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Biodiversity in West African Biomes and the Involvement of Traditional Healers in Bio-processing and Therapeutic Drug Development

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INTRODUCTION

Understanding biodiversity and biome phenomenon in West African geographical landscape is crucial in this age of genomic science. Applications of knowledge derived from genomics can further illuminate the relevance of genetic mapping of food crops and plants with healing properties which exist in the desert, grassland, tropical rain forest and the wetland biomes in West Africa. The tiny vestige of tropical rainforest constitutes a natural treasure trove of medicinal plants. These flora have not been comprehensively studied, characterized and genotyped in the wide expanse of West African biodiversity. With the inception of the genomic age, there are ample reasons to preserve bio-genetic diversity.

Bio-diversity includes the physical, biological make-up of an area, including the natural nidality, species of plants and animals and the vegetation of an area. In the same vein, biomes can be defined as a wide expansion of vegetation and the assemblage of similar plants and animal species. In West Africa, the five main ecological biomes are the desert, grassland, tropical, rainforest and wetland, which meander into the Atlantic Ocean [Figure 1].

The economic and medical value of plants are multifarious; their medical utility, their aesthetic value, recreational and intrinsic essence for many observances. Plants also have ecological benefits in enabling us to control carbon dioxide emission and the control of global warming. The imminent challenge is the possibility of extinction of these endangered species over their natural range. With the innovative genomic technologies being developed rapidly in the industrialized nations, it seems plausible that more sophisticated techniques could yield to unknown bio-medical data about these flora with therapeutic benefits worldwide.

Traditional healers rely on this rich ecological niche for utilizing the flora and fauna which have therapeutic benefits. In 1978, The World Health Organization (WHO) accorded recognition to traditional medical practitioners at its primary health care declaration at the Alma ATA conference in the former Soviet Union. In fact since 1976, WHO has stressed the importance of traditional medicine which was then defined as "the total of all the knowledge and practices whether explicable or not, used in diagnosis, prevention and elimination of physical, mental or social imbalance and relying exclusively on practical experience handed down from generation to generation whether verbally or in writing"[1].

In many African nations, traditional medical practitioners rely on remedies derived from plants with healing properties. For example, in Ghana, Ivory Coast, Republic of Benin, Nigeria, and other West African, Central and East African nations, the population to health care ratio remains inadequate. Both groups of practitioners are usually overwhelmed by the broad spectrum of endemic diseases. To illustrate in Nigeria, there are 110 patients to everyone traditional healer and 15,740 patients to that of one medical doctor trained in the university [2]. In Ghana, in the Kwahu district, there are 224 patients to traditional medical doctor compared to 21,000 patients to one university trained physician [3]. In Swaziland, the ratio of patients to one traditional healer is 110 patients, compared to 10,000 patients to university-educated medical practitioner. In Tanzania the statistical ratio is 30,000 patients to one traditional healer and 40,000 patients to one university educated medical practitioner [4]. In an effort to meet the Millennium Development Goals, combat increasing drug resistance and clinically tackle the problems of

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emerging infectious diseases, it is imperative that top-ranking medical administrators break down the barriers that exist between Western-trained physicians and their indigenous medical counterparts.

Figure: 1A and 1B: The West African Ecological Biomes and the Study Sites

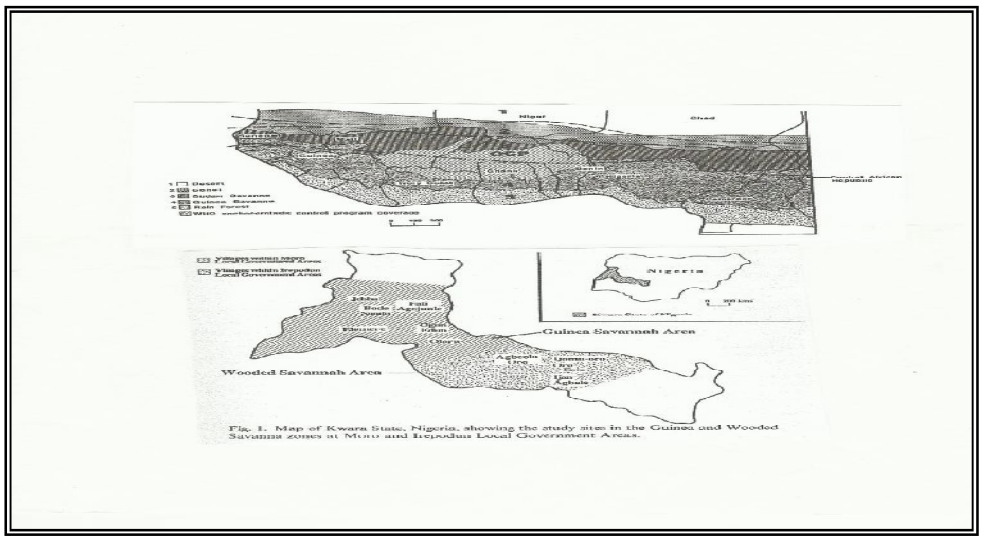


Fig. 1. Map of Kwara State, Nigeria, showing the study sites in the Guinea and Wooded Savanna zones at Moro and Irepodun Local Government Areas.

