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# PHYTOMEDICINE: MAN'S HOPE IN HIS WAR OF ATTRITION WITH BACTERIAL PATHOGENS

***By***
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# Preamble

I am most delighted to come before you today to deliver my inaugural lecture. I have been thinking and ruminating over what topic to present at my inaugural lecture. I have conducted a vast number of studies in my chosen area of specialization over the span of my career.

The topic — "*Phytomedicine: Man's Hope in His War of Attrition with Bacterial Pathogens*" came out of very deep thoughts I have nursed over the years.

Herbs, shrubs and trees growing around man have provided remedies against the ravaging effects of pathogens and diseases. From holy religious books, we see that plants were created to be for both food and medicine. Take for instance the following quotes from the Bible:

Ezekiel Chapter 47 Verse 12 *"Along the bank of the river, on this side and that, will grow all kinds of trees used for food; their leaves will not wither, and their fruit will not fail. They will bear fruit every month, because their water flows from the sanctuary. Their fruit will be for food, and their leaves for medicine."*

Revelation Chapter 22 Verse 2 *"In the midst of the street thereof and on this side of the river and on that was the tree of life, bearing twelve (manner of) fruits, yielding its fruit every month: and the leaves of the tree were for the healing of the nations."*

No wonder therefore, there is a traditional Welsh rhyme which says:

*"Eat leeks in March and wild garlic in May, and all the year after the physicians may play."*

Also the traditional American rhyme says, *"An apple a day keeps the doctor away."*

## 1.0 Background

Finding healing powers in plants is as old as mankind. People on all continents have long applied poultices and imbibed infusions of hundreds, if not thousands, of indigenous plants, dating back to prehistory for medicinal purposes. There is evidence that Neanderthals living 60,000 years ago in present-day Iraq used plants such as hollyhock; these plants are still widely used in ethno-medicine around the world. Historically, therapeutic results have been mixed; quite often cures or symptom relief resulted.

Man was really oblivious to the effects of disease causing organisms and their ravaging effects through the instrumentality of medicinal plants growing in his environment. He was able to survive the onslaught of these disease causing agents and lived with them by keeping them at bay. It is informative to know that man was in tune and total control of his environment. The natural environment was very conducive for man's existence; everything was natural including the food, fruits, trees and plants (which he resorted to and used as medicine both for diagnostic and curative purposes). Despite the effects of the pathogens, therefore, man survived his environment. As a matter of truth, life expectancy was very high as many lived beyond 100 years, the minimum (Abalaka, *et al*., 2009c).

In Africa and especially in our history as Nigerians, we know that our forefathers lived until they were tired of life itself or life became tired of them. Some were taken to outside during the day for a few hours to enable them feel the sun. They lived to the point of being unable to recognize themselves not to talk of someone else. Their longevity was tied to their peaceful co-existence with the environment and the inter-dynamic relationship with the ecosystem. Man was used to eating fresh, natural foods, fruits, enjoying freshness of the air at all times. Working minimally daily, eating well balanced diets (nearly everything he ate was organic) and taking enough rest (Abalaka, personal communication).

However, man is adventurous! Man, by observations of his environment, ventured into making changes that should be of utmost benefits to him but by so doing also altered his environment to the detriment of his own survival. For instance, instead of going very far to look for wild fruits, animals and other necessities, he thought to domesticate them. This ultimately changed the eco-dynamism of man's environment.

Plants and animals are prone to infections and ultimately, diseases that were once alien were eventually transmitted to man. Such diseases that are transmitted from animal to man are commonly called zoonotic diseases or zoonoses. Diseases that naturally should not affect man were brought closer home to man from the wild and man became susceptible to these diseases. More adventures by man (called civilization) in changing the face of his environment by building good shelters, roads, dams and other constructions helped altered the natural environment and man became completely exposed to the danger that microbial disease causing organisms pose to him (Michelle*ett al.*, 2018;Niemelä, 1999). Man who has been in the comfort of his environment then began to survive at the mercies of the same environment which he was once in tune with and had the control over. What a pity!

From this point forward, therefore, the history of the human species, it has been said, became synonymous with the history of infectious disease. Over the centuries, humans have been exposed to a vast amount and arrays of contagious conditions, including the Black Death and other forms of plague, typhoid fever, cholera, malaria, influenza, and the acquired immunodeficiency syndrome, or AIDS, Ebola disease (Baron, 1996) and most recently Corona virus disease commonly referred to as Covid-19. Only in the past few hundred years have scientists begun to have any sort of accurate idea concerning the origin of such diseases, and that they occur through the action of micro-organisms and other parasites.The efforts of a host of Scientists and Microbiologists led to the affirmation that diseases occur as a

result of some unseen creatures (very tiny to be visualized by the naked or unaided eyes) which were later called micro-organisms.

## 1.1 Disease

It is a disorder of structure or function in a human, animal, or plant, especially one that produces specific symptoms or that affects a specific location and is not simply a direct result of physical injury (Baron, 1996).

## 1.2 The Kingdoms of Living Things

Biologists generally classify living organisms into one of the five kingdoms. Bacteria are the most primitive and likely represent the earliest living organisms, from which the protista and other kingdoms are likely to have evolved (Madigan and Martinko (2006); Whitman (2015).Species from all the five of the kingdoms have the potential to influence human health, either positively or negatively.

## 1.3 Bacteria as Pathogens

While only about 5% of bacterial species are pathogenic, bacteria have historically been the cause of a disproportionate amount of human disease and death. There is good evidence that from the 1300s through the 1800s tuberculosis, bacterial pneumonia, typhus, plague, diphtheria, typhoid, cholera, dysentery were major causes of diseases and premature death in Europe and the United States. Among those born in the United Kingdom in the 1800s, it is estimated that 70% died before the age of 25, and a large proportion of these deaths were due to bacterial infections. Not surprisingly, this burden of diseases and early death fell most heavily on the poor. During the 19th century, however, there was the emergence of "the sanitary idea" in England and the United States, and the efforts to provide better waste disposal, clean water, better nutrition, and better working conditions were rewarded with remarkable reductions in disease and death rates. Nevertheless, bacterial pathogens still pose a threat (Madigan and Martinko (2006); Whitman (2015).

## 2.0 Bacterial infections

Bacteria are single-celled microorganisms known as prokaryotes.They are estimated to be at least one nonillion bacteria on Earth. A nonillion is a number one (1) followed by 30 zeros. Much of Earth's biomass is made up of bacteria (Barbara *et al*., 2021).

### 2.1 Bacteria take three main shapes (Plates 1-3):

**Spherical**: These are usually the simplest to treat and are known as cocci, **Rod-shaped**: These are called bacilli and **Spiral**: Coiled bacteria and are known as spirilla. If the coil of a spirillus is particularly tight, they are known as spirochetes.

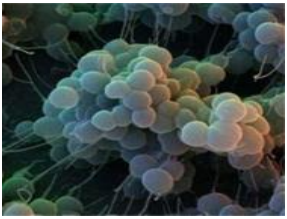

*Plate 1 Staphylococcus aureus*

*Plate 2 Escherichia coli*

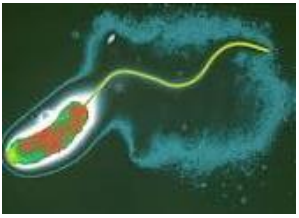

*Plate 3 Vibrio cholera*

Source: Mora *et al.* (2011)

There are trillions of strains of bacteria, and few of these cause diseases in humans. Some of them live inside the human body without causing harm, for example in the gut or airways. Some "good" bacteria attack "bad" bacteria and prevent them from causing sickness.

