrieved from http://www.cairn.info/resume.php?ID_ARTICLE=EDD_235_0041)

II). HIV/AIDS

1. HIV: Description and History

The Human Immunodeficiency Virus is a retrovirus belonging to the Lentiviridae family. *Lenti* is Latin for "slow," appropriate for this virus as it may lay dormant within a host cell for up to ten years. It replicates by converting its own viral RNA into host DNA through utilization of host energy and resources. Encapsulated by an envelope composed of variant lipid-protein compositions, the virus is able to make itself invisible to the host immune system and eventually cause immunodeficiency. The virus was first clinically identified in America, year 1981. Among its initial discovery, it was first classified as HTLV III, Human T-cell Lymphocyte Virus (Marlink & Kotin, 2004). Based on experimentation from 1983-1984, Robert Gallo of the National Institutes of Health, Luc Montagnier of the Pasteur Institute in Paris, Jay Levy of the University of California at San Francisco, and a small group of researchers from the Centers of Disease Control concluded that HIV was the cause of AIDS. By 2003, HIV infection was present in every country (Hunter, 2003).

2. **Virus Mechanism and Activity**

Studies on the viral genome have provided insight into the mechanism of viral attack and more about the viral life cycle. The progression and replication of HIV depends on the specificity of the complex virus-host interactions (Mahan & Escott-Stump, 2007). Along with virus entry into the body is a simultaneous collaborative effort by immune cells. B cells release special antibodies which bind to the viral envelope and prevent further infection. T cells recognize and eliminate infected cells. CD8+ T cells destroy and disable the viral-infused cells while CD4+ T cells, also known as "helper T cells" alert the body of the viral attack, recruiting B and CD8+ cells to the site of infection. Acting as directors and assistants, CD4+ cells have a most significant role in the immune attack, and hence are the main target of HIV. When the virus

comes into contact with an immune cell, it binds to the host cell through virions. Virions are double-stranded RNA segments consisting of 9 genes that reside in the viral envelope. The viral RNA is converted to the host DNA through reverse transcriptase, and this integration makes the virus discrete and invisible to the immune system. The virus then instructs the T cell to reproduce more viruses, and the virions form buds on the cell membrane, and are eventually released into the body. This release results in cell death along with infections of other cells. Although it involves many steps, the process of infection is quick; approximately 1 billion virions are produced and released each day. The depletion of T cells due to this death is the main contributor to immune suppression in AIDS. Because of the reverse transcriptase mechanism, HIV remains the most genetically diverse virus. Unlike DNA transcription, reverse transcription is not proof-read or monitored which makes possible a high probability of mutations. Recurrent mutations and the ability of HIV to evolve independently give rise to the ever-expanding HIV strains and types. HIV-1 has eleven subtypes, titled A through H and Group O, while HIV-2 has six subtypes. HIV-1 A-D make up 95% of new infections, and HIV-1C is the most common type seen in sub-Saharan Africa. (Marlink & Kotin, 2004). Although transmitted the same way, HIV-1 is most prevalent because it mutates readily and is the root of countless strains. HIV-2 is transmitted less easily due to the long time period between infection and illness (Mahan & Escott-Stump, 2007).

3. HIV Transmission

Human Immunodeficiency Virus is transmitted from one individual to another through the exchange of bodily fluids through such as blood, semen, pre-semenal fluid, vaginal fluid, breast milk, cerebrospinal fluid, synovial fluid, and amniotic fluid (but not saliva, tears, or urine). Such fluid trades can take please through sexual intercourse, child birth, breast feeding, drug injection, and blood transfusions. The action of these behaviors is influenced by sociocultural

norms, and their occurrence or manner in which they are performed is thus dependent on culture. Heterosexual intercourse accounts for 80% of infections and the odds of disease acquisition are increased when either partner is infected with a sexually transmitted disease, due to the symptomatic open sores and inflamed tissue. In developing countries, 40% of infants born to HIV+ mothers are infected at birth (Marlink & Kotin, 2004). In general, there is a 15-25% chance of mother-child transmission but this risk increases 20-45% when breast feeding is implemented. Because of this increased threat, the U.S. and other developed countries discourage such behavior. Contrarily, breast feeding is considered a favorable option in impoverished countries with a lack of clean water and formula (Mahan & Escott-Stump, 2007). Injection drug use is more common in areas with socioeconomic conflict and therefore coincides with a deficiency in health care, human rights abuse, and poverty. Illegal drug use also produces difficulty in tracking infections and little participation in treatment or research. Exposure to contaminated blood is most common in resource-scarce and war-torn areas, a category in which sub-Saharan Africa fits in perfectly. The disease-tainted region seems to possess all of the cultural factors associated with high-risk transmission behaviors (Marlink & Kotin, 2004).

4. Stages of Infection

Once transmitted to an individual, the immune system spawns an immediate response to the decrease in CD4+ cells. This initial immune reaction is usually able to return CD4+ amounts back to normal for a short time, creating a temporary equilibrium between HIV replication and a decrease in viral blood. Between one week and several months after the primary infection, an acute HIV infection is developed, as HIV antibodies are produced. Anywhere from a few months to ten years later, the virus further evolves into an asymptomatic chronic HIV infection, leading to a decrease in body mass and increased susceptibility in obtaining other pathogens. The next stage of infection is symptomatic, characterized by constant sweat, fever, and fatigue. The

presence of a life threatening disorder connected to decreased immunity soon follows with a diagnosis of advanced HIV, better known as AIDS. The central nervous system and gastrointestinal tract are the major reservoirs for infection as the virus advances through its life cycle and throughout the body (Mahan & Escott-Stump, 2007).

5. HAART

Highly Active Antiretroviral Therapy (HAART) was first available in wealthy nations, and has remained that way as there is no existing data for developing countries and HAART usage, due to their lack of access.

