THE ROLE OF PHYTOBIOTECHNOLOGY IN PUBLIC HEALTH

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Keywords: Phytobiotechnology, Medicinal plants, Antibiotics, Antimicrobial, infections disease control Public health, Neutriceutical

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Summary

An evaluation on the role Phytobiotechnology could play in disease prevention, treatment and effect sustainable health is presented. This report is based on work by the author over an eight year period [2000 to 2008] built on traditional knowledge and medicinal plants used in traditional medicines surveyed from amongst tribes in Cameroon, Nigeria and Benin republics. These formed the basis for experimentation, validation, development and application of appropriate biotechnologies for cheap, low-tech disease control strategies with an equally high efficiency and ecological acceptability. The findings generally show that most African tribes as well as globally have a rich heritage of indigenous knowledge and medicinal plants that can be utilized through product formulation using simple and cheap biotechnologies to attend to human and livestock diseases rather than the over dependence on synthetic drugs with its
uncomfortable side effects. Herbiotics formulated from screened plant extracts whose antimicrobial activities have been ascertained can be used directly to control infectious diseases such as Salmonellosis, Amoebiasis, tuberculosis, cryptosporidiosis, Malaria, Toxoplasmosis, Hepatitis, Leishmaniasis, Dracunculiasis, HIV and AIDS etc, replace pesticides/insecticides for vector control, tick sprays for ectoparasites of man such as lice e.g., Sarcopptic mange, Pediculosis humanus var capitis etc., as well as on animals, phytocosmetics for skin problems in human and livestock and in the end reduce the dependence on synthetic biocides and drugs. Plants such as Allium sativum (garlic), Vernonia amygdalina (bitter leaf), Moringa oleifera (Horse radish plant), Lantana camara, Ocimum gratissimum (basil), Aspilia africana (Iodine plant), Carica papaya (pawpaw), Aloe barbadensis, Khaya senegalensis, Artemisia annua, Distemonantus benthamianus, Standia kamerunansi, Viscum album, Arctium lappa, Cucurbita pepo (pumpkin) and macrofungi such as Ganoderma lucidum, pleurotus tuberregium, Termitomyces titanicus amongst several others were identified as important candidate plants and macrofungi that could bring about hygiene and sanitation when used directly and can provide important leads in the production of natural antiseptics, antibiotics, fungicides and insecticides for the control of diseases. Some of these plants have been formulated with starch from maize and paraffin to control cercaria, Cyclops, and larvae of Annopheles and culex mosquitoes respectively. Extracts from Moringa oleifera and termitomyces have been used as nutricuticals to boost immunity in HIV and AIDS patients. Moringa oleifera seed extracts amongst others have been used in sand filter systems to purify domestic water while other plants have the potential to control treated waste water for irrigation. Medicinal plants and phytodrugs useful in attending to cardiovascular diseases, hypertension, diabetes etc have been cited. The conclusion is made that Phytobiotechnology has a crucial role in bringing about sustainable health as it is comparatively cheaper and effective. There is therefore the need to further develop and promote it.

1. Introduction: The Concept of Medicinal Plants and Phytobiotechnology

Seventy to eighty percent of the people in Africa live in rural areas and practice subsistence farming. They are generally poor and lack basic amenities and infrastructure. They play host to many diseases: Malaria, Typhoid, Skin diseases etc, and due to the high cost of drugs and inaccessibility to urban areas to purchase these drugs (when money is available), they resort to the use of indigenous plants and traditional medicine. The exploitation of this indigenous knowledge, especially medicinal plant resource base, and its enhancement for easy usage by our rural population is a viable tool in reducing the problems raging in our rural communities.