Diseases caused by bacteria include but not limited to cholera, diphtheria, dysentery, bubonic plague, pneumonia, tuberculosis, typhoid, typhus, bacterial meningitis, otitis media, gonorrhea, upper respiratory tract infection, gastritis, food poisoning, eye infections, sinusitis, urinary tract infections, skin infections, sexually transmitted infections (STIs) etc (Madigan and Martinko (2006);Whitman (2015). An infection happens when a foreign organism enters a person's body and causes harm. The organism uses that person's body to sustain

itself, reproduce, and colonize. These infectious organisms are known as pathogens. Examples of pathogens include bacteria, viruses, fungi, and prions. Pathogens can multiply and adapt quickly. Some infections are mild and barely noticeable, but others are severe and life-threatening, and some are resistant to treatment. Infection can be transmitted in a variety of ways. These include skin contact, bodily fluids, contact with feces, airborne particles, and touching an object that an infected person has also touched (Barbara *et al*., 2021).

These bacterial pathogens have visited man with untold hardships that has caused man much pains, maim, major economic losses and above all, even cost man his life (Plates 4-18).

Before the advent of **Microbiology**, where and when such diseases occurred, especially in an epidemic level, they were mistaken to be the anger of certain gods especially in Africa and Asia where idolatry and animism were highly entrenched and believed. They made sacrifices to these 'gods' to no avail. However we now know that their ordeal came from the world of some tiny, negligible, invisible creatures which could have devastating effects on human health and his existence. The invisible world (of micro-organisms) seems to have more and very powerful control over the visible world (of macro-organisms).

Infectious diseases and plaques have had serious debilitating effects on man for ages. The discovery of **Antibiotic** by Alexander Fleming in 1928 was thought to be the defining moments in the fights between man and infectious diseases. Upon the discovery of antibiotic in 1928 Alexander Fleming stated, "I woke up this morning not knowing I was going to make a discovery that will revolutionize the field of medicine" (Colebrook 1956; Bennett and Chung 2001). Indeed his discovery actually brought about a turnaround in man's fight against infectious agents. Antibiotics are low molecular-weight (non-protein) molecules produced as secondary metabolites, mainly by micro-

## 2.2 Signs of some bacterial diseases

**Plate 4 Staphylococcal infection**

**Plate 5 Streptococcal sore throat**

**Plate 6 Streptococcal sore throat**

**Plate 7 Streptococcal sore throat**

**Plate 8 Contact dermatitis**

**P late 9 Leprosy**

**Plate 10 *Escherichia coli* infection**

**Plate 11 *Escherichia coli* infection**

**Plate 12 Salmonella infection**

**Plate 13 Salmonella infection**

**Plate 14 Diphtheria**

**Plate 15 Salmonella infection**

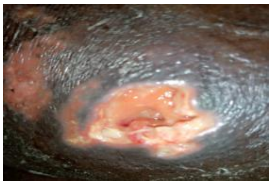

**Plate 16 *S. aureus* flesh eater Infection**

**Plate 17 Staphylococcal infection**

**Plate 18 *P. aeruginosa* infection**

Sources: Thapa *et al*. (2017); Thomas & Bomar (2021)

organisms that live in the soil. In fact, antibiotics were once seen and described as "miracle cure-all".

Soon after Fleming's discovery of antibiotic, a host of other antibiotics were discovered. Among the molds, the notable antibiotic producers are Penicillium and Cephalosporium, which are the main source of the beta-lactam antibiotics (penicillin and its relatives). In the Bacteria, the Actinomycetes, notably Streptomyces species, produce a variety of types of antibiotics including the aminoglycosides (e.g. streptomycin), macrolides (e.g. erythromycin), and the tetracyclines. Endospore-forming Bacillus species produce polypeptide antibiotics such as polymyxin and bacitracin. Antibiotics have been used extensively against pathogenic organisms especially bacteria (Colebrook 1956; Bennett and Chung 2001).

Man in his quest to tackle his fight with infectious agents and diseases, went into lots of research activities which saw him able to produce numerous antibiotics ranging from naturally occurring, semi synthetic to complete synthetic antibiotics.

Many of these antibiotics helped man against these pathogens ravaging many over the ages. However, as soon as man thought the fight is being won by him the pathogens began to fight back! Indiscriminate use of the antibiotics, prolong use, non-adherence to prescription, self-prescription, outright drug abuse coupled with menace of adulteration of drugs (mostly in the developing nations) soon led to the pathogens becoming resistant to the antibiotics that once were terrorizing them. In some cases, hardly can the people afford the antibiotics because they are too expensive even when available while in some cases they are not available. Man again has left off his guards and fallen prey to these pathogens and therefore began again to live at their mercy.

**And so the fight continues!**

**But there must be a solution!**

The quests to find solutions to the arsenals targeted at man by pathogens soon led man to go back to the basics---back to nature. Natural products of all kinds are being used against these organisms and these seem to be more effective than the so-called orthodox medicine we have come to embrace. However, they also have their shortcomings: lack of dosage quantification, bulkiness, loads of impurities, lack of adequate knowledge about their chemical make ups, low levels of metabolism, accumulation in visceral organs, safety concerns etc are some of the banes of the use of plant materials for medicinal purposes (Sofowora, 1993). More scary now is the lack of adequate knowledge about these medicinal plants and the fact that scarce information about them are gradually fading away with the passing of older generations of those that used them.

Herbal medicine is still the most abundant, affordable, reliable, trusted and well understood by locals in virtually all African villages. Before the coming of the colonial masters and the consequent advent of orthodox medicine, our people have relied on herbs growing in and around them to take care of their health problems. Plants growing around them were for both food and medicine. Kidney problems, liver diseases, enteric fevers, complications due to childbirth, shortage of blood, leukemia, diabetes, high blood pressure etc were not their problems as some of these diseases were rarely known(Helwig, 2005). Unbelievably, life expectancy was very high, compared to nowadays, as most of them lived well over hundred years. The coming of orthodox medicine seemed to have relegated our herbal health care system but development of resistance against orthodox medicine by pathogens and high costs as well as non availability of some of these drugs have made man to turn to nature for help (Abalaka, personal communication).

## 3.0 Traditional medicine

Traditional medicine can be described as the total combination of knowledge and practices, whether explicable or not, used in

diagnosing, preventing, or eliminating a physical, mental or social disease and which may rely exclusively on past experience and observation handed down from generation to generation, verbally or in writing. One of the earliest records of the use of herbal medicine is that of *Chaulmoogra* oil from species of *Hydnocarpus gaertn*, which was effective in the treatment of leprosy (Sofowora, 1993). Such use was recorded in the Pharmacopoeia of the Emperor Shen Nung of China between 2730 and 3000 B.C.

It has become very necessary to explain and bring to fore **African Traditional Medicine** and most importantly to make a demarcation between it and the use of medicinal plants and plant supplements. Traditional African medicine is a traditional medicine discipline involving indigenous herbalism and African spiritism, typically involving diviners, midwives, and herbalists. Practitioners of traditional African medicine claim to be able to cure various and diverse conditions such as cancers, psychiatric disorders, high blood pressure, cholera, most venereal diseases, epilepsy, asthma, eczema, fever, anxiety, depression, benign prostatic hyperplasia, urinary tract infections, gout, HIV, and healing of wounds and burns and even Ebola (Helwig, 2005; Mills *et al.,* 2005).