Table 4.1. Number of adults and children (combined) receiving and needing antiretroviral therapy, and percentage coverage in low- and middle-income countries by region, December 2008 to December 2009[a]

Geographical region	As of December 2009			As of December 2008		
	Number of people receiving antiretroviral therapy	Estimated number of people needing antiretroviral therapy, based on WHO 2010 guidelines [range][a]	Antiretroviral therapy coverage, based on WHO 2010 guidelines [range][b]	Number of people receiving antiretroviral therapy	Estimated number of people needing antiretroviral therapy, based on WHO 2010 guidelines [range][a]	Antiretroviral therapy coverage, based on WHO 2010 guidelines [range][b]
Sub-Saharan Africa	3 911 000	10 600 000 [9 700 000-11 500 000]	37% [34-40%]	2 950 000	10 400 000 [9 500 000-11 300 000]	28% [26-31%]
Eastern and Southern Africa	3 203 000	7 700 000 [7 200 000-8 300 000]	41% [38-45%]	2 416 000	7 600 000 [7 000 000-8 100 000]	32% [30-34%]
Western and Central Africa	709 000	2 900 000 [2 500 000-3 200 000]	25% [22-28%]	533 000	2 800 000 [2 500 000-3 200 000]	19% [17-22%]
Latin America and the Caribbean	478 000	950 000 [810 000-1 000 000]	50% [46-59%]	439 000	910 000 [790 000-1 000 000]	48% [44-56%]
Latin America	425 000	840 000 [700 000-940 000]	51% [45-61%]	400 000	810 000 [680 000- 900 000]	49% [45-59%]
Caribbean	52 400	110 000 [95 000-120 000]	48% [42-55%]	39 900	110 000 [93 000-120 000]	37% [33-43%]
East, South and South-East Asia	739 000	2 400 000 [2 000 000-2 900 000]	31% [26-36%]	571 000	2 300 000 [2 000 000-2 900 000]	25% [20-29%]
Europe and Central Asia	114 000	610 000 [550 000-710 000]	19% [16-21%]	84 400	570 000 [510 000-660 000]	15% [13-17%]
North Africa and the Middle East	12 000	100 000 [88 000-120 000]	11% [10-14%]	9 100	91 000 [75 000-110 000]	10% [9-12%]
Total	5 254 000	14 600 000 [13 500 000-15 800 000]	36% [33-39%]	4 053 000	14 300 000 [13 200 000-15 400 000]	28% [26-31%]

Note: some numbers do not add up due to rounding.
a See Box 4.2 for further information on the methods for estimating the need for and coverage of antiretroviral therapy in 2008 and 2009.
b The coverage estimate is based on the unrounded estimated numbers of people receiving and needing antiretroviral therapy.

(Provided by the World Health Organization, 2010)

The ACTG 076 Study of 1993 produced the first antiretroviral drug, Zidovidine, and it resulted in a high cost and extensive treatment plan. Soon after came the development of Nevirapine for mothers soon to give birth. It took less time and money to create and administer, but proved

detrimental to maternal health. The therapy consists of a "drug cocktail," or mixture of several antiretrovirals. The drugs most often target the genes pol and env, which are responsible for replication and envelope formation, respectively. Since the introduction of HAART, a trend has been observed in its treatment effectiveness. The first line of treatment decreases HIV RNA and increases CD4+ counts but soon develops resistance. The second line is then applied, but has various success rates and eventually leads to diminished CD4+ cells and incidences of opportunistic infections (Marlink & Kotin, 2004). Development of new drugs have varied in action; NRTI's block the reverse transcriptase enzyme, NNRTI's inhibit reverse transcriptase activity, PI's block protease, and fusion inhibitors block virus-cell attachment (Jassim, 2005). The effectiveness of HAART requires a 95% adherence to the strict protocols, and any divergence from this plan could lead to intolerances, which can cause hepatic necrosis, acidosis, and nephratoxicity. Its effects on the body also increase the risk of cardiovascular disease and diabetes. Also, long-term use of protease inhibitors has been correlated with bone loss and osteoporosis (Mahan & Escott-Stump, 2007).

III). Opportunistic Infections

Along with suppressed immunity and sickness due to attempted treatment, AIDS also comes with psychological side effects and new infections due to a depleted guard against pathogens. Autoimmune disease decrease CD4+ counts, opening the body to bacterial, fungal, and viral infections. The most common opportunistic infections associated with AIDS include pneumonia, diarrhea, tuberculosis, hepatitis C, sexually transmitted diseases, and neuromuscular disorders. One of these illnesses increases the risk of contracting HIV and co-infections of HIV/AIDS with one of these infections also worsen the effects and symptoms of both. Such a

co-infection requires ideal nutrition and superlative medical financing, both rarities in developing countries. It is these opportunistic infections that are the ultimate cause of death in 9 out of 10 people living with HIV/AIDS (Mahan & Escott-Stump, 2007).

IV). HIV/AIDS in Africa

1. High Prevalence

They are a mere 10% of the global population, but the inhabitants of southern Africa make up 70% of the people living with AIDS on earth. When its prevalence was discovered twenty years ago, a lack of needs had already destroyed most immune systems to the point of no return. The 220 million people who reside in sub-Saharan Africa live without the resources or food needed to sustain life sufficiently. This region has the highest ratios of non-productive people: productive people and children: adults in the world (Hunter, 2003). According to many residents, AIDS has also made a considerable economic impact on their country, family, and selves: two out of three have had a decline or complete loss of income, one-half of the children are starving, and one-quarter of people under age 15 have lost at least one parent to the disease. The average amount spent on health care per capita each year is $10, compared to industrial nations which range from $2,000 to $4,200 (Van Niekerk & Kopelman, 2005).

2. SIV

As the HIV sweeps through southern Africa, health and society worsen, and the virus acts as a catalyst for further infections. Its geography, history, and culture all contribute to the cycle of disease and suffering. HIV was live and present in Africa decades before it was discovered. Simian Immunodeficiency Virus, the closest related known microbe to HIV, was discovered in *Pan troglodytes*, a chimpanzee of West African origin. Contrary to popular belief, humans did not attain the virus by having sex with monkeys, but through the cultural consumption of “bush

meat." (Hunter, 2003) Home to the oldest population on earth and the birthplace of HIV, it is no surprise that every known subtype of HIV is present in Africa. This presents the possibility of more co-infection and the emergence of new subtypes and strains.