The World Health Organization has identified traditional healers as one of the important means to achieve comprehensive health care coverage of the world population [5]. In the early part of the nineteenth century, traditional medical practitioners were not only professionally derided but economically marginalized. In genomic community, governments, pharmaceutical companies, researchers and international non-profits organizations now recognize the role of traditional medicine and its practitioners. Therefore, official government efforts are necessary to invest the requisite funds to study plants with healing properties. Scientists must identify the ecological biomes, which are conducive for the growth of these plants, so as to enrich the pharmacopeia of herbal healing in developing nations. At an alarming rate, massive deforestation of the tropical rain forest erodes the flora and fauna which traditional healers rely on and use as medicinal plants for the treatment of their patients. The study describe here was designed to:

- Assess the causes of deforestation and the ecological effects of deforestation
- Identify plants with healing properties at specific West African biomes
- Identify the role of traditional healers in plant identification
- Design a model for utilizing the services of traditional healers in bio-processing,
- Develop strategies to eliminate the barriers in professional collaboration among university educated physicians, agronomists, botanists, epidemiologists, pharmacologists, microbiologists and traditional healers.

RESEARCH METHODS

This study on the identification of plants with healing properties was designed as a prospective investigation in 1982. Five paid field workers were recruited to visit traditional healers in four states in Nigerian villages. The villages consist of Babana villages in Northern Nigeria, Shao, Elemere, Gbangbalaku, Olomigbono in Kwara State, Akure in Ondo State and Benin City Edo State in Nigeria. Between 1985 and 1988, the investigator including the research assistants visited the traditional healers to explain the protocol for the collaborative study. Between 1988 and 2011, the paid assistants continue to visit the traditional healers to monitor the existence of many of the herbal plant species. Although two of the traditional healers have died, additional two healers not previously associated with the original study were newly recruited. Establishing trusting relationships and camaraderie with the traditional healers, varieties of herbal plants used in the practice of traditional medicine were collected and identified with the assistance of taxonomic literature at the University of Ilorin, Ilorin, Kwara State, Nigeria.

A detailed account of the study areas and the various ecological biomes covered in this investigation were published elsewhere [5,6,7,8,9] Paid research assistants were given one month training about techniques for conducting surveys with traditional healers. Initially, the research assistants were trained by emphasizing the

relevance of patience, allowing sufficient time to visit and develop intimacy with the healers. Research assistants must accentuate the value-added impact of traditional healing as the rationales for surveying the healers in the age of plant genomic science.

Six paid research assistants from five ecological zones in Nigeria were trained to visit the traditional healers in the desert biomes at Babana in Northern Nigeria, the Kwara state Guinea savanna, the wooded savanna biomes, the tropical forest and the wetland areas of Nigeria.

The key questions in the oral survey were for the healers to list and enunciate plants with therapeutic properties in their ecological environment and the types of health problems for which such plants were used. What was their personal observation about deforestation and desert encroachment? What were the best strategies to retrieve the loss of biodiversity in each of the ecological biomes in which there were noticeable depletion of plants with healing properties. Finally, traditional healers were asked to state how best they could be remunerated for their services and for them to list the role they could play in bio-processing. Ethno-botanical data were collected directly from qualitative opened-ended interviews and discussion with the traditional healers.. In many instances, traditional healers used a combination of herbal plants, the roots and barks of some plant species to enhance synergy and the effectiveness of some herbal remedies.

Causes of Deforestation

About 200 years ago, the tropical rain forest extended as a complex community covering the lowlands of humid tropics of central and South America, Africa, Southeast Asia and Indonesia. A sizeable portion of the evergreen raining forest still exists in Africa, Amazonia, Borneo and New Guinea. In West Africa, particularly Nigeria, the slash and burn agricultural practices which many farmers practice have done some demand to the various ecological biomes. However, desert encroachment and the development of new housing estates for the teeming population continue to create inordinate extinction of the large species of flora and fauna with healing properties. Industrialization and prospecting for petrochemical products are other man-made disasters that have created the extinction of plants with healing properties due to the destruction of wildlife, incessant logging, and the pollution of atmosphere, hydrosphere and lithosphere of the wetlands and the remaining tropical rainforest in Nigeria and other West African Nations. For agricultural purposes, the tropical rain forest has been intensively cultivated by planting bananas, cocoa, mangoes, bush mangoes, oil palm, coconut, cassava and timber. About five decades ago when there was rubber and timber boom in West Africa, vast expanse of the tropical rain forest were cleared for the cultivation of these cash-crops.