The African environment is probably the least explored in terms of available resources. One needs to take a course to the plant world to discover untapped resources. Medicinal plants, vast indigenous knowledge and herbal medicine is readily available in our diverse vegetation, cheap and above all carries the potentials of introducing new templates into modern medicine. Medicinal plants have a long history of use in most communities throughout the world. As a matter of fact 80% of Africans depend on homeopathic medicine. In Africa, people still consult traditional healers even when being attended to in conventional orthodox clinics. The history of medicinal plants is widely documented in various pharmacopoeias; Planta medica, Napralert, etc, around
the world. Unfortunately, little effort has been made in transforming this vast knowledge using simple low cost technologies. Apparently, a great number of rich unclassified indigenous knowledge on the therapeutic ability of medicinal plants abounds in Africa that has not been documented for possible modification and application by academia to address the pressing problems of indigenous people on the African continent. Historically, medicinal plants have provided a source of inspiration for novel drug compounds, e.g., Quinine the oldest antimalaria drug was inspired from a south American plant, Cinchonna tree bark, Vincristine and Vinblastine, the famous and widely used antileukaemia alkaloid drug was derived from Rose perinwinkle (Vinca rosea), Ergot Fungus (Clavicep purpurea), Artemisia annua and a host of others are medicinal plants widely known to have inspired synthetic drugs used in modern medicines today. The use of plants in Medicine predates orthodox medical practice. For instance, the ayuverdic practice of India is a medical system more than 3000 years old. Similar traditional medical systems of China had been documented in China 2730 years ago by Shen Nuny. Plant derived medicines have made large contributions to human health. It can be recalled that as far back as 1660, Napoleon Bonaparte used ipecacuanha, -Kurchi- bark to treat amoebic dysentery and other complications of amoebiasis. Many of such examples of indigenous knowledge and practices abound throughout the world and remain largely underutilized through appropriate technology. There are increased use of herbal products globally, for instance, between 1990 and 1997, the use of herbal based products reached 38%. The World Health Organization (WHO) has estimated that up to 80% of the world’s population relies on plants for their primary health care while in Nigeria, WHO surveys in 1985 estimated that up to 75% of the population patronizes traditional medicine.

For technology to be effectively transferred, penetrate and impact the wider society, especially in the third world, the technologies must be simplified with a sound foundation on indigenous knowledge reminiscent of the region or locality. For most of the times, this has not been the global trend. Enhancing and applying indigenous medicinal plants and formulations without attempting to manipulate these plants through genetic engineering to control insects and pests of medical importance, attend to diseases of humans, preserve food are components of Phytobiotechnology that will not only cut down health cost but will demonstrate the power and benefit of drawing inspiration from the well springs of nature.

Phytobiotechnology is a marriage of two words, Phyto derived from a Greek vernacular Phyton meaning Herb or vegetable, then biotechnology which is the application of science or knowledge to life systems to derive useful products. Unfortunately, a lot of focus on the definition of biotechnology has been skewed toward the use of microorganisms and molecular biology. Phytobiotechnology is the application of Science or Knowledge to the Plant Kingdom (this includes higher and lower plants like mushrooms, algae, lichens, that can be seen with the unaided eye) to derive products for the benefit of humanity. Phytobiotechnology includes plants and plant based technology for nutrition and control of diseases (nutritherapy) and Phytotherapy, means treatment of diseases by the use of medicinal plants and or medicinal plant extracts. The plant or part thereof can be made in one or more of the following forms: decoction, concoction, infusion, galenical, tincture or a tisane or taken with food or as an enema or in the form of ointment for topical application.
The present form in which traditional medicine on the African continent is practiced cannot really be termed as phytobiotechnology. Phytobiotechnology would require that an existing traditional knowledge on the uses of a medicinal plant is validated using scientific protocols and then formulated into a product using basic pharmaceutical knowledge in its natural form and some form of Standardization (basic analysis of phytochemical constituents), quality control employed. Phytobiotechnology is an ecological approach to drug development from mother earth without artificial interference. The knowledge on medicinal plants and natural product research is widespread globally with an increasing interest but the fundamental phytobiotechnology approach is lacking. The overall purpose of this report is to present the level of work carried out in developing appropriate biotechnologies (phytobiotechnology) from African indigenous plants/knowledge in attending to human diseases, sanitation problems, livestock, pests and ectoparasites of humans and animals. The ultimate goal is to come up with a health system in Africa and the world at large that originates from the available and cultured vegetation. “The world will never starve for want of wonders but for want of wander” - G.K. CHESTERTON