3. Geography

Although second behind Antarctica, Africa is considered the least developed continent in the world, due to its comparable population. This scarcity is most obvious in the southern part of the continent. Much of its destitution has been appointed a result of geography. The climate produces frost on the mountain tops, poor tropical soils, and heavy rains. Year-round heat aids parasites in proliferation, invading plants, animals, and people. Collectively, these natural realities decrease human productivity and any chance of success in agriculture. With this come poor nutrition, vitamin deficiencies, and an augmented vulnerability to illness. Dense vegetation in some areas prohibits any development of roads or rails, cutting off modes of communication and transportation. The geography also contributes to the nature of resources present. A small number of quite valuable resources can be found in Africa, yet they are limited in number and few are the number of people who know where and how to extract them. It is these natural resources and lack of local knowledge which attracted colonialists in the 1800's (Hunter, 2003).

4. Colonization

The likelihood of quick, widespread infection expansion within a community becomes close to a reality when there is interference to social organization, infrastructure, and a resulting disruption to health care access. In the 19th century, Europe and other developed countries attempted to sustain and prove their authoritative power through the conquest of colonies. The colonization of southern Africa, disguised as an effort to humanize Africa and rise above slavery, resulted in thirty new colonies and 10 million square miles of new territory. This time of

imperialism introduced new diseases, depleted resources, forced oppressive taxes onto residents, and led to an impoverished society (Hunter, 2003).

5. Migration, War, and the Spread of Disease

The resulting conflict of such unstable times forced refugee migrations and were based upon the abuse of human rights; the South African Law Commission had a reported 1.6 million rapes during this time period, 20,000 involving children. Over one million migrants traveled to South Africa's gold-mining capital Witwatersrand, only to return home with sexually transmitted diseases, which others spread to different areas of the continent. Soldiers returning from World Wars I and II brought also back sexually transmitted diseases, along with Tuberculosis and Pneumonia. Approximately 20-60% of the South African army was infected with sexually transmitted diseases, and the likelihood of AIDS fatality quickly overcame the risk of death in combat (Hunter, 2003).

6. Collapse of Infrastructure

As the colonists disrupted and replaced every pre-existing social norm, infrastructures of all types began to collapse. In the 1960s, when resources were depleted to their minimums and African dependency became apparent, the colonialists abruptly left the country and the cut them free of all rules and laws. This left a nation, already struggling to rebuild, ill-prepared for self rule. The destructive results are seen in the demolished health care system, where the lump sum of the public health budget has claimed to go towards AIDS effort, but there has yet to be any evidence of such spending. Public education, which would be useful in spreading knowledge about the disease and safe sexual practices, is non-existent and 41% of the population is illiterate. The importance of education is an unknown idea in sub-Saharan Africa, as people would rather know less than know more (Hunter, 2003).

7. Political Influence

As a people desperate for rule and guidance, the corrupt governments and political systems of southern Africa are revered with the utmost respect by most residents. Repeated instances in which government officials have challenged science have thus had a profound effect on communities. In 1998, President Frederick Chiluba of Zambia made advertising condoms illegal. In 1999, President Mbeki of South Africa allegedly consulted with "AIDS dissidents;" and soon after announced that AIDS is not caused by HIV, but malnutrition and drug use. The president then allied with the South Africa Department of Health to proclaim that pharmaceutical companies exaggerate AIDS to profit from poor countries. Mbeki has also been noted to prohibit multiple prevention programs, even when offered free HAART trials (Marlink & Kotin, 2004).

8. Depletion of Health Care

As the gap between rich and poor grows in a boundless manner, the distribution of wealth also becomes less equated among people. Although most hospitals are located in urban environments, 70% of the sub-Saharan population lives rurally due to expenses. Rural living involves disintegrating or non-existent institutions, no access to resources, and limited means of travel. Health care for the general population is under-resourced, and many of the medical terms and conditions are fully understood by neither physician nor patient. Provisions of even basic health care are sparse. It has become an industry for those who can afford it, and those most at risk for illness have the least access (Wreford, 2009).

9. Norms: Role of Women and Stigmatization

Cultural values and beliefs have the ultimate effect on behaviors and opinions which are contributing to the spread of illness and socioeconomic consequence, and vice-versa. Women make up 70% of the poorest global population, and must often engage in "survival sex" for money to pay rent or feed their children. Treated as inferior, most women have little say in refusing sex and would never be expected to request her partner to wear a condom. In Africa,

girls age 15-19 are 5-6 times more likely to contract HIV than boys in the same age group. The female population contains the most illness, yet is the least likely to receive care, most likely due to their static, traditional role as submissive, illiterate objects (Van Niekerk & Kopelman, 2005). Like this view on women, stigmatization of people with HIV/AIDS is contributing to its spread. Society's view of people with HIV/AIDS is not based on the virus, but the view of those at risk. First perceived to be only present in sexual deviants, the denial of care and abuse of human rights is justified as an appropriate response to unethical behavior (Marlink & Kotin, 2004). This stigma is most often a disincentive against getting tested, for fear of being rejected and ostracized (Wreford, 2009).

V). Traditional African Medicine

Of people living with HIV and AIDS in sub-Saharan Africa, 70 % have zero access to antiretroviral treatment and resort to traditional medicine. Traditional African medicine is much more common with the population, as it is inexpensive and widely available. Traditional medicine practitioners also outnumber conventional doctors by a substantial amount.