Traditional medicine is a method of healing founded on its own concept of health and disease. Healing knowledge is jealously guarded in certain families. In Africa, the popularity of traditional healers is attributed to the fact that they take full account of the socio-cultural background of the people. The components of traditional medicine include herbal medicine, therapeutic fasting and dieting, hydrotherapy, radiant healing therapy, surgery and bone-setting, spinal manipulation and massage, psychotherapy, therapeutic occultism, psychiatry and preventive medicine (Abdullahi, 2011).

Moreover, the practice of traditional medicine in Africa was usually shrouded in secrecy and mystic tendencies. They often wanted the people to believe the powers of the herbs to heal are tied down to

some powers of a deity which only they (the herbalists) can consult for answers. Many times processes of diagnoses and treatments may be done through animal sacrifices. When these animals are sacrificed the blood is collected and administered in such suspicious ways that some people become scared and try to distant themselves from use of traditional medicine (Williams and Whiting, 2016).

In an attempt to shroud the healing virtues in the herbs (plants) used for curative purposes, the herbalists often make it look as if there are celestial or unseen powers behind the working of their medicines. This they do by making some kinds of incantations, gestures, chewing some items like alligator pepper or some strange items. All those do not in any way add to the potentiality of plant materials. They only use this in order to monopolize the use of the process and keep other people away for their own selfish gains. They therefore conceal the names, uses of a lot of herbs in their environment. In some cases, they even go at night to collect the herbs so that no one sees them when and where they collect them. The best they do in most cases is to hand down information concerning the herbs to a trusted child who will hand down his own line. In addition, such approach has made traditional healing/medicine somewhat non-appealing to so many people especially in the face of religious beliefs outside of the African tradition.

So many taboos are placed on traditional medicine. For example, women are not expected to touch certain prepared medicine, some medicine must not touch the ground once prepared, some medicines are prepared only at night and can be seen by the traditional medicine man or the apprentices, incantations are often used to prepare the medicine while chewing alligator pepper, clay pot must be used to boil some medicines etc or else they lose their curative powers or abilities (Abalaka, personal communication).

The traditional medicine men often dress in unique regalia which distinguish them from any other human beings in the society. Their

dresses often made them look scary with a number of body paintings (Plate 19) a striking difference from that of South Korea (Plate 20). Most of the times they move about making certain sounds with their teeth, mouths or instruments. Some put a piece of leaf or grass in their mouth and enter through the door using their backsides (Abalaka, personal communication).


Plate 19 African Herbalist (Lugira, 2009)

Plate 20 South Korean Herbalist (field photograph)

I must say categorically and emphatically here that every efforts put in by the traditional African/Nigerian medicine men all aim at making sure they maintain their monopoly of the sector. No amount of drama they do will ever add, increase or reduce the active components of any plant employed for diagnostic and/or curative purposes. There is nothing mystic about the power of plants to cure diseases by killing infectious agents and pathogens. Plants naturally produce or synthesize primary and secondary metabolites which are antagonistic to these micro-organisms. Such monopoly has very negative effects on the continuity of traditional medicine because as those who know much about it have kept it to themselves, when they pass away and sometimes those they entrust into their hands are neither interested or die young, the knowledge passes on with them.

### 3.1 Medicinal plants

A medicinal plant is any plant which, one or more of its organs (leaves, stem, roots, flowers, seeds etc.) contains substances that can be used for therapeutic purposes or which are precursors for the synthesis of useful drugs (Sofowora, 1993). Several diseases of man, animals and in some cases, plants have been treated over the years with the use of plant materials.

Medicinal plants, also called medicinal herbs, have been discovered and used in traditional medicine practices since prehistoric times. Plants synthesize hundreds of chemical compounds for functions including defence against insects, fungi, diseases, and herbivorous mammals. Numerous phytochemicals with potential or established biological activity have been identified. However, since a single plant contains widely diverse phytochemicals, the effects of using a whole plant as medicine are uncertain. Furthermore, the phytochemical content and pharmacological actions, if any, of many plants having medicinal potential are yet to be explored through rigorous scientific research to define efficacy and safety (Ahn, 2017).

An herb is a plant or part of a plant valued for its medicinal, aromatic, or savoury qualities. Herbs can be viewed as biosynthetic chemical laboratories, producing a number of chemical compounds. Herbal remedies or medicines consist of portions of plants or unpurified plant extracts containing several constituents, which often work together synergistically. Herbal medicine or herbalism is the use of herbs or herbal products for their therapeutic or medicinal value. They may come from any part of the plant but are most commonly made from leaves, roots, bark, seeds, and flowers. They are eaten, swallowed, drunk, inhaled, or applied topically to the skin. Herbal products often contain a variety of naturally-occurring biochemicals from plants, many of which contribute to the plant's medicinal benefits. Chemicals known to have medicinal benefits are referred to as "active ingredients, active components, active compounds or active principles " and their presence depend on a number of factors including the plant species, the time and season of harvest, the type of soil, the way the herb is prepared, etc (Kunle *et al*., 2012).

The use of herbs as medicine is the oldest form of healthcare known to humanity and has been used in all cultures throughout history (Barnes *et al*., 2007). Early humans recognized their dependence on nature for a healthy life and since that time humanity has depended on the diversity of plant resources for food, clothing, shelter, and medicine to cure myriads of ailments. Led by instinct, taste, and experience, primitive men and women treated illness by using plants, animal parts, and minerals that were not part of their usual diet. Primitive people learned by trial and error to distinguish useful plants with beneficial effects from those that were toxic or inactive, and also whose combinations or processing methods had to be used to gain consistent and optimal results. Even in ancient cultures, tribal people methodically collected information on herbs and developed well-defined herbal pharmacopeias (Solecki, 1975).

Medicinal plants are widely distributed throughout the world but most abundantly in tropical countries. It is estimated that about 25% of all modern medicines are directly or indirectly derived from higher plants (WHO, 2005; De Smet, 1995; Duke and Martinez, 1994; Majno, 1975; Ackerknecht, 1973). Thus, herbal medicine has led to the discovery of a number of new drugs and non-drug substances (Kunle *et al*., 2012). Some of the herbs used in traditional medicine in Nigeria and their local names are as shown in table 1 below.

**Table 1 Some medicinal plants found in Nigeria, their English and local names in some major tribes/languages**

| S/N | BOTANICAL NAMES | LOCAL NAMES | | | | PARTS COMMONLY USED |
|---|---|---|---|---|---|---|
| | | Yoruba | Igbo | Hausa | Others | |
| 1 | *Pergularia daemia*(Forssk.) Chiov. (Asclepiadaceae) | ijoyun, kole ori ogba | utaezi | | | Leaf and bark |
| 2 | *Bryophyllum pinnatum* (Lam.) Oken (Crassulaceae) | abamoda, eru-odundun | | | danweshin (edo) | Leaf and root |
| 3 | *Mangifera indica*Linn. (Anacardiaceae) | Mangoro | mangolo | mangwaro | | Leaf and bark |
| 4 | *Alstonia boonei* De Wild (Apocynacea) | ahun, ako-ibepo | egbu ora | | ukhu (edo); | Root, bark and leaf |
| 5 | *Cleistopholis patens*(Benth) Engl. and Diels (Annonacaceae) | apako, oke | Ojo | | otu (edo) | Leaf and bark |