Ecological Impact of Deforestation

Increased agricultural production, cattle ranching, industrialization, rural urban drift and the resources to defray the mounting debt burden in Africa have necessitated the unbridle ambition to harness the resources of the tropical African rain forest with resultant extinction of many medicinal plants. The ecological effects of deforestation are many and varied. Currently, the evergreen tropical rain forest with canopies of interlocking leaves and branches, which provide shelter for assorted varieties of living things are destroyed daily. The elimination of such protection is imminent. If the tropical rain forest is destroyed, the ominous prediction is that million species of therapeutic plants and the regional and global bio-diversity and the genetic heritage could be disrupted. In addition, the motives for deforestation of the tropical rain forest biome are multifarious. Peasant farmers utilize the forest trees as the principal source of firewood. Firewood is not only the principal source of energy for cooking, but also for warming sleeping rooms during the extremely cold month of November, December and January.

With over 250 million people worldwide making their livelihood directly by depending on tropical rain forest, peasants who are rubber tapers, wine tapers and oil palm producers, palm-kernel processors all make their living on the richness of the tropical rain forest. The global fear entertained by ecologists is the incalculable catastrophe which might plague humanity by the complete destruction of the tropical rain forest. As a result of the evergreen tropical rain forest with canopies of interlocking leaves and branches which provide shelter for assorted varieties of living things are being destroyed daily. The elimination of such protection is imminent. If the tropical rain forest is destroyed, million species of a major proportion of universal biological biodiversity and genetic heritage will be lost.

In the age of genomic science, the opportunity to study the therapeutic benefits of plants in West African has never been more crucial, because the healers who rely on these complex biodiversity do not have access to the relevant genomic technology to characterize the underlying mechanisms by which some of these herbal remedies and the combination of multiple plant species and animal parts are efficacious for specific diseases. In the

developing nations particularly in West Africa, very little is known about the subtle and long term consequences of deforestation and the onset of global warming [9, 10, and 11].

RESULTS

The data collected for this explorative study derive from the establishment of interpersonal relationships and collaboration with traditional healers at the border villages between Republic of Benin and Nigeria in Babana villages, and the Oloru district communities with over thirty-five villages in Kwara State, Nigeria. Of the thirty-five villages of the Oloru district community visited, there were ten fast-flowing seasonal streams in this tropical Guinea Savanna area. Many of the traditional healers were extremely friendly having confirmed that our investigating research scientists were also involved in guinea worm eradication projects and onchocerciasis abatement initiatives [Figures 1a & b] Additional herbal remedies were collected in the Guinea and wooded Savanna zones at the Moro and Irepodun Local Government areas of Kwara State Nigeria. At Akure in Ondo state, Benin City , Edo State and in the Akwampin region of Ghana, several plants which have therapeutic benefits were gathered. These plants are ecologically adapted to the to the delta regions of Ghana and Nigeria. The healers confirmed many professional challenges involving traveling to some far-flung hinterland to collect some plants species if they do not grow in one ecological biome. They also revealed that desert encroachment, deforestation, prospecting for petrochemical products, and intensive mechanized farming continue to rob them of their means of livelihood. For natural ecological facts, the practitioners of traditional healers are no longer as committed and competent as their grandparents and the elderly paternal practitioners.

Summarized in Table 1 are the plants with therapeutic benefits principally for the management of mental health dysfunctions. At Abeiye Village in Kwara State, the traditional healer had in storage over 90 percent of the plants in listed in the Table. These herbs were stored hanging from the healers' kitchen for drying to avoid putrefaction. The healer confided in the investigator that in many instances he traveled to villages of Ogbomosho and Oshogbo in Nigeria to collect these plants products since they grow only in many of the farms and forest of the neighboring states.