1. Statistics and Tradition

According to the World Health Organization, 80% of the population in developing countries use and prefer traditional medicine. Within this context, 70% of African babies are delivered by traditional medicine practitioners. Traditional medicine is also used for psychosocial counseling by 80% of the sub-Saharan community (Homsy et al, 2004). Traditional African medicine is an all-encompassing experience, focusing on the health of mind, body, and spirit, and the appropriate integration of the three entities. The medical discourse of this practice was gained through sharing of knowledge between cultures as a result of travel and communication, until the emergence of scientific medicine in the 1800s, which attempted to

undermine traditional practices. Traditional medicine persists, both because of the availability of healers and herbs, and with the spiritual attachment to its principles. The devotion to tradition trumps scientific evidence and healers make themselves available for consultation twenty-four hours a day (Liverpool et al, 2004). Healers are recognized as high members as society and considered within their communities as professional healers. Instilled by all with trust and respect, they offer guidance and insight into long term health issues and misunderstandings of health issues (Wreford, 2009). Most often, patients will refuse surgery or extraordinary treatment unless first sanctioned by their healer. Traditional medicine is also publicly endorsed by the government, and herbal medicines are marketed in clinics (Nyika, 2007).

2. Beliefs

In these rural African communities, everyone is believed to have equal access to goods and rights but there still remain elected roles and titles; a community healer is one of the most respected. Responsible for mastering the indigenous knowledge passed throughout generations without documentations, healers also practice necromancy. The spiritual aspect of traditional African medicine, necromancy is the act of consulting ancestors for diagnosis and treatment (Nyika, 2007). Although ancestral rituals cannot be changed, they are experienced in contemporary terms, with aims to avoid misfortune by pleasing the ancestors. In many instances, there is no separation of medicine from religion, and the healing herbs are considered sacred; that is, they are known to heal but because of the spiritual power they encompass (Grossinger, 1982).

3. Practices

Healers practice through a psychic diagnostic state and the idea of harmony with nature is often seen in their treatment. Many believe in leading the patient to their own healing, maintaining traditional practices as accurately as possible (Liverpool et al, 2004). The remedies recommended by healers are often specific and prescriptive, yet never questioned. Although

some methods of healing are mechanical (stimulation, relaxation, pulsation) or invasive (shampooing, incisions), most treatments are plant-based teas, tinctures, salves, smokes, and other crude mixtures (Wreford, 2009).

4. Herbalism

With the use of plants as food, timber, and fuel, there lies a significant and substantial trust in the medicinal properties of herbs and plants. An ethnobotanical field study of Mozambique revealed local knowledge of over 5,500 plant species in medicine. Of the fifty major plant species used, 46% were effective antidiarrhoeals, 30% were effective against malaria, and 28% were shown useful against respiratory infections. Here lies evidence in the capability of traditional medicine to efficaciously treat many fatal infections associated with AIDS (Bandeira et al, 2001).

5. Mistrust

As western and modern scientists and physicians attempt to intervene and offer help, they are often dismissed by sub-Saharan Africans. Many believe it is a scheme to take over their lives and healthcare by the powerful and self-righteous. None, if any, could forget the events due to colonization, exploitation, and monopoly that affected their ancestors and still detriment their lives today (Nyika, 2007). Realistically, the sufficient health care needed is beyond reach of the vast majority without some assistance. Decades of racial mistrust and the lack of government focus on health care has left most with no other options but traditional medicine.

VI). Pharmacognosy

1. Western Views of Traditional Medicine

With the introduction of science-based medicine in the 19th century, traditional medicine was dubbed erroneous by many, as its remedies and practices were not scientifically supported. This distrust by conventional doctors still exists today, as western physicians judge the practice

without a full understanding. Such opinions are made through evaluations of traditional medicine customs, based on western paradigms. The use of traditional healing for people living with HIV/AIDS is justified with necromantic revelations and "testing" by healers, which can be viewed as inaccurate diagnosis and experimentation without consent. Here, those making critical observations must keep in mind that the sacredness engrained in traditional medicine requires no informed consent by healer or patient. Another denounced procedure is the mode of passing medical information on to others; that is, it has no records and fails to emphasize dosages and side effects. According to conventional physicians, the most considerable blunder is the laxity of regulation involved in treatment: the healer may prescribe any herb without providing its name, contraindications, mode of action, or evidence of safety (Nyika, 2007). It is simple to pass judgment when playing the role of an outsider; however, those both giving and receiving natural medicine are held together by a strong sense of ritual symbolism. Victor Turner, an anthropologist who has offered multiple writings on African religion concluded that "medicine is given to humor rather than to cure" and that "a rich and elaborate system of ritual and magical beliefs and practices provides a set of explanations for sickness and death and gives people a false sense of confidence that they have the means of coping with disease." (Grossinger, 1982: p.47). Such strong presence of ethnocentrism while learning about other ways of life, especially in this case, has created a binary of science and traditional medicine and thus created an aura of disjunction in the region. One from a less developed world could propose that modern health care does not adequately address the spiritual and emotional needs of a patient, but this does nothing besides disregard the good that western medicine does bring. Evaluating one domain by using another's criteria is neither effective nor applicable when dealing with such a global phenomenon.

2. History of Traditional Medicine

African traditional medicine has been a tradition for over a thousand years (Nyika, 2007), and has also existed globally for a longer time. The World Health Organization defines traditional medicine as "health practices, approaches, knowledge and beliefs incorporation plant, animal and mineral based medicines, spiritual therapies, manual techniques and exercises, applied singularly or in combination to treat, diagnose and prevent illnesses or maintain well-being." (WHO, 2003) The oldest record of ethnomedicine is from 2,600 BC, where cedar oil, cypress, and poppy flower were used to treat cough, parasites, and inflammation. The Egyptian "Ebers Papyrus" (1,500 BC) also suggests a myriad of herbal concoctions to treat certain illnesses. Although most may not be aware, 80% of the world population resorts to pure plant extracts for their primary health, while the other 20% utilizes some type of plant derivative. Of the 119 major modern drugs, 84 are of ethnomedicinal origin and would not exist if not for traditional medicine (Chattopadhyay & Naik, 2007). Perhaps those of the developed world adhere to and rely on some form of traditional medicine more often than one would suppose.