| S/N | BOTANICAL NAMES | LOCAL NAMES | | | | PARTS COMMONLY USED |
|---|---|---|---|---|---|---|
| | | **Yoruba** | **Igbo** | **Hausa** | **Others** | |
| 6 | *Musanga cecropioides*R. Br. (Cecropiaceae) | aga agbawo | ulu, egbu, onru, ujuju | | egbesu (itsekiri) | Bark and root |
| 7 | *Ceiba pentandra*Linn. Gaertn (Bombacaceae) | Araba | Akpu | Rimi | | Leaf, bark and root |
| 8 | *Pseudospondias microcarpa* A. Rich. Engl. (Anacardiaceae) | okikan aja | | rimin kuroni | | Bark |
| 9 | *Anchomanes difformis* Engl. (Araceae) | igo, langbodo, ogirisako | Oje | cakara | olikhoror (edo) | Root, stem, leaf |
| 10 | *Rauvolfia vomitoria*Afzel. (Apocynaceae) | Asofeyeje | akanta | Wada | | Bark and root |
| 11 | *Spondias mombin*Linn. (Anacardiaceae) | Iyeye | ijikara | tsaadar lamarudu | | Leaf and bark |
| 12 | *Voacanga africana*Stapf. (Apocynaceae) | ako dodo | pete pete | | | Bark and root |

| S/N | BOTANICAL NAMES | LOCAL NAMES | | | | PARTS COMMONLY USED |
|---|---|---|---|---|---|---|
| | | Yoruba | Igbo | Hausa | Others | |
| 13 | *Spathodea campanulata* P. Beauv. (Bignoniaceae) | Oruru | imi ewu | | okuekue (edo) | Bark |
| 14 | *Canarium schweinfurthii* Engl. (Burseraceae) | ako, anikantuhu, origbo | ube ohia | Atile | | Bark |
| 15 | *Basella alba* Linn. (Basellaceae) | amunututu, efo tutu | | | | Leaf |
| 16 | *Holarrhena floribunda*(G. Don) Dur. and Schinz. (Apocynaceae) | ako ire | Mba | bakin mutum | | Root |
| 17 | *Terminalia ivorensis*A. Chev. (Combretaceae) | afara dudu | awunshin | | egboen-nebi (edo). | Bark |
| 18 | *Ananas comosus*Linn. (Bromeliaceae) | ogede-oyibo, ope-oyibo | akwu olu | abarbaa | edinebo (edo) | Fruit and leaf |

| S/N | BOTANICAL NAMES | LOCAL NAMES | | | | PARTS COMMONLY USED |
|---|---|---|---|---|---|---|
| | | Yoruba | Igbo | Hausa | Others | |
| 19 | *Stemonocoleus micranthus* Harms. (Caesalpiniaceae) | | Nre | | erhaneben i (edo) | Whole plant |
| 20 | *Piper guineense*Schum. and Thonn. (Piperaceae) | ata-iyere | Uziza | | | Fruit, leaf and seed |
| 21 | *Adansonia digitata*Linn. (Bombaceae) | luru, ose | | bakko, kumbali | usi (edo) | Leaf |
| 22 | *Moringa oleifera* Lam. (Moringaceae) | ewe igbale | | | | Root |
| 23 | *Newbouldia laevis*Seem. (Bignoniaceae) | akoko | ogirisi | aduruku | ikhimi (edo) | Bark, root and leaf |
| 24 | *Aneilema beninense*(P. Beauv.) Kunth. (Commelinaceae) | godobo-funfun, odo | obo-ogu uku | | ohiovbo (edo); | Leaf |
| 25 | *Terminalia catappa*Linn. (Combretaceae) | | | | mbansan mbakara | Bark and young leaf |

| S/N | BOTANICAL NAMES | LOCAL NAMES | | | | PARTS COMMONLY USED |
|---|---|---|---|---|---|---|
| | | Yoruba | Igbo | Hausa | Others | |
| | | | | | (efik) | |
| 26 | *Bixa orellana* Linn. (Bixaceae) | osun buke | uhie aro, mkpulu ofia, ula | | | Seed and leaf |
| 27 | *Telfairea occidentalis*Hook. F. (Cucurbitaceae) | apiroko, egusi, iroko | ohi (fruit), ugu | | ubon (efik) | Leaf |
| 28 | *Kalanchoe crenata*Haw. (Crassulaceae) | eleti | Unwa | harfifi | | Leaf |
| 29 | *Calotropis procera*Ait. F. (Asclepiadaceae) | bomubomu | | bambambele | | Leaf, root and bark |
| 30 | *Myrianthus arboreus*P. Beauv. (Cecropiaceae) | ewe ade, ibisere | Ujuju | | ihi eghe (edo) | Bark |
| 31 | *Canna indica* Linn. (Cannacea) | ido, idoro | abereka mwo | bakalekale | | Leaf, root, shoot and stem |
| 32 | *Xanthosoma* | | ede eko, | gwaazaa- | iyokho | Root and leaf |

| S/N | BOTANICAL NAMES | LOCAL NAMES | | | | PARTS COMMONLY USED |
|---|---|---|---|---|---|---|
| | | Yoruba | Igbo | Hausa | Others | |
| | *mafaffa*Schott. (Araceae) | | akasi oyibo, ede ohia | mai-gooraa | akara (edo) | |
| 33 | *Kigelia Africana*(Lam.) Benth. (Bignoniaceae) | orora, pandoro,uyan | alamborog oda, uturukpa | hantsar giiwaa, rahainaa | ugbon-gbon (edo) | Leaf, bark and fruit |
| 34 | *Cnestis ferruginea* DC (Connaraceae) | akara oje, oyan aje | | fura amarya | ukpo-ibieka (edo) | Bark, leaf, root and fruit |
| 35 | *Mariscus alternifolius*Vahl. (Cyperaceae) | samikoko, alubosa eranko | ataku mainya, nne ikute | Ayaa | efo'aba (nupe) | Whole plant |
| 36 | *Heliotropium indicum*Linn. (Boraginaceae) | agogo igun, ogbe ori akuko | azu uzo, ilolo isi mwa-eku, utaba ani | kalkashin kooramaa | | Leaf |

| S/N | BOTANICAL NAMES | LOCAL NAMES | | | | PARTS COMMONLY USED |
|---|---|---|---|---|---|---|
| | | Yoruba | Igbo | Hausa | Others | |
| 37 | *Lagenaria siceraria*(Molina) Standl. (Cucurbitaceae) | ado, igba, akengbe, itakun igba | mbubu, igba, ebele | bumbu, dan kwakwangi | ekpere (edo) | Leaf, seed and root |
| 38 | *Opuntia dillenii* Haw (Cactaceae) | oro agogo agogo | | | | Stem, leaf and fruit |
| 39 | *Cyperus esculentus*Linn. (Cyperaceae) | imumu ofio omu, erunsha | | arigiza, ayaa rigiza, bakar | efa ( nupe) | Leaf |
| 40 | *Thevetia neriifolia*Juss. (Apocynaceae) | olomiojo | | | | Leaf and bark |
| 41 | *Aspilla Africana*(Pers.) C.D. Adams (Compositae) | ako yunyun, yinrin-yinrin, ako | azuzo, oramejina | jamajina, kalankuwa | edeme edon(efik) | Whole plant and leaf |
| 42 | *Vernonia amygdalina*Del. (Compositae) | ewuro, orin, pako, ewuro jije | olubi, olugbu, onubu | chusar doki, fatefate, mayemaye | oriwo (edo) | Leaf, root, bark and fruit |