Table 1: Medicinal plants with Mental Health Therapeutic Benefits

Plant Species	Therapeutic Applications
Rauwolfia serpentina	Mental health problems
Rauwolfia vomitoria	Mental health problems (bipolar disorders)
Solanum calycina	Mental health (tranquilizer)
Bryophillum pinnatum	Mental health (tranquilizer)
Commelina vogelii	Mental health (tranquilizer)
Chorophora excelsa	Mental health (tranquilizer)
Cola caricifolia	Mental health (tranquilizer)
Draceana fragrans	Mental health (tranquilizer)
Musa sapienium	Mental health (tranquilizer)
Garcinia kola heckle	Mental health (tranquilizer)
Newbuoldia laevis	Mental health (tranquilizer)

The younger patients at Abeiye, on drinking the herbal concoction from the admixture of Rauwolfia serpentine and Rauwolfia vomitoria, were observed to drool excessively. While our team advised the etiological reason for drooling could be due to excessive dosage, the healer countered our contention, and he remarked drooling is a key component of bipolar disorder.

However, the younger patients were observed to have more pronounced side-effects than the adult psychiatric patients. Those patients treated and adjudged to have been cured were usually cleansed and sacrificial observances were performed before their discharge to their significant others. The healer maintained that recidivism is rare in his psychiatric practice [9].

A higher proportion of healers who specialized and treated cardiovascular diseases and cancers were males whereas the traditional birth attendants who manage maternal and child health-related diseases were principally elderly females. Male healers perceived cardiovascular diseases such as congestive heart disease, atria fibrillation and myocardial infarction as the health problems suffered principally by males. Regarding cancers, traditional healers rarely associated various cancers as dysfunctions which are common in both males and females. Breast cancers were usually managed by male healers. The emerging onset of child hood leukemia is usually most baffling to the healers. Periodically they were more prone to refer the child with leukemia to the university educated medical practitioners because of the invasive nature of the disease [Table, 3].

Table 2: Medicinal Plants with Therapeutic Benefits for Complex Diseases

Plant Species	Therapeutic Applications
Convallaria majalis	Heart tonic for high blood pressure
Digitalis purpurea	Management of congestive heart disease
Crataegus oxyacantha	Management of congestive heart disease
Carica papaya (seeds)	Management of high blood pressure
Hog plum	Management of high blood pressure
Annona senegalensis	Management of cancer
Poteriem spinosum	Management of cancer
Merdan lucida	Management of cancer
Spondias mombin	Management of ovarian and uterine cancer
Ageratum conyzoides	Management of childhood leukemia
Cybopogon citrates	Management of childhood leukemia
Xylopia aethiopica	Management of childhood leukemia
Xanthoxylum zanthoxyloides	Management of childhood leukemia
Catharanthus roseus	Management of childhood leukemia
Vernonia amydalina	Management of cancer and diabetes
Allium sativum	Management of blood cholesterol
Musa sapientum	Management of high blood pressure
Zingiber officinal	Management of stroke and myocardial infarction
Stachytarpheta jamaicensis	Management of high blood pressure
Physostigma vnenosum	Induces diarrhea diuretic
**** Crocodile gall**	Severe vomiting, induces diarrhea and death
Python gall	Severe vomiting induces diarrhea and death

Table 3: Medicinal Plants with Healing Effects for Skin- infections and STI and Asthma

Plant Species	Therapeutic Applications
Eleophorbia drupifera	Management of dracunculiasis
Hoslundia opposite mixed with Red kola nut	Management of dracunculiasis
Vitellaria paradoxa/Shea nut butter	Treatment of dracontiasis & skin infections
Spondiasmombin	Maternal and child care, contraceptive
	Management of ovarian and uterine cancer
Yohimbine combined with hug plum	Management of male impotence
Pistia stratiotes	Management of smallpox
Desmodium adscendens	Management of asthmatic attacks
Papilionacea thonningia	Management of asthma
Deinbolia pinnata	Management of asthma
Deinbolia Sapindaceae	Management of asthma
Fagara xanthozyloides	Anti-sickling agent
Carcina manni	Anti-microbial agent
Baphia nitida	Anti-microbial agent
Cinchoma succirubra	Antimicrobial agent
Oldenlandia affins	Management and to ease delivery of babies
Momordica foetida	Relaxes the smooth muscles
Ficus exasperates	Treatment of gonorrhea and other STI
Chasmathera dependents mixed with Buty-rospermum paradoxum	Treatment of fractures
Citrus lemon and leaves of ocimum gratissimum	Treatment of pile
Zanthoxylum zanthothoxyloides	Treatment of fever
Garlic(Allium sativum, Ginger, Zingiber Officinale and lemon	Treatment of fever

DISCUSSION

At the inception of this project, the first group of traditional healers that we interviewed were those healers who specialized in mental healthcare. They live predominantly in the guinea and wooded savannah areas of the northern Border town of Babana, Nigeria. These healers successfully identified plants and fauna that have medicinal properties. At the Guinea savannah areas that are typically arid, where people rely on seasonal streams,