The expected outcomes:

- To reduce artificial interference and cut down on the use of synthetic drugs and biocides.
- To optimize the use of available resources in fighting diseases and poverty.
- To promote indigenous solutions in disease-control and environmental pollution.
- To enhance the available knowledge on the efficacy of natural products as drugs and pesticides.
- To reduce cost of health management in our communities’ especially occupational diseases due to agriculture, and hence make drugs available to a wider group of people.
- To provoke interest in the medicinal potentialities of various vegetation.
- To provide data on the status of ethno medicinal plants and their scope of applications in various regions of the world.
- To promote skills in the formulation and application of natural products in meeting some of our health needs and finally, to strengthen research on natural products and phytobiotechnology and boost our confidence.

“The only disability in life is a bad attitude” - SCOTT HAMILTON

2. A Recap of Infectiology and Contemporary Challenges in the Control of Infectious Diseases

Infectious diseases constitute the nerve wire of global health today. In particular 80 - 90% of all diseases in Africa are infectious. The transmission dynamics falls within one or more of the following areas; foods, fluids, flies, fields, faeces, fingers, sexual and or congenital. It is estimated that WHO spends more than ¼ of its budget on the control and treatment of infectious diseases. Despite ample studies on the incidence, prevalence, epidemiology, pathogenesis, pathology, pathogenicity and virulence, immunology, transmission, prophylaxis and chemotherapy, the global picture of infectious disease has not improved. The study of microorganisms, forms the bedrock of infectious diseases.
Most microorganisms are free-living and perform useful activities that benefit animal and plant life. Without micro-organisms, dead organic matter would not be broken down and converted into the carbon, nitrogen and sulfur compounds which animals and plants require for their existence. Apparently, the majority of microorganisms is rather useful for humankind and could even be used to control harmful ones (antibiosis). Groups of microorganisms causing diseases of medical importance include viruses, mycoplasma, rickettsia, bacteria, protozoa and fungi. Microorganisms that cause diseases are called pathogens. The ability of pathogens to cause disease is virulence. The degree of pathogenicity of a micro-organism depends on its degree of invasiveness or its ability to produce toxins. The invasion of the body by a pathogenic organism is called infection, although not all infections, however, lead to a disease. The immune system of an infected person may be able to prevent the multiplication and spread of a pathogen and resist the effect of toxins in the tissues. It may even be possible for a person to overcome the infection and become a healthy carrier of the pathogen but able to infect the next person. It is in this light that Hippocrates (father of medicine) once asserted that “what cannot be cured by the forces within the body can certainly not be cured by the forces outside”