| S/N | BOTANICAL NAMES | LOCAL NAMES | | | | PARTS COMMONLY USED |
|---|---|---|---|---|---|---|
| | | Yoruba | Igbo | Hausa | Others | |
| 43 | *Dioscorea dumetorum* (Kunth) Pax.(Dioscoreaceae) | esuru, ewu eleso, gudugudu | adu, akpana, ona igbo | gursami, kisra | ufua (edo) | Tuber and root |
| 44 | *Dacryodes edulis* (G. Don) H.J. Lam. (Burseraceae) | elemi, ibagbo | ubwe oyo, ube, ube-oyibo | | orunmwun (edo) | Leaf and bark |
| 45 | *Sclerocarya birrea* (A. Rich.) Hochst. (Anacardiaceae) | | | danya, huli | | Bark, leaf and root |
| 46 | *Terminalia glaucescens* Planch (Combretaceae) | idi, idi-apata, idi-odan | edo, barbar | baushe | | Root, leaf and bark |
| 47 | *Sterculia tragacantha*Lindl (Sterculiaceae) | alawefon | | | | Bark and leaf |
| 50 | *Pterocarpus* | | oha ojii | madoobiyaa | urube | Leaf and bark |

| S/N | BOTANICAL NAMES | LOCAL NAMES | | | | PARTS COMMONLY USED |
|---|---|---|---|---|---|---|
| | | Yoruba | Igbo | Hausa | Others | |
| | *mildbraedii* Harms (Leguminosae) | | | | (edo) | |
| 51 | *Harrungana madagascariensis*Lam. Ex Poir. (Guttiferae) | asunje | Uturu | alillibar raafii | | Stem bark, root bark and leaf |
| 52 | *Citrullus lanatus*(Thunb.) Mansf (Cucurbitaceae) | bara, egusi agbe, sofin | egusi, ogili, nkbuluko | agushii, bambus, guna | ikpogi (edo) | Fruit, seed and leaf |

**Source:** Duke and Martinez (1994)

## 3.2 Advantages and disadvantages of herbal medicine

### 3.2.1 Advantages

There are a number advantages associated with using herbal medicines as opposed to orthodox pharmaceutical products. Examples include the following:

i. Fewer side effects: most herbal medicines are well tolerated by the patient, with fewer unintended consequences than pharmaceutical drugs. Herbs typically have fewer side effects than orthodox medicine and may be safer to use over time (Shailesh *et al*., 2015).

ii. Effective with chronic conditions: herbal medicines tend to be more effective for long-standing health complaints that do not respond well to orthodox medicine. One example is the herbs and alternative remedies used to treat arthritis. Vioxx, a well-known prescription drug used to treat arthritis, was recalled due to increased risk of cardiovascular complications. Alternative treatment for arthritis, on the other hand, has few side effects. Such treatments include dietary changes like adding simple herbs and reducing white sugar consumption.

iii. Inexpensive: another advantage to herbal products is cost. Herbs cost much less than prescription medications. Research, testing, and marketing add considerably to the cost of prescription medicines. Herbs tend to be inexpensive compared to drugs (Shailesh *et al.*, 2015).

iv. Increase in natural immunity: herbal medicine concentrates on increasing the natural immunity and fighting the bacteria in a person's body. These herbal medicines do not use chemical compounds that will fight against diseases and risks, rather, they increase the

production of natural compounds in the body which help an individual to fight these diseases, risks, and conditions. The enhanced immunity helps the individual fight the diseases and risk of infections, making him/her stronger.

v. Accessibility: yet another advantage of herbal medicines is their availability. Herbs are available without a prescription. You can grow some simple herbs, such as peppermint, lemon grass, aloe-vera leaf and chamomile, at home. In some remote parts of the world, herbs may be the only treatment available to the majority of people (Shailesh *et al*., 2015).

### 3.2.2 Disadvantages

Herbs are not without disadvantages, and herbal medicine is not appropriate in all situations. These are a few of the disadvantages of herbal medicine:

i. They are often bulky: plant extracts are laden with enormous impurities therefore are often consumed in large quantities for it to be effective. Herbal drugs are usually mixtures of many constituents.
ii. The active principles are in most cases unknown. The practitioners only know the herbs are effective but cannot tell the compounds contained in these herbs responsible for their activities. Plant materials are chemically and naturally variable.
iii. Lack of standardization: dosage not quantified because it is not determined. The dosage prescribed is most often than not subjective and overestimated. There is therefore a real risk of overdose (Shailesh *et al.*, 2015).
iv. There is the risk of poisoning associated with herbs intake: the bulkiness of herbal medicine presupposes that some of the impurities are poisons. Toxicological evaluation of the

medicinal plants is not carried out because the practitioners have no knowledge of such studies.

v. Target organs are, in some cases, not reached by the herbal drugs thereby making them ineffective while in most cases there is accumulation of herbal components in visceral organs of the body.

The above disadvantages of these naturally available remedies for man's fight against infectious agents woke our curiosity that we began to find solutions to them.

## 4.0 My efforts so far in Pharmaceutical Microbiology

It was both with excitement and sense of purpose when we launched into studies of medicinal plants way back in the mid 90s. Our efforts were aimed at finding a common ground in the claims and counter claims of herbalists on the curative abilities of the various plants at their disposal. It should be noted that these so-called medicine men (herbalists) make claims of their ability to cure so many diseases, whether they can actually do so is highly subjective.

The antimicrobial activity of leaf extracts of *Calotropis procera* were expressed against bacterial organisms like *Pseudomonas aeruginosa*, *Clostridium perfringens*, *Streptococcus feacalis* and *Klebsiella ozaena* at very low crude concentration of about 250µg/ml (Mann, *et al.*, 1997).

This was followed by very aggressive research into medicinal plants of all kinds which took us many places in this country. The reason for the wide and diverse studies conducted was to make sure we unearth and authenticate the claims and counter claims by traditional medicine practitioners among the tribes across the country and beyond.

## 4.1 Studies on *Momordica charantia*

The early studies were mostly on crude extracts using arrays of solvents; both polar and non-polar solvents. One of the plants extensively studied in the course of my devoted rigorous research

period was *Momordica charantia* (Bitter melon, Ampalaya etc). Several bacterial pathogens responsible for many severe and mild diseases were employed to study the efficacy of this plant. In one of the studies, four bacterial pathogens, *Streptococcus pyogenes*, *Staphylococcus aureus*, *Salmonella typhi* and *Escherichia coli* (Gram positive and Gram negative organisms), were challenged with extracts from *Momordica charantia* at different test concentrations to determine their susceptibility pattern to the extracts. Almost all the test organisms were highly susceptible to ethanolic extract, moderately susceptible to water extract and least susceptible to petroleum ether extract. The results indicate that *Streptococcus pyogenes* is the most susceptible to the extract followed by *Staphylococcus aureus*.

Further tests on the plant were against pathogenic fungi and yeast such as genus Aspergillus and genus Candida. Results were positive activities against these organisms. Also scrutiny of the active ingredients revealed plant's secondary metabolites like alkaloids, saponin, tannins, cardiac glycosides, athraquinones, among others (Abalaka, *et al.*,2009a;2009b; 2009c 2009d; 2010b; 2010c; 2011e; 2011f; 2011g; 2011h).

### 4.2 Studies on Ziziphus species (*Ziziphus mauritiana* L. and *Ziziphus spinachristi* L.)

Our studies on these two Ziziphus species (*Ziziphus mauritiana* L. and *Ziziphus spinachristi* L.) with some microbial pathogens yielded good results against the test organisms. Activities of these plants were expressed against *Escherichia coli, Staphylococcus aureus, Streptococcus pyogenes, Aspergillus niger* and *Candida albicans* at low concentrations of 1 mg, 5 mg/ml. These plants were also studied for in-vitro antioxidant and free radical scavenging potential.