3. Usefulness in Botanical Medicine Research

Perhaps an expanded emphasis on pharmacognosy would reveal the prestige and promise of natural medicines. The American Society of Pharmacognosy defines its objective as "the study of the physical, chemical, biochemical, and biological properties of drugs, drug substances or potential drugs or drug substances of natural origin as well as the search for new drugs from natural sources." (ASP, 2010) Exploration in this field may furnish rational alternatives to the biological and social issues arising from leading to the difficulty in HIV treatment. Vaccine design is time-consuming, especially with HIV because of its complex genetic makeup. The average amount of time between disease identification and vaccine production is three decades, and that needed for HIV assumes to take longer. This drug development is especially challenging

because of the habitual mutations specific to HIV quickly lead to new strains and drug resistance. A successful vaccine would boost the immune system and prevent self-attack, but such a development is estimated to cost $500 million (Hunter, 2003). Pharmaceutical companies are the top most profitable agencies in the world, raising prices higher than the rate of inflation. Approximately 90% of the money allotted for drug design is spent on conditions that devise only 10% of global diseases, being those most common in developed countries. The insufficient health care structure of under-developed countries causes problems in accessing medication, leading to no treatment or interruption of adherence to treatment schedules (Van Niekerk & Kopelman, 2005). When the amount of antiretrovirals in the blood is depleted due to non-adherence, new mutations develop and require the synthesis of more drugs (Mahan & Escott-Stump, 2007). Effective therapies against HIV thus also require less toxic compounds with antiviral activity. Plants not only offer a control strategy, but also harbor the capacity to act as antivirals. Plants are more suitable options than the extremely limited lifespan of antiretrovirals, and cultivation of plants for the use of botanical medicine will not only hinder the extinction of many endangered plant species, but also give insight into the power of the products of our own earth. Studies should not only inspect anti-viral activity, but also side effects, efficacy, and modes of standardization.

VII). Recent Research

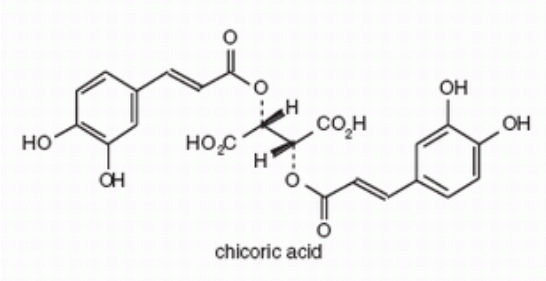
1. Phytochemicals

Phytochemicals are secondary plant metabolites, existing as active constituents with medicinal properties. Structurally, they maintain a close resemblance to the naturally occurring compounds of the body in terms of elements, bonds, and interactions. These chemical properties facilitate recognition and integration into the metabolism, offering easier processing and less

toxicity in comparison to synthetic antiretrovirals. More precisely, they show ample promise in their immeasurable structural diversity, yielding correspondence to the ever-changing composition and modes of action of Human Immunodeficiency Virus.

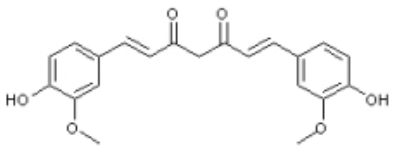
Phenolics/Polyphenols

In their simplest form, phenolics are single-substituted phenol rings with a functional hydroxyl (-OH) in their highest oxidation states. The phenolic ring is readily esterified or methylated which allows liquid extraction through water, ethanol, or both in combination with a weak acid. By attaching to proteins on the host cell surface, they reduce the amount of viral adsorption, and inhibit reverse transcriptase of HIV-1. The anti-viral activity is dependent on the location and number of hydroxyl groups (Sakagami et al, 2005).



chicoric acid

McDougal et al extracted D-chicoric acid from *Humulus lupulus* (a common hop) and discovered its ability to inhibit HIV integrase. The anti-viral activity is not affected by decarboxylation, but was dependent on the bis-catechol moieties.

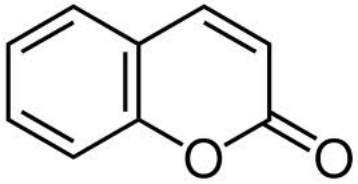


Curcumin (keto form) gives turmeric is characteristic yellow color.

Curcumin is a yellow pigment of *Curcuma longa*, related to ginger and also known as turmeric. Roth et al discovered its ability to block HIV-1 and HIV-2 replication through inhibiting integrase, protease, and virus-cell fusion.

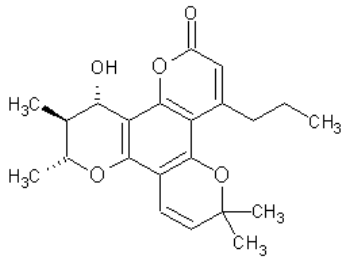
Coumarins

Coumarins are fused benzene and α-pyrone rings:



Coumarin Structure

Through stimulation of macrophages, coumarins produce an indirect effect on viral activity. Calanolides are coumarins substituted with methyl groups at C-10 and C-11, along with a hydrogen bond acceptor at C-12.

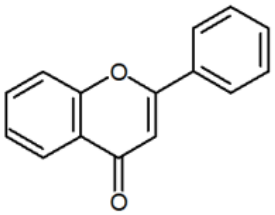


Calanolide A

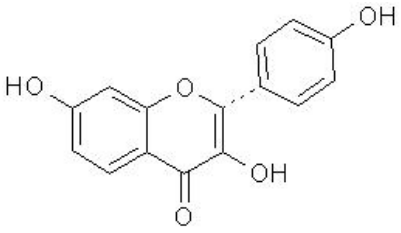
From the rainforest tree *Canophyllum inophyllum*, Dharmaratne, et al concluded this compound inhibits RTase.