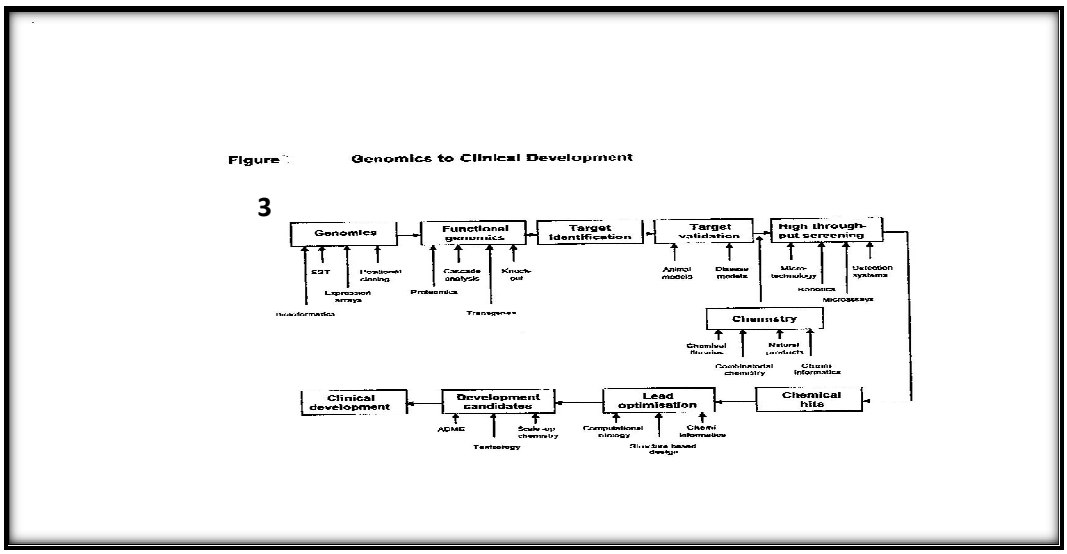
onchocerciasis and dracontiasis were heavily endemic but the latter diseases was seasonal [7,10]. At these endemic foci, rural dwellers with or without the assistance of traditional healers utilized shea butter plants for the management of their skin infections which were scabies, guinea worms and onchocerciasis. The vector of the latter disease being Simulium damnosum complex. The other vectors of river blindness, consists of S. damnosum, S. sirbanum, S. sanctipauli, S. soubrense, S. yahensel, and S.squamosum. At the wooded savannah area of Kwara state , the exclusive species were S. damnosum and S. sirbanum. In addition to the clinical manifestation of onchocerciasis, skin irritation, leopard like skin and lympho-adenopathies and the complete visual impairment, blind patients were incapacitated and unable to participate in political activities. Victims of these infections routinely harvested the leaves and barks of Eleophorbia drupifera, hoslundria paradoxa for the treatment of of their skin infections from onchocerciasis and guinea worms. The organic Shea nut butter (Vitellaria paradoxa) was also used by patients suffering from scabies and other skin infections including eczema. Whereas in the tropical rainforest and wetland areas, decoction of Avocado pear (Persea Americana) combined with leaves and fruits of African pepper (Xylopia aethiopica) were used as the concoction for laxatives [11, 12].

The concomitant infections from schistosomiasis, trypanosomiasis and onchocerciasis predisposed adult males in rural areas of the West Africa to the onset of absolute impotence. In these rural villages, combination of medicinal herbs and bark of Hog plum and Yohimbine are extracted with alcohol (C2H5OH) and patients were advised to drink two table tea spoon full consistently before sexually intercourse. However, this concoction is by no means effective against congenital impotence [13].