A free radical is an atom or molecule that has an unpaired electron and is therefore unstable. This unstable radical has the tendency to become stable through electron pairing with biological macromolecules such as proteins, lipids, and DNA in healthy human cells, thus causing protein and DNA damage. Such radical-caused cell damage can

become more widespread due to weakened cellular antioxidant defense systems. Antioxidants are substances that prevent and stabilize the damage caused by free radicals by supplying electrons from antioxidants to these damage cells. Antioxidants also turn free radicals into waste by-products, which are eliminated from the body. There is strong evidence that many dangerous pathophysiological processes, such as cancer, diabetes, cardiovascular and neurodegenerative diseases are associated with the accumulation of free radicals. Consumption of antioxidant-enriched fruits and vegetables is known to lower the risk of several diseases caused by free radicals. Such health benefits are mainly due to the presence of phytochemicals such as polyphenols, carotenoids, and vitamin E and C. The results of the research conducted by Abalaka, *et al.* (2010a, 2011c) were excellent in showing the antioxidant capabilities of these plants. The ethanol extracts and hexane extracts of *Z. spina-christi* and *Z. mauritaniana* leaves were tested for their free radical (Hydroxyl radical, DPPH radical [2,2-Diphenyl-1-picrylhydrazyl], Lipid peroxidation inhibition, and Superoxide radical) scavenging properties using different in vitro techniques. These plants were observed to have more antioxidant activities even than ascorbic acid with $EC_{50}$ (50% effective concentration) values of 357.23, 253.71, 234.11, 382.02, 356.78, 298.65, 376.25, 282.01, 203.70, 265.22, to those of ascorbic acid 219.31, 78.12, 191.42, 138.26. These findings highlight the importance of African medicinal plants as having curative ability against pathogens as well as capacity to be used as supplements. The phytochemical screening of leaves of *Ziziphus mauritiana* L and *Ziziphus spinachristi* L revealed vast numbers of secondary metabolites such as cardiac glycosides, polyphenols, saponins and tannins.

### 4.3 Studies on *Khaya senegalensis*

Non-refined secondary metabolites or active ingredients were part of our studies as we got slowly to find some active compounds of importance in medicinal plants. Studies on the plant *Khaya*

*senegalensis* (African mahogany) were carried out on several occasions both on the crude extracts as well as the semi refined and refined extracts. The plant, which is being used extensively by the locals, has been shown to have activity against disease causing organisms. This alludes to claims by the people on the medicinal importance of the plant (Abalaka *et al.*,2011a). The leaf, bark, roots and the stems of *Khaya senegalensis* were screened for antimicrobial activity. The plant showed activity against *Staphylococcus aureus*, *Streptococcus faecalis*, *Salmonella typhi*, *Escherichia coli* and *Candida albicans* at varying concentrations of the crude extracts. Fractions had activities against all susceptible test organisms at very low concentrations. Secondary metabolites such as Saponins, Cardiac glycosides, Tannins, Alkaloids and Anthroquinones, phenols have been isolated from the plant (Abalaka *et al.*,2011a).

### 4.4 Quantification of dosages of *Euphorbia hirta, Euphorbia heterophylla and Phyllanthus niruri* (MIC and MBC)

Dosage quantification is often the problem of traditional medicine. Bulkiness of traditional dosage has been a thing of concern as lots of impurities are consumed which when accumulated in the visceral organs are dangerous and attendant consequences are scary. Dosages of drugs are usually formulated by determining their minimum inhibitory concentrations (MIC) and the minimum bactericidal concentrations (MBC). The minimum inhibitory concentration (MIC) is the lowest or least concentration of an antimicrobial substance that slows down the growth of an organism but cannot kill it. On the other hand, the minimum bactericidal concentration (MBC) is the lowest or least concentration of an antimicrobial substance that is able to kill or have cidal effects on a microorganism.

*Euphorbia hirta, Euphorbia heterophylla and Phyllanthus niruri* were plants that also caught our attention due to the fact that the locals use them to treat diseases like typhoid fever, as well as other enteric disorders. The studies were essentially directed at the typhoid fever causative organisms which include the two species of Salmonella and

are*Salmonella enterica* and *Salmonella bongori*. The results indicate that each of these plants can be used to treat typhoid fever as they show activities at varying test concentrations. Furthermore, the combined therapy of the plants extracts at the ratio of 1:1:1 revealed even stronger activities against the organisms with MIC and MBC as low as 0.010mg/ml and 0.110mg/ml respectively. Drugs that can be developed from these plants will certainly be very viable alternative medicine for the treatment of typhoid fever (Abalaka *et al.*2011b; Abalaka *et al.* 2011c). The presence of Alkaloids, Anthraquinones, Cardiac glycosides, Phlobatannins, Polyphenols, Tannin and Steroids gave us the assurance that the anti-typhoid activities of these plants could be due to the presence of the secondary metabolites.

**4.5 Studies on several other medicinal plants**

*Asmina triloba, Jatropha curcas*, *Azadirachta indica* and *Telfairia occidentalis* were studied for in vitro antimicrobial activities against very well known pathogens and based on the claims of the locals on the curative tendencies of these plants (Abalaka *et al.*, 2003; Abalaka *et al.*2012a; Daniyan *et al*. 2011; Abalaka *et al*. 2012b). Activities of *Euphorbia heterophylla* on Typhoid disease causative agents as well as *Moringa Oleifera* were studied and each revealed strong activities against the test organisms used in these studies (Abalaka *et al*. 2012a). Oyewole and Abalaka (2012) studied the antimicrobial Activities of Telfairia occidentalis (fluted pumpkins) leaf extract against selected Intestinal Pathogens. Abalaka *et al.* (2013a) discovered the antifungal potential of *Gomphrena Celosioides* (Soft Khaki Weed) on some fungal pathogens. Abalaka *et al.* (2013b) determined the antibacterial effects of *Prunus amygdalus* (Almond Leaf) and *Ocimum gratissimum* (Basil Leaf) and showed they are medicinal.

Abalaka and Sani (2009), Abalaka *et al.* (2011b), Abalaka *et al.* (2014), and Abalaka *et al.* (2015, 2016a), studied the antimicrobial broad spectrum efficacy of *Khaya senegalensis*, the in vitro susceptibility of the typhoid pathogens to synergistic action of *Euphorbia hirta*, *Euphorbia heterophylla* and *Phyllanthus niruri* for

possible development of effective anti-typhoid drugs, the antibacterial efficacy of gold nanoparticles derived from *Gomphrena celosioides* and *Prunus amygdalus* (Almond) leaves on selected bacterial pathogens, the medicinal values of cola species-*Cola Nitida* and *Cola acuminata.* The results obtained from all these research activities indicate most test organisms were susceptible to test extracts at varying concentrations and we concluded they can be candidates for drugs for the treatment of disease caused by any of these bacterial and fungal pathogens some of which include *Candida albicans, Salmonella typhi, Salmonella paratyphi A, Salmonella paratyphi B, Salmonella paratyphi C* (now known as *Salmonella enterica*), *Staphylococcus aureus, Streptococcus faecalis and Escherichia coli.*

Saidu *et al.* (2015, 2016) explored the antibacterial activity of eight medicinal plants against diarrhoeal pathogens and found them very effective for the treatment of diarrhoea. These plants were *Timarindus indica, Guiera senegalensis, Prosopis africana, Deterium microcarpum, Citrus aurantifolia, Psidium guajava, Acacia nilotica* and *Momordica charantia.* Enteric pathogens responsible for diarrhea (*Salmonella typhi, Pseudomonas aeruginosa, Escherichia coli, Klebsiella pneumoniae, Proteus vulgaris and Citrobaceter sp*.) were susceptible to extracts of these medicinal plants even at very low concentrations. These plants and their herbal formulations could be used for treatment of diarrhea.