Flavones/Flavonols/Flavonoids

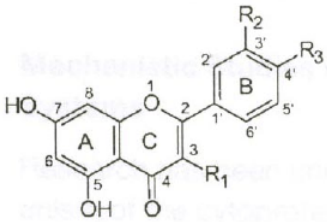
From the Latin *flavus* meaning "yellow," some compounds in this category contribute to flower petal pigment color. A flavone is a hydroxylated phenolic with one carbonyl, while a flavonol possesses a third hydroxyl group. Flavonoids are constituted of two aromatics joined by a C_6-C_3 linkage.



Flavone



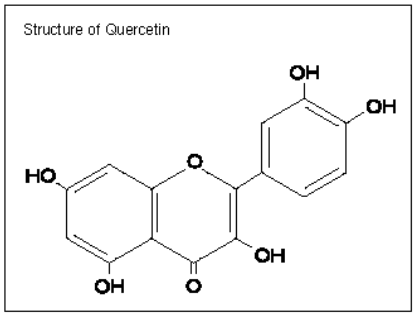
Flavonol



Flavonoid

Ubiquitous in nature, there have been multiple applications in studying the phytochemistry of these compounds. Flavonoids have been found to engage in anti-tumor, anti-inflammatory, and anti-allergic activities. Recent findings have also assessed the anti-viral capabilities of Flavonoids.

Quercetin, a polyphenolic flavonoid, is found in apples, onions, and tomatoes, and has long been regarded for its anti-inflammatory abilities. In 2009, Nair et al assessed the anti-viral effects of the flavonoid Quercetin on HIV-1 infected peripheral blood mononuclear cells (PBMC's).



The group of researchers hypothesized that quercetin would exert anti-HIV activity by differential modulation of pro-and anti-inflammatory cytokine expression in PBMC's. The inhibition of HIV-1 by quercetin was evaluated through HIV-1 p24 antigen production, HIV-1 LTR gene suppression, and a MAGI cell assay. After isolation of PBMC's through centrifugation, the cells were infected with HIV-1 (IIIB). The infected cells were then washed with quercetin in varying amounts, similar to those found in human plasma ([0-50 µm]) and cultured for further analysis.

The culture supernatants were used for analysis of HIV-1 p24 antigen protein production by an ELISA kit, and the results showed a decrease in antigen production with increasing amounts of quercetin (Fig. 1b).

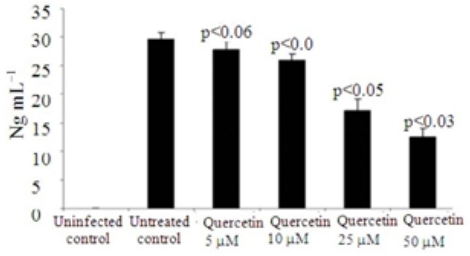


Fig. 1b: Effect of quercetin on p24 production in PBMC infected with HIV-1 IIIB

Note: Effect of quercetin on p24 production in PBMC infected with HIV-1. PBMC (3×10^6 cells mL^{-1}) infected with HIV-1 IIIB were treated with quercetin 0-50 µM for 7 days After incubation, supernatants were collected and analyzed for HIV-1 p24 antigen levels by ELISA. The data represents the means ± SE of 3 independent experiments. Statistical significance was calculated by students "t" test

Quantitative Real Time PCR was used to measure HIV-1 LTR gene expression in PBMCs. The LTR (long terminal repeat) gene is distinctive of virus genomes, and regulates transcription initiation and adenylation. RNA extracted from the culture pellet underwent rapid reverse transcriptase and amplification to quantitate LTR gene expression. Increasing dosages of quercetin decreased with LTR gene expression (Fig. 1a).

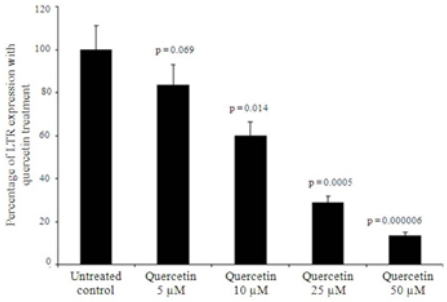


Fig. 1a: Effect of quercetin on LTR gene suppression in PBMC infected with HIV-1 IIIB

Note: Effect of quercetin on LTR gene suppression in PBMC infected with HIV-1. PBMC (3×10^6 cells mL^{-1}) infected with HIV-1 IIIB were treated with quercetin 0-50 µM for 7 days. Cells were harvested, RNA was extracted and reverse transcribed followed by quantitative real time PCR for LTR gene. Relative expression of mRNA species was calculated using the comparative C_T method. The data represents the means ± SE of 3 independent experiments. Statistical significance was calculated by students "t" test

MAGI (multinuclear activation of a galactosidase indicator) assay quantitively measured HIV-1 infection of PBMC. The MAGI cells were transfected with CD4 and a reporter construct made of the β-galactosidase gene, as its expression is Tat-dependent. As a transactivator of transcription gene in HIV, the presence of the virus would turn on gene expression of the reporter construct. The cells were stained with X-Gal, and blue cells represented infected cells. As the concentration of quercetin increased, the number of blue cells diminished (Fig. 2).

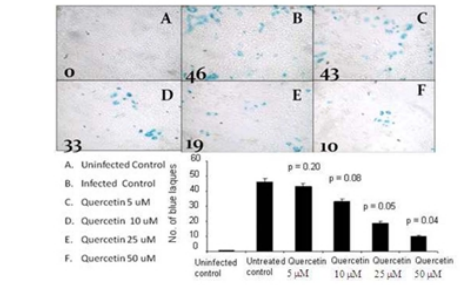
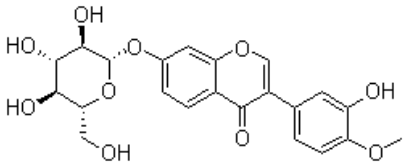


Fig. 2: Effect of quercetin on HIV-1 IIIB virus infectivity in PBMC by MAGI cell assay

Note: Effect of quercetin on MAGI cell assay. MAGI cells (4×10^4 cells $well^{-1}$) were treated with 100 µL cell suspension of PBMCs that were infected with HIV-1 IIIB virus and subsequently treated with quercetin (5-50 µM) and incubated for 3 days at 37°C, 5% CO_2. Cells were fixed and stained with 5-bromo-4-chloro-3-indolyl-D-galactopyranoside (X-Gal) and blue cells were counted as infected cells. The data represents the means ± SE of 3 independent experiments. Statistical significance was calculated by students "t" test

Calycosin 7-O-β-D-glucopyranoside is another member of the flavonoid family, isolated from the roots of *Astragaluus membranaceus,* a flowering perennial. Its extensive and long-term use in traditional Chinese medicine for diarrhea, edema, anemia, and nephritis has revealed its pharmacological potential.