Bio-processing for Medicinal plants

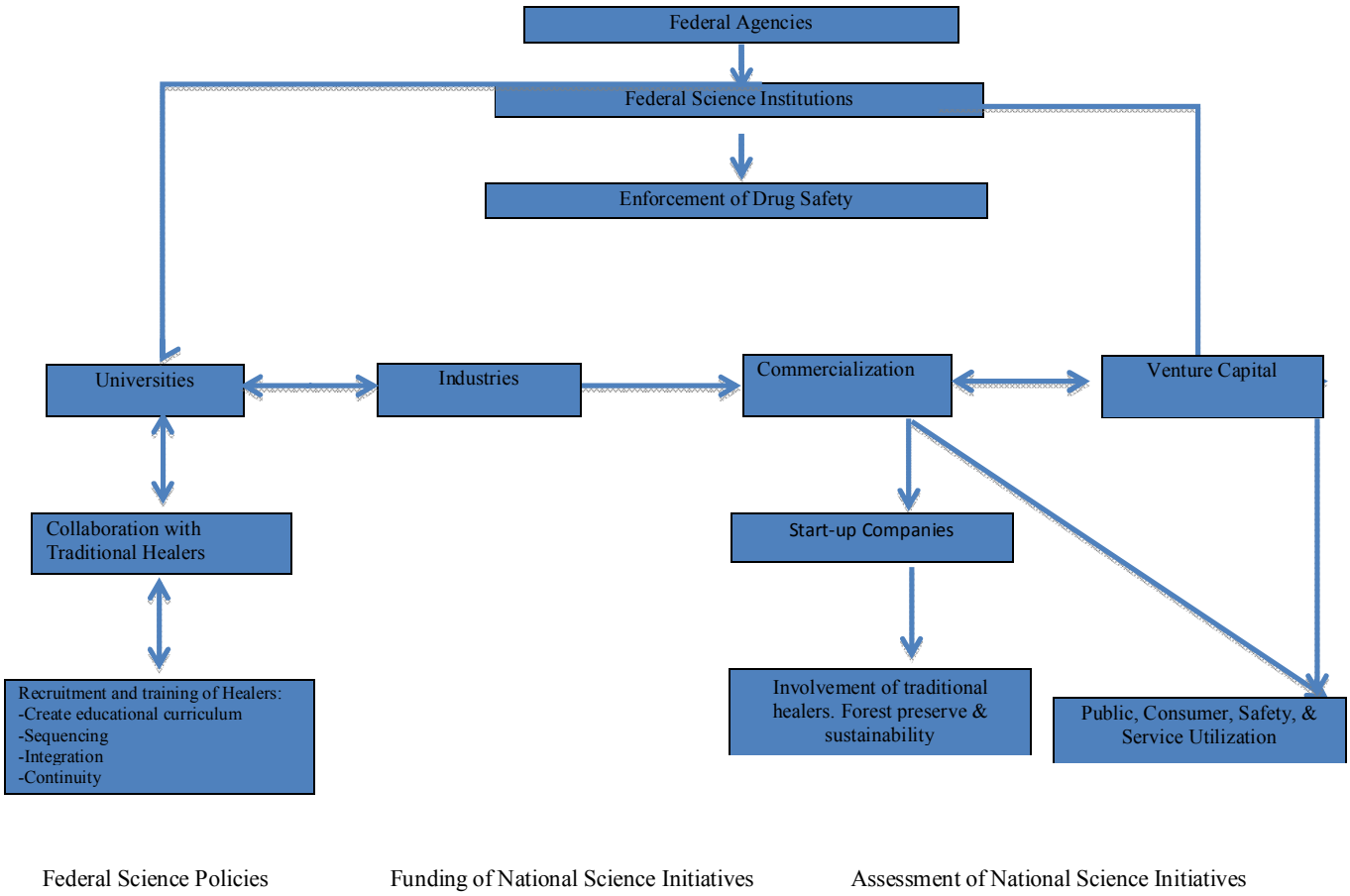
In West Africa, history is replete with the conservation efforts of many rural communities for sustainable development of their bio-diversity in medicinal plants. Their reasons focused on the ready availability of these inexpensive plants. Also, traditional practices surrounding their use reflect local knowledge and wisdom, and the plants are relatively inexpensive. Besides, instructing the general community about these sacred cash-crops protect bio-diversity and inhibits their extinction by politicians who indiscriminately use technology to advance the concept of agricultural mechanization which occurs to the detriment of the ecological value of the flora and fauna in the areas. These medicinal plants are only able to grow and flourish in only selected biomes in Africa. Most of the African medicinal plants are not necessarily ubiquitous. Traditional medicinal practitioners have preserved traditional knowledge and practices of phyto-medicinal treatment for several years.

In the age of genomic science, traditional healers have monumental role to play in identifying most of these plants with healing properties. Geneticists, and other scientists can assist in genotyping and finding out the essential active principles in these herbs and those with toxic properties could be expunged. As illustrated in Figure 2, genomic enhancement of African medicinal plants can be aggressively pursued by the commitment of governments and the generous funding of research centers to collaborate with traditional healers in the areas of bi-prospecting, training of the healers and the commercialization of medicinal plants by emphasizing sustainable development of their cash-crops [Figure 2].



Horak recently espoused the added value of indigenous knowledge through scientific innovation in relation to bio-prospecting [12]. Indigenous knowledge is unique to every culture and it is the basis for making decision in agriculture, health care education and natural resource management. Indigenous knowledge may have ancient origins; however, it is relevant to the phenomenological daily nuances of people. The knowledge gleaned for traditional healing while ancient, it is still relevant to environmental sustainability and partnerships for innovative development.