### 4.6 Purification of plants' extracts (TLC, GC-MS, NMR)

Many of the studies carried out above centred on the efficacy of the plants' crude extracts, their fractions as well as the pure compounds extracted from them. Our results show very clear distinctions between activities of these plants' materials when in crude form, fractions or pure compounds. This is expected because crude extracts have much impurity which tends to mask the efficacies of the secondary metabolites. Fractions of medicinal plants show more activities than the crude extracts while pure compounds have the highest activity in

pharmaceutical studies. For the purification of compounds from plants, we deployed thin layer chromatography (TLC), gas chromatography-mass spectroscopy (GC-MS), and nuclear magnetic resonance spectroscopy (NMR), among others. The following active principles were isolated and identified from most of the medicinal plants using the above mentioned screening methods. They include n-Hexadecanoic acid (this was found in abundance compared to others), 9-Oxabicyclo(6.1.0)nanone, 9, 12-Octadecadienal, Oleic acid, N-Cyano-2-methylazeridine, 4-Chloro-3-n-butyltetrahydropyran, Octadecyl propyl ether, Hexadecanoic acid, 2-Hydroxy-l-(hydroxymethyl)ethyl ester and many more (Oloninefa *et al.,* 2018a, 2018b). It is believed that these compounds are responsible for the activities of these plants against bacterial pathogens.

### 4.7 Toxicological studies (determination of safety levels of medicinal plants)

A major aspect of pharmaceutical Microbiology is toxicological studies. This is because our responsibility is basically to authenticate the claims by the users of medicinal plants (herbalists, the sick, the promoters of such drugs etc) that they are effective and safe. Against the backdrops of safety concerns, we carried out extensive and expensive toxicological analyses to validate the safety of these products. Virtually all plants studied for antibacterial efficacy by me and my teams were also toxicologically studied and their safety levels evaluated.

We can now report that contrary to the claims that all herbs are safe to use as medicinal plants and that they have no side effects whatsoever, there are safety concerns in some plants. Our studies revealed that while some of the plants are safe with no side effects even at very high concentrations, some are moderately toxic and others are extremely toxic and are therefore not fit as candidates for medicinal purposes.

For example Saidu *et al.* (2015, 2016) evaluated the toxicological potential of leaf extracts of *Guiera senegalensis* and concluded that although the plant was safe for use by humans the prolong use could

have toxic effect. Other safe medicinal plants, according to our findings, include but not limited to *Euphorbia hirta, Phyllanthus niruri, Gingibar officinale, Azadiracta indica, Khaya senegalensis, Citrus sinusis,* and *Euphorbia heterophylla.* However, plants such as *Helianthus anuus, Calotropis procera, Vernonia amygdalina* (commonly known as bitter leaf), *Anacardium occidentale, Jatropha curcas, Physalis angulata* etc have demonstrated some levels of toxicity in laboratory animals when administered at higher doses (Abalaka *et al.,* 2017; Mann *et al.* 1997; Daniyan *et al*. 2011). We therefore concluded that, not all plants are safe for use for medicinal purposes due to the level of their toxicity even though they may have activity against pathogens.

### 4.8 Drug delivery challenge (nanotechnology: drug nuclear warhead)

Disease causing organisms called pathogens survive in fluids environment. The environment of pathogens could be laboratory media or bodily fluids of the susceptible organisms called the hosts. Whatever the environment, it is never favourable to the activity of any antimicrobial agent as the agent must first overcome the actions of the fluid before attacking the pathogen. This is in addition to other devices marshaled by the pathogen to circumvent the activities of antimicrobial agents. Thus, pathogens often limit the extent to which chemical agents have access to them. This has been the problem of drug administration through time which is the inability of drugs to reach the target organs.

While some pathogens fortify themselves from antimicrobial drugs that can destroy them by producing enzymes, adhesines, spores, capsules, mutagenes, others evade attack by antimicrobials by hiding far away from where the antimicrobial can reach. For example, organisms that reside in the vertebral column, spinal cord, the brain are often very hard to reach by antimicrobial agents. This is because most drugs are transported by the blood and lymph and these places are unassailable by these body transport media.To overcome these

problems there was the need to shift the focus of our research activities from drug discovery and development to drug delivery with focus on target organs using nanotechnology.

Abalaka *et al.* (2016a, 2017) evaluated green synthesis and antibacterial activities of silver nanoparticles against *Escherichia coli, Salmonella typhi, Pseudomonas aeruginosa* and *Staphylococcus aureus* as well as Synthesis of Silver Nanoparticles (AgNPs) from Bark and Root of African Mahogany (*Khaya senegalensis*) and the Comparative Studies of their Antimicrobial Properties. The results were mind boggling as the nanoparticles produced tremendous effects beyond the other agents. Our studies on the antibacterial efficacy of gold nanoparticles derived from *Gomphrena celosioides* and *Prunus amygdalus* (Almond) leaves on selected bacterial pathogens revealed higher activities against the pathogens by the gold nanoparticles (AuNPs) (Abalaka *et al*.,2014). Also, extensive studies of the conjugated silver nanoparticles (AgNPs) derived from *Euphorbia heterophylla* showed activities of these plants against *Escherichia coli, Klebsiella pneumoniae, Salmonella typhimurium* and *Pseudomonas fluorescens*(Oloninefa *et al*., 2022).

### 4.9 Targeting specific sites and enzymes on pathogens

Standard antibiotics are active against bacteria by targeting certain sites or components on the bacterial cell. These targets give antibiotics their modes of action. In order to ascertain that modes of action are not limited to standard antibiotics alone, we also studied modes of action of certain plant products by administering them to target specific parts of bacterial cell. We studied their effects on cell wall components, protein synthesis, cell membrane function as well as enzyme functions in some pathogens and so were able to determine the modes of action of the plants' extracts. Our studies (Abalaka *et al.,* 2013a; 2013b; Daniyan *et al.,*2011; Abalaka and Bello 2016) on *Anacardium occidentale* (Cashew tree), *Citrus sinensis*, *Occimum gratissimum*, *Psidium guajava*, *Carica papaya*, *Gomphrena celosioides*, *Vernonia amygdalina*, *Prunus amygdalus* etc revealed their activities against

cell wall synthesis, cell membrane function, enzyme functions as well as protein synthesis in the test organisms employed.