Before a pathogen can cause disease, it must be able to enter the body by a route which will enable it to reach a site where it can establish itself and multiply e.g. parasites of the genus *leishmania* get to the tissues. Factors like temperature, oxygen tension, hydrogen ion concentration, availability of nutrient etc. influence the sites in the body selected by micro-organisms. The routes taken depend on whether the organism is ingested (e.g. *Entamaeba histolytica*), penetrates the skin (e.g. *Schistosoma spp*), contaminates the skin (e.g. *Trypanosoma cruzi*) or is inhaled with air and reaches the lungs as is the case with pneumonia. Some pathogens require vectors for part of their development as well as for transmission. For example, *Plasmodium* parasites require mosquitoes, *Trypanosomes* require tsetse flies etc. Other vectors that are involved in the transmission of pathogens include ticks, mites, fleas, lice etc. These vectors transmit diseases to man through bite when the organisms are ingested into the blood. The name vector is given to any living or non living agent that can carry a disease from one host to another e.g. water, food, dust, vomit, an insect, tick, flea, mite or lice, rats or rodents. The state of the health of a host is important before a pathogen can cause disease in man. For some organisms entry of a large number of organisms may be necessary before a healthy person’s defense mechanisms are overcome, whereas only a few organisms may be required to produce a disease in a person with poor health or one who is malnourished especially children. Particularly virulent organisms like *Shigella dysenteriae* can cause disease in very small numbers. Boosting the immune system and nutrition plays a key role in the control of infectious disease. Examples of pathogenic bacteria (the study of bacteria being bacteriology), and some of the diseases they cause include: *Clostridium tetani* – causing tetanus, *Brucella spp* – causing brucellosis, *Vibrio cholerea* - causing cholera, *Neisseria meningitides* causing meningitis – while, *Mycobacterium tuberculosis* causing tuberculosis, *Treponema pallidum* – causing syphilis etc. Viruses of medical importance (the study of which is Virology) includes the measles virus, yellow fever virus, lassa fever virus etc. Protozoa (the study of which is Protozoology) of medical importance includes the malaria parasite i.e. *Plasmodium* species, *Entamoeba histolytica* causing amoebic dysentery, *Trypanosoma* species causing *Trypanosomiasis*, *Leishmania* species causing leishmaniasis, *Toxoplasma gondii* causing...
Toxoplasmosis etc. Diseases caused by fungi are referred to as Mycosis. Fungal diseases are generally opportunistic infections or allergies, by eating food contaminated by fungal toxins (Mycotoxins). Fungi in recent years do not rank with protozoa, bacteria or virus as causes of human suffering but they are now taking prominence as emerging diseases of the 21st century due to their role in HIV and AIDS as well as cancers. They seldom kill and unlike malaria, yellow fever or cholera, they do not cause wide-spread or dangerous epidemics. Examples of fungal infections include candidiasis caused by \textit{Candida albicans}, ringworm infection (dermatophytosis) caused by \textit{Microsporum} species and Cryptococcosis caused by \textit{Cryptococcus neoformans}. Another less common group in routine practice is Rikkettsia and mycoplasma. \textit{Rickettsia} spp (though similar to bacteria in many ways) cause diseases such as typhus with etiology being \textit{R. typhi} and \textit{R.prowazeki}, that causing scrub typhus is \textit{R. tsutsugamushi} and the spotted fever group include \textit{R. rickettsii}, \textit{R. conosi} etc. Mycoplasma of medical importance include \textit{Mycoplasma pneumoniae} causing pulmonary diseases including upper respiratory diseases sore throat, inflammation of the ear etc. \textit{M. hominis} causes pelvic inflammatory diseases in women may also be associated with spontaneous abortions and postpartum fever. Proper and prompt diagnosis of infectious diseases is the key to its control. Some diseases are referred to as communicable diseases, they are transmitted directly from one organism to another e.g. sexually transmitted disease like gonorrhea. A \textit{communicable disease} is often referred to as infections or when transmitted from one person to another is referred to as \textit{contagious}. Some major communicable bacterial diseases in tropical countries include leprosy, cholera, typhoid, tuberculosis, gonorrhea, syphilis, meningitis, whooping cough, measles, bacillary dysentery etc. The study of a particular disease, why it occurs, how it is spread among a group of people and what can be done to prevent it and improve the health of the community is known as epidemiology. An \textit{endemic disease} refers to the constant presence of a disease or agent of a disease in a community or region while \textit{sporadic disease} is one which breaks out only occasionally. An \textit{epidemic} usually means an acute outbreak of a disease, but when referred to communicable diseases, it is defined as “the occurrence in a community or region of a group of illnesses of similar nature, clearly in excess of normal expectancy and derived from a common and propagated source”. Many endemic diseases can rapidly become epidemic if environment or host influences changes in a way which favor transmission. A disease is referred to as \textit{pandemic} if it spreads to several countries and affects a large number of people e.g. influenza and cholera, and now HIV and AIDs. Human carriers are important in the spread of diseases. A carrier is a person, who is infected by a pathogen, but experience from it, such a person can excrete the pathogen he or she is carrying over a long period of time and be a source of infection to others without knowing it. There are several routes of transmitting infectious diseases some of which include: by inhaling aerosols (air-borne droplets) containing pathogens secreted by an infected person coughing, spitting, sneezing, nose blowing or laughing as in the case of respiratory diseases like tuberculosis, whooping cough, measles, pneumonia etc. by ingesting pathogens in water or food contaminated with urine or faeces from person disease carriers e.g. gastrointestinal diseases, typhoid, dysentery etc. by direct transfer of pathogens from one person to another as in venereal diseases, by transfer of pathogens from the skin of one person to another as in ringworm infection, by pathogens from, contaminated soil or dust entering the skin e.g. tetanus infection, by pathogens entering wounds, burns or cuts by way of contaminated hands or unsterile instruments e.g. infections of the skin or tissues such as boils and abscesses, by.
pathogens entering the blood and tissues through bites of arthropod vector e.g. malaria and bubonic plaque, by transfer of pathogens in blood from mother to fetus as in the case of syphilis and toxoplasmosis pathogen can also be transferred from mother to infant during childbirth e.g. gonorrhea. Pathogens can also be transferred in the blood or through blood products e.g. in hepatitis and AIDS infections, just to cite a few. Factors that affect the transmission and spread of infectious diseases include, inadequate preventive and control measures e.g. lack of primary health care in the rural areas to detect and treat patients with communicable diseases, Socio-economic factors e.g. poverty, poorly constructed houses, overcrowding, malnutrition etc. Inadequate and contaminated water supplies, inadequate sewage disposal system, unhygienic practices, little or no health education, climatic factors including an increase in vectors during the rainy season or an increase in dust-borne particles, and damage to nasal mucosa in the dry season. Local customs especially with regards to food preparation, home delivery of babies, post natal care and feedings of infants. Poor communications in rural areas make it difficult for patients on long term drug therapy such as that of tuberculosis to attend treatment center.