Multidimensional Linkage in the Implementation for Genomic Enhancement of African Medicinal Plants



Traditional healers can use their comprehensive knowledge of biodiversity in their ecological biome to guide multi-disciplinary genomic team about bio-processing for medicinal plants, and the latter can be guided about how to cultivate these plants in commercial quantity. The multidisciplinary genomic team should introduce state-of-the- art technological devices for preservation of medicinal plants to eliminate the actions of microbial agents in putrefaction. This needless waste can be contained because the rich agro-businesses in the distinct ecological biomes of West Africa if efficiently nurtured and managed by a team of scientists and traditional healers can augment the pharmaceutical arsenal against the broad spectrum of diseases not only in West Africa but worldwide. Authenticity can be created by subjecting these medicinal resources into clinical trial. Recently this technique has been enhanced clinically by genomic scientific breakthrough.

Drug Clinical Trials- the protocol in Genomic Age

To illustrate, after the completion of human genome sequencing by April of 2003, The United States Food and Drug Administration introduced innovative techniques to modernize drug development by incorporating

scientific advances such as genomics and advanced imaging technologies into scientific drug development process. The genome-oriented pipeline to enhance the protocol for drug clinical trial developed by Lehman Brothers is illustrated in Figure 3. At inception, suspected medicinal herbs or plants are crushed, analyzed with positional cloning. At functional genomics level, cellular analyses which occur at the proteomics phase include cascade analyses which are tested in knockout to specific target identification.

Target validation is carried out with the use of animal and disease models particularly on which a practitioner or traditional healer had previously tested their medicinal plant. In rigorous scientific community, combinatorial chemistry and chem-informatics are used to generate multiple lead compounds which are tested against the targets by utilizing high throughput screening. Genomics-oriented innovations which have potential drug screening process are micro-technology, nanotechnology, robotics and the state-of- art array techniques. From the myriad medicinal plants used for a variety of health problems, potential drug candidates emerging from this phase are optimized by applying various techniques which consist of computational biology and, structural drug design before subjecting the medicinal plants or potential candidate drug to toxicology test and other preclinical testing.
With all the emotional and ethnocentric rationales compiled to justify the legalization of traditional medicine, from observing their practice for over thirty years, statistics on both iatrogenic diseases and nosocomial infections suffered by their patients are shrouded in profound secrecy. We have even seen cases in which many rural patients died and the healer migrated further into geographically isolated villages to escape national penal systems [6,13].

Imperatives for Clinical Trials

At both national and international levels, the herbal concoctions used in traditional medicine ought to be subjected to clinical trial. In the age of genomic medicine, this rigorous scientific method could on the long-run be most beneficial to those in traditional healing professions. In the scientific community, clinical drug trials involve four main phases.

Phase 1

Detailed information about the drugs pharmacokinetics and pharmacological effects are required to enable official government drug safety agencies to permit the design of authentically controlled, scientifically valid phase 2 studies. At this initial phase, drug metabolism, structure-activities and the mechanism of actions in humans are recorded. At this phase and in the case of adverse researchers, the Center for Drugs Evaluation and Research (CDER) can impose clinical hold that is, prohibiting the study from procedure or stop a trial that started for safety reasons. The other reason could be that the sponsor refused to accurately disclose the risk of study to investigators.

Phase 2

The clinical trial involves the "experimental study drug" given to a large cohort of people (100-300), to determine if it is effective and to continue monitoring the possibility of its safety. At this phase, early chemical studies are conducted to obtain adequate preliminary data on effectiveness of the drug for a particular indicator or adverse reactions from experimental patients with a disease such as cardiovascular disease, cancer or HIV/AIDS. This phase also assesses short-term side-effects and associated risks with the drug.

Phase 3

The experimental drug is given to larger group of subjects of about 1000-3000. The intent is to confirm the effectiveness of the drug and to continue to monitor any side effects. The drug is also compared to other commonly used drug, and the data collected are meant to enable official government authorities to allow the drug to be used safely.
Phase 3 also provides adequate rationale for extrapolating the results to the general population. Also at this stage information could be transmitted in the physician labeling.