Calycosin

After discovering its viral-inhibiting properties, Ma et al took an alternative approach to their research on the plant, and turned their focus to the cytotoxic effects of the extract, as anti-viral treatment also requires anti viral compounds that will not harm host cells. Isolation from the plant roots was achieved by an extraction of 95% ethanol under reflux, followed by concentration under reduced pressure. The resulting residue was suspended in water, and then fractionated. The compound was identified through nuclear magnetic resonance. Human T cells (line C8166) were infected with HIV-1 (IIIB), and then treated with various concentrations of the flavonoid. The cytotoxic effects were measured by MTT colorimetric assay, and wells that had been reduced to a purple color represented the presence of viable cells. Calycosin 7-O-β-D-glucopyranoside was shown to be safe between concentrations of 0.64 – 200 µg/mL (Fig. 1).

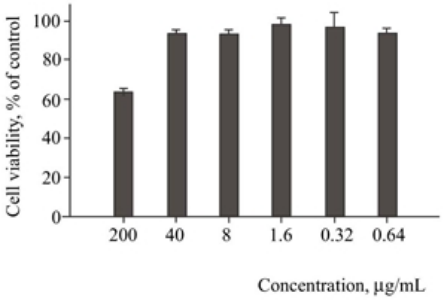
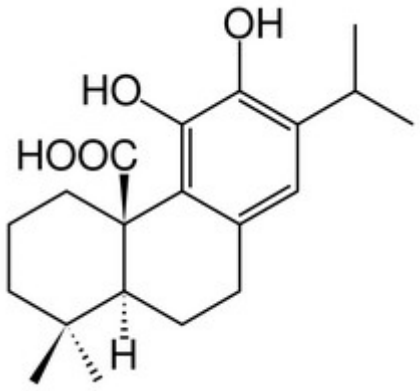


Fig. 1

Essential Oils/Terpenes

Essential oils are the *quinta essential* of plants, contributing to their olfactory characteristics and existing as phenolics with a C_3 side chain and low oxidation. Oils enriched with isoprene are called terpenes. Terpenes substituted with reactive compounds such as oxygen are known as *terpenoids*.

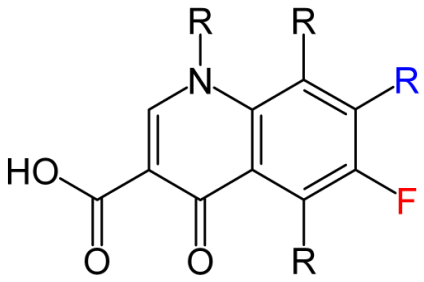


Carnosic Acid

From the woody perennial *Rosmarinus afficinalis*, a study conducted by Paris et al concluded that the compound allowed 90% inhibition of HIV-1 protease, due to its benzylic CH_2^+ and free carboxyl groups.

Quinones

Quinones are highly reactive aromatics with two ketones, and are responsible for the browning of fruits, henna, and melanin. By irreversibly binding with nucleophilic amino acids, they inactivate and expire the function of viral proteins.

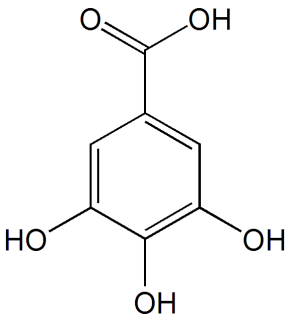


Fluoroquinolone

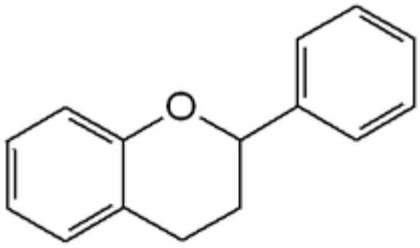
Found in *Pterocaulon sphacelatum*, a flowering plant otherwise known as "apple bush," Richter et al examined its anti-viral mechanisms and discovered it inhibits HIV reverse transcriptase.

Tannins

Tannins are polymeric phenols composed of two categories: hydrolysable tannins are based on the structure of gallic acid, while condensed tannins are compounded flavan monomers. Best known for their antioxidant properties, recent studies have also revealed anti-viral power. Tannin found in beverages such as green tea and red wine form complexes and interact with microbial proteins, inactivating virus adsorption, transport proteins, and reverse transcriptase (Yoshida et al, 1996).



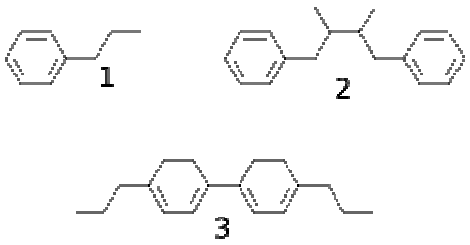
Gallic Acid



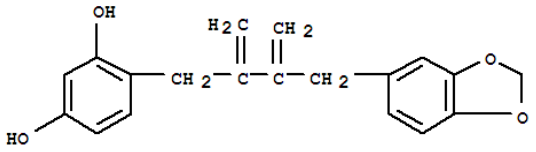
Flavan

Lignans

Lignans are polyphenols derived from the dimerization of cinnamic acids, linked at C_3 and C_6 through a β,β' bond. These are highly present in sunflower seeds, flax seeds, and grains.