2.1 Challenges involved in Controlling Infectious Diseases

Infectious diseases in tropical Africa are prevalent because of the combined effect of suitable ecological and climatic factors on the micro-organisms and their vectors, human behavioral practices, customs, traditions and the socio-economic conditions that prevail. Infectious diseases have contributed immensely to undermining the health status of the people and jeopardizing the economic development of nations especially in Tropical Africa.

There is more to controlling infectious diseases in tropical Africa than insecticide, drug resistance studies, and knowledge of life cycles and transmission dynamics which still requires a lot of studies. There are still undocumented means of transmission and control of diseases away from the traditional life cycles. Human factors play an eminent role for the persistence of infectious diseases and can be viewed in the following perspectives: Lack of organized or basic health infrastructure, lack of manpower both in quality and quantity, lack of adequate financial provision (where international) agencies like WHO, FAO or World Bank assistance, the moment they withdraw, the problems worsen, lack of drive by the government to control such diseases, failure of authorities to appreciate the advantages to be derived from control, political disturbances and instability like revolutions, war, civil disturbance etc., and/or rejection of some of the measures by the people. Very often wrong emphasis is placed by some authorities on causes of mortality instead of morbidity thereby ignoring conditions which produce prolonged illness and suffering of people and reduce their productive power to enjoy life to the full, increased in occupational diseases due to agriculture in developing countries that has not been researched adequately. The documented conventional mechanisms of controlling infectious diseases are numerous, a few cited are: Socio-economic realities inhibit the provision of pipe borne water, public latrines and good sanitary conditions in most of Africa. Provision of piped water alone will reduce 80% of all infectious diseases of man while installation of efficient sewage disposal and treatment systems will check diseases like amoebiasis, dysentery, hookworm infection etc. Diseases like malaria and filariasis, which is transmitted by mosquitoes, can be controlled or reduced drastically.
by developing good drainage system to eliminate mosquito-breeding sites and introducing strategies for reducing man/vector contact. Diseases like Schistosomiasis and Onchocerciasis can also be controlled by taking adequate precautions during the planning stage when appropriate safety measures can be built in.

Some infectious diseases are also zoontic (i.e. are transmissible between man and animals). Thus interaction with domestic animals and controlling their movement becomes essential. Many domestic and wild animals also serve as Reservoir hosts (are healthy carries of infection). Thus close interaction with animals should be avoided.