Phase 4

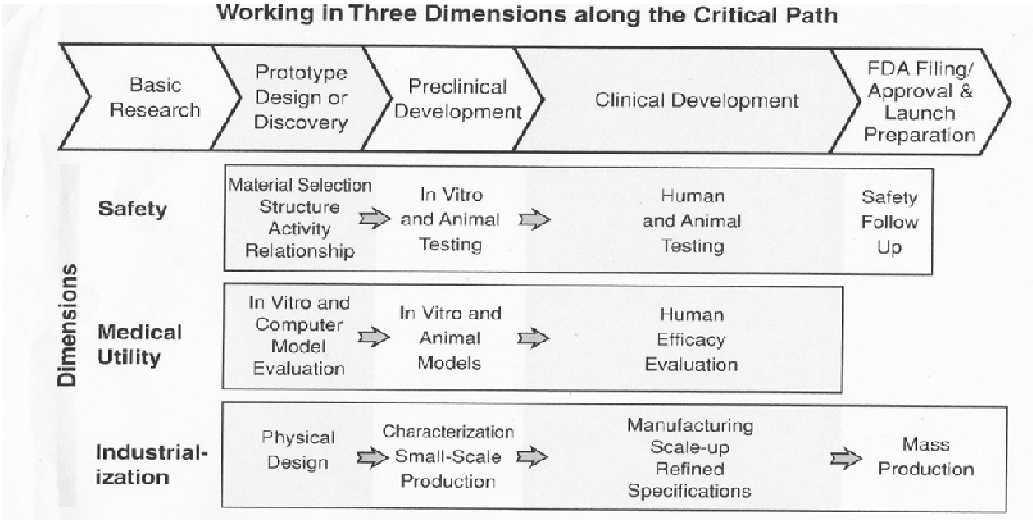
Post-marketing studies are put in place to delineate additional information about the risks and benefits of the drug. If the experimental subjects were predominantly Caucasians, comments for other ethnic groups are compiled and used to enhance the therapeutic effectiveness/benefits of the drug [14, 15]. A relatively detailed account was provided to illustrate the processes that pharmaceutical companies undergo in complying with official government regulations. By subjecting traditional medicinal plants through clinical trials, the healer can be adequately remunerated for those drugs and plants with therapeutic benefits or medical utility. Concerted efforts can be made to inhibit bio-piracy and the marginalization of the indigenous healers [16].

Critical Path Initiatives (CPI) and Drug Safety

To ensure public safety, Woodcock and Woosley [17] recently outlined the latest commitment of the US FDA in designing the critical path initiatives and its impact on new drug development. CPI was advanced with the expressed intent of modernizing drug development by incorporating genomics and advanced imaging technologies into the process of public-private partnerships and consortia which are required to accomplish relevant drug prospecting research.

The salient mission of drug regulating bodies in United States and other industrialized nations is to protect and promote the health of the public worldwide. To illustrate, when thalidomide, a drug manufactured in Germany became teratogenic, urgent and concerted efforts were made to withdraw that drug from the global market to protect public health. The activities of US FDA consist of translating new products such as medicinal plants into scientific innovations and commercial products but not at the risk of public health. The advocated tenets of CPI are three folds, 1-drug safety, 2-medical utility and 3- industrialization [Figure4].

Figure 4: *Woodcock J, Woosley R. 2008. Annu. Rev. Med. 59:1-12*



Within the past half-a century, many systematic advances made in pharmacotherapy, which were approved by USFDA have improved the management of cardiovascular diseases, psychiatric problems and cancers. After approving drugs for these conditions, many international regulatory bodies were willing to collate relevant anthropogenic and clinical data on drug-drug interaction and continued to test the newly developed drugs on a broad spectrum of subjects irrespective of gender, ethnicity and other haplotypes characteristics.

For traditional African Medicinal practice to gain global acceptance and medical utility, these herbal products, the fauna and the various heavy metals used in the traditional medicine must be subjected to scientific clinical trials to enable pharmaceutical companies and other scientists work in collaboration with the healers to expunge drug toxicity, and the microbial agents which are routinely detected in stored herbal remedies. Once some of these drugs have passed through the rigorous clinical trial and approved for human therapy, new generation of scientifically literate marketers could be encouraged to advertise these drugs to the public worldwide.

By far most crucial, is the retraining of rural traditional healers to understand the distinctions between drugs and the nutritional leafy greens, avocado, bananas, as food items and not drugs. The establishment of traditional African herbal institute is necessary to train individuals who are very interested in such profession. In India and China, practitioners of indigenous herbal medicine are trained in botany, ecology, therapeutic remedies and other socio-cultural disciplines. With the current era of genomic science, and just as we have urged physicians worldwide to learn additional medical information about medical genomics and pharmaco-genomics, all healers must be retrained in the theme of drug-drug interaction, and the issues of pharmacogenomics. This academic innovation in the preparation of traditional healers can significantly enhance their remunerations and international acceptance of their profession. Their patients will eventually repose more confidence in their practice.

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