Lignan (2) and derivatives



Anolignan A

A compound derived from *Anogeissus acuminata* (also known as the button tree), this lignan exhibited inhibition of drug-resistant HIV-RTase in a study conducted by Rimando, et al.

Lectins

Lectins are positively charged peptides connected by disulfide bonds. Their characteristic non-catalytic domains bind to definitive carbohydrates on the viral capsid through monosaccharide specificity, inhibiting viral-cell fusion. This is defined in the mannose-specific lectins of genus *Cymbidium*, or the boat orchid; the lectins interact with particular glycosylation sites containing glycoprotein gp120 rich in mannose (O'Keefe, 2001).

2. Established Use of Plants

Many plants and herbs used in global traditional medicine have recently been found to hold the aptitude to inhibit HIV attack, prevent the onset of AIDS, or prevent the opportunistic infections which claim most lives of the HIV-infected population. Cat's claw (*Uncaria tomentosa*) is a pan-tropical genus with over sixty species. A long, climbing vine with spines, its bark has often been used to increase immunity and reduce inflammation as a result from many illnesses. In 1999, Keplinger et al discovered that a 4:1 standard with HCl and extract of the root bark proved to be beneficial for HIV+ individuals. After five months of treatment, leukocyte numbers increased to their normal levels. It also increased the lysis of virally-infected cells only, as quantified by the measured surge in uric acid. Its main active constituents include oxindole alkaloids, existing in the easily isomeric tetra- and pentacyclic forms (Mahan & Escott-Stump, 2007).

Echinacea (*Echinacea purpurea*) is an herbaceous, flowering plant belonging to the daisy family. Its use has been recorded by Native Americans tribes such as the Cheyenne, Choctaw, and Dakota as the primary treatment for all health issues. Keplinger et al also found that treating HIV-infected peripheral blood mononuclear cells escalates the quantity and action of non killer cells, a type of lymphocyte. Its effective components include caffeic acid derivatives and flavonoids. Interestingly, it also contains the alkaloid betaine which lacks the 1, 2 unsaturated ring system most often associated with such alkaloids that would usually be hepatoxic (Mahan & Escott-Stump, 2007).

Aside from its mystical reputation of warding off vampires, garlic (*Allium sativum*) has had a notable role in herbal medicine. Cultivated for over 5,000 years with its roots in Asia, the genus *Allium* now grows globally, giving rise to over 700 species including chives, leeks and shallots. Its uses in traditional medicine include alleviating cold, cough, bronchitis, earache,

toothache, high blood pressure, diarrhea, dysentery, diphtheria, tuberculosis, and hepatitis. It acts with its abundant amounts of sulfur, especially the thiosulfinate *allicin* which contributes to immunomodulation and liver protection (Mahan & Escott-Stump, 2007).

The shitake mushroom of Asia has been a long-time oral solution to decreased immunity, due to its high content and optimal ratios of protein, fat, carbohydrates, fiber, vitamins, and minerals. The derivative *lentinan* is also used as an adjunct in treating HIV, with its recorded effect of increasing CD4+ counts (Ulbricht, 2010).

Probiotic yeast (*Saccharomyces boulasdii*) is a nonpathogenic yeast strain most revered for its abilities in digestion regulation. It has also been shown and used to treat or prevent HIV-associated diarrhea, a top cause of death especially in developing countries (Ulbricht, 2010).

.The long term usage and proof of efficacy in the traditional medicinal botanicals mentioned here and listed in multitudes of literature should both support and encourage further studies in pharmacognosy and phytochemicals.

VIII). Conclusion

The complex roots of the domination and expansion of AIDs in Africa requires a solution of both scientific and social measures. Botanical medicine may be a start in such a dynamic approach. Developed countries can utilize their power and advanced capabilities once used for exploitation instead to address the widespread damage done in developing countries. The British disease ecologist Tony McMichael has claimed that “we’re borrowing against the environmental capital of future generations,” (Hunter, 2003, p.8), and I suggest that we resort to benefit them instead. The integration of modern technology and medical knowledge into standard practices of African traditional medicine will address the cultural, socioeconomic, and financial causal agents

of the strife experienced by these people. As AIDS is influenced by the specific social, economic, and political realities faced by the affected communities, culture also influences the design and application of assessing the problem. Western medicine must first invest the value and respect placed in traditional medicine by the community before enlisting its help and suggestions. With cultural relativism, western health care officials and AIDS advocates can work side by side with traditional medicine practitioners to educate them on HIV/AIDs research, correct usage of plants, and possible HAART/botanical contraindications. This will contribute to managing the spread successfully by dwindling risks via communication and making the available treatments effective. As those with the greatest access and acceptance by the community, traditional healers can also be considered vehicles for promotion and the spread of knowledge. Plant use in medicine is an obvious answer in the quest for safe, inexpensive, and potent antiretrovirals. Although pharmacognosy has shown promise in the treatment of the virus, none have proven perfect yet. Research does, however, show concrete evidence in treating opportunistic infections, the major concern for all with HIV/AIDS. An incentive in the compliance of communities and the prevention of further issues would be the implementation of resource protection plans. Intellectual property laws would accommodate healers and their communities for providing knowledge, and could possibly be the reason for creating trust funds for community health development. Protection of indigenous knowledge will enable the sustainable development of traditionally acceptable health practices including cultivation, harvesting, and utilization. Conservation programs could make possible the prevention of herb or plant extinction; companies involved with phytochemicals could put a portion of their proceeds towards this conservation. The goals of these programs should be both to sensitize communities to their resources and knowledge, with a priority in their heritage and health. This dialogue and

coordinated approach may pacify any mistrust these communities have in developed society, provide crucial information, and the initiation of effectual bonds. A global epidemic solicits the formation of a global partnership to share knowledge and resources in assessing the specific causes of each area affected, and ensuring that the needs deserved equally by all humans are met.

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