## 4.10 Specific findings

i. The scientific study of plant medicine that has ethnic connotations is referred to as ethnomedicine. The use of chemical agents to treat disease is called chemotherapy and the chemicals are chemotherapeutic agents. With no word to describe chemical agents used in ethnomedicine, I came up with the word "ethnochemotherapy" to refer to chemicals of plant origin used in ethnomedicine (Abalaka *et al.,* 2009d)

ii. Drug is known to be curative while vaccine is preventive. Drugs cure disease while vaccines prevent occurrence of disease, none of them does the two simultaneously. We however, stumbled on the plants *Momordica charantia*, *Ziziphus mauritiana* and *Ziziphus spina-Christi* having both curative and preventive capabilities in that they have effects on the test pathogens and also potentiate the production of white blood cells in laboratory animals thereby eliciting recruitment of phargocytes and aiding phargocytosis (Abalaka *et al.,* 2010a, 2011d, 2011f).

iii. Cells, organs and tissues are proned to injuries due to the presence of many free radicals in the body as a result of metabolism. These oxygen radicals cause enormous damage to the body. This is generally referred to as oxidative stress. Many of the plants studied possessed both antimicrobial as well as antioxidant properties. The antioxidant effects of *Momordica charantia*, *Ziziphus mauritiana* and *Ziziphus spina-Christi* were more than those of Ascorbic acid (Abalaka *et al.,* 2010a, 2011d, 2011f).

iv. Micro-organisms differ structurally, chemically and physiologically and that is why drugs are often specific so that drugs developed against protozoa may not necessarily work

against bacteria or the ones for bacteria against viruses or fungi. However, our studies have revealed some plants extracts as having activities against arrays of microorganisms such as protozoa, bacteria, fungi and viruses at the same time (Abalaka *et al.*, 2011c, 2011d, 2013b, 2017).

These findings show that most plants perform dual and, in some cases, triple functions which provide edge above orthodox medicine.

## 4.11 Pharmaceutical Products formulation

The pharmaceutical Microbiologist and Clinician are very much interested in the presence of active compounds in plants that will be the beginning of the discovery and development of novel drugs, medicine and other pharmaceuticals.

The following pharmaceutical products have been produced from medicinal plants and have been found to be very effective against diverse disease causing organisms and are therefore useful in the treatment of diseases caused by these pathogens.

1. *Euphorbia hirta, Euphorbia heterophylla and Phyllanthus niruri* typhoid tea
2. *Chromoloena ordorata* wound cleansing preparation (tincture of iodine)
3. *Gomniphera celosioides* (and other species) antifungal pastes effective against eczema and other fungal peripheral infections
4. Clear skin orange ointment made from peels of *Citrus sinensis*. The Raw Materials Research and Development Council (RMRDC) has given grant for the production and optimization of this particular product in recognition of its efficacy
5. Orange peel tea made from *Citrus reticulate* commonly referred to as tangerine

## 5.0 Conclusion

Man's ordeal in the hands of bacterial pathogens and the nightmare of resistance of disease causing organisms to drugs and antibiotics is such that we think deeply of alternative medicine if man must survive the onslaught. Medicinal plants have been and remain a sure and best alternative for man if he must win the war between him and the pathogenic bacteria. Herbs are administered in the form of powder, infusion, decoction, porridge, poultices, steam, etc and are effective with minimal or no side effects and the organisms have not been able to develop resistance against them because of the diversities of their chemical compositions.

Thomas Jefferson wrote, "The greatest service which can be rendered any country is to add a useful plant to its culture." Plants will forever be catalysts for our healing. Using plants as the inspiration for new drugs provides an infusion of novel compounds or substances for healing disease. Evaluating plants from the traditional African system of medicine provides us with clues as to how these plants can be used in the treatment of diseases. Nevertheless, there is the need to determine the safety level as well as quantification of dosage of every promising herb before use.

## 5.1 Recommendations

To reinforce the knowledge of herbal remedies, I advocate:

1. Teachings on identification of medicinal herbs/plants at elementary/secondary schools in various languages. Let them know these plants that grow everywhere in the surroundings and their local names;
2. A blend between orthodox medicine and herbal medicine. It is common knowledge today that doctors ask some patients to make use of supplements when they come for consultation. These supplements are imported with huge foreign exchange but

the irony is that we have plants' supplements that could have done the same services and even more but we either do not know or despise them;

3. Finally, I appeal to the Vice Chancellor to create the Department of Pharmaceutics, Pharmaceutical Microbiology and Alternative Medicine in the School of Life Sciences to safeguard our herbal heritage from extinction.

With these, I know, we should be able to bridge the gap between orthodox medicine and herbal medicine. We stand the chance to benefit immensely if we did and to turn the tide on the bacterial pathogens once again.

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My Vice-Chancellor Sir, Deputy Vice-Chancellor (Academics), Deputy Vice-Chancellor (Administration), the Registrar, the Bursar, University Librarian, Dean of the Postgraduate School, Dean of the School of Life Sciences, Deans of other Schools here present, Head of Department of Microbiology, Heads of other Departments in School of Life Sciences and the University, Professors here present, Colleagues, Students, Gentlemen of the Press, Distinguished ladies and Gentlemen, I thank you for your patience and kind attention.

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## A BRIEF PROFILE OF THE INAUGURAL LECURER

Professor Moses Enemaduku Abalaka was born on the 6th of July, 1968 at Ejule in Ofu Local Government Area, Kogi State to the family of Prince Abalaka Itanyi and Princess Hawawu Abalaka (nee Idachaba). He attended the defunct Christian Religion Institute (CRI) at the then Qua Iboe Church, Ejule when he was just aged 4 years. Professor Abalaka attended St. Martin's Primary School, Ejule from 1974-1980 where he obtained the first school leaving certificate. He then went on to obtain the O, level certificate after attending Community Secondary School, Ejule, Kogi State from 1980-1985. He proceeded to School of Basic Studies Makurdi with the intention to obtain A' level results for Interim Joint Matriculation Board Certificate (IJMB) in order to gain admission to the University. However, he sat for JAMB and was offered admission to Federal University of Technology, Minna where he enrolled in 1989 and graduated in 1994 with a Bachelor of Technology Degree in Microbiology. Professor Abalaka had his NYSC from 1994-1995 at Federal Polytechnic, Bida, Niger State. He went to University of Ilorin where he obtained M. Sc degree in Microbiology in 2004. He thereafter proceeded for his terminal degree (PhD) in Microbiology at Ahmadu Bello University, Zaria and obtained it in 2010.

With the passion to impart knowledge of Microbiology to students he decided to take up appointment with the Polytechnic after the one year youth service (NYSC) in June 1995 as Assistant Lecturer. He rose through the ranks to the position of senior lecturer in 2006. As an individual who likes higher challenges he decided to leave the Polytechnic to the Federal University of Technology, Minna as a Lecturer 1 in October, 2007. As a hardworking fellow, he rose through the ranks to become a Professor of Microbiology on 1st October, 2017.

Professor Abalaka served on various committees at the Federal Polytechnic Bida before coming to Federal University of Technology, Minna. He has handled many administrative responsibilities since

joining this Institution which include, Level Adviser to various levels; Departmental Secretary; PG Coordinator; Chairman, Committee to re-compute undergraduate 2007/2008 students results; Member, School of Science and Science Education University Board for Research; Member SSSE Board; Member, School of Natural and Applied Sciences Board; Member, Centralized SSSE Postgraduate Seminar; Researcher and Contributor to Centre of Excellence for Genetic Engineering and Biotechnology. He is one of the researchers that have attracted external research grants to this great University.

A prolific writer, Professor Abalaka has authored many books some of which are:

i. **Modern Tropical Biology, (JEBP Scientific publications ISBN 978-37919-2-3, 2003)**
ii. **Modern Scientific Writing: A Guide for Undergraduate Microbiology, (First Edition, JEBP Scientific publications ISBN 978-978-49583-7-0, 2010)**
iii. **Modern Scientific Writing: A Guide for Undergraduate Research work, (Second Edition, JEBP Scientific publications ISBN 978-978-49583-7-0, 2013)**
iv. **Agrobacterium Transformation: A Boost to Agricultural Biotechnology, (Lap Lambart Academic Publishing, Germany, 2012)**
v. **Polio Eradication