Personal preventive measures /health education is also good prospects for controlling infectious diseases. The following measures need to be taken: Protective personal hygiene especially among children and food vendors. Avoiding eating raw or undercooked meat, fish, green vegetables or fruits contaminated with cysts or eggs. Such a practice will reduce diseases like Taeniasis, Echinococosis, Spanogonosis etc. Human faces should not be used as fertilizers and shoes should be worn. This will reduce infection with intestinal nematode. Wearing protective clothing is also important in areas where vectors of diseases like trypanosomiasis transmitted by tsetse flies are abundant in order to prevent bites leading to diseases.

In the case of snail borne infections like schistosomiasis, contact with bodies of water should be avoided. Bad habits like spitting and coughing indiscriminately can also help in spreading some diseases like pneumonia and tuberculosis. A good knowledge of the way certain diseases are transmitted is useful in avoiding infections. Chemical control of vectors-This is the use of chemicals (i.e. insecticides, mulluscides, etc) against vectors of diseases. These have been successfully applied in the past, but are now branded as agents of pollution. Problems associated with chemical control include: Vectors easily develop resistance. The prohibitive cost of chemicals, their application, monitoring etc. detecting and treating human infections using many drugs have got toxic side effects, apart from being expensive with possibility of patient going to be exposed to re-infection all over again if the vectors promoting transmission have not been removed. For most diseases caused by micro-organisms, no chemo prophylactic methods have been developed. There is also the problem of drug resistance, as well as prohibitive cost of developing new drug particularly when they have to pass through stringent safety tests for toxicity etc. use of vaccines – Vaccines have been developed for a few infectious diseases, and where available, they have to be repeated almost annually. The cost of production of the vaccines is also high. Genetic control- This offered bright prospects in the laboratory. But has great problems on the field e.g. use of the male sterile technique.

For third world countries, the prospect for controlling infectious diseases remains gloomy. Sources of funding and proper planning of infrastructures like good water and sewage disposal mechanisms, development of organized primary health care system will be very important especially if rooted in indigenous knowledge. There is need for every village to have a trained village based health worker who can carry out health education and have some first aid training to assist at village levels. The cooperation and support of community leaders will also be very important. The modern day scientist would need to liaise with rural people to study their historic modes of life in the past and how
indigenous people cope with diseases; these are promising platforms to build research and development reminiscent of each ecological niche. The solutions and impact surprisingly may not be deep rooted in high tech. There is a need to review the processes involved in the control of infectious diseases as afore highlighted. Despite all the available high tech-measures, the prevalence of infectious diseases are rather galloping especially in rural Africa and it is envisaged that the status quo would likely not change so soon. The need to co-opt indigenous knowledge systems, study them, apply simple low cost technologies that will be accessible and easy to use by our people stands unequivocal, thus the rationale for developing phytobiotechnologies. This could change the health for our people in a more sustainable way.

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Biographical Sketch

Kenneth Anchang Yongabi was borned a Cameroonian on July 2nd 1972 did his undergraduate and post graduate studies in clinical Microbiology at Abubakar Tafawa Balewa University (ATBU) Bauchi, Nigeria, from 1995 to 2003, where he looked at semen infection and development of Phytopharmaceuticals for male infertility problems. In 2000, he joined the same university, as a lecturer and researcher attached to the ZERO Emission Research facility of the university. He taught a range of courses including, biotechnology and business management, pharmaceutical and medical microbiology, microbial physiology and Research methods. Took a fellowship program as a Crawford fellow at Adelaide University, South Australia in anaerobic digestion, integrated biosystems and mushroom cultivation in 2002. He undertook UNESCO courses on higher education pedagogy in 2005. He has 30 journals/referred publications within local and international journals, 2 technical and 20 conference papers as well as articles, newspapers /bulletins, and has co supervised a few undergraduate thesis and review for a couple of local journals. Currently a professional member of the American Naturopathic medical Association, and the International organization for Biotechnology and Bioengineering and served as country representative in 2005. He is a medical consultant at a community clinic that looks at diseases of elderly people in Cameroon, and founder and coordinator of Phytobiotechnology Research Foundation(PRIF) and clinics with focus on low tech diagnosis and phyto therapy. Married with two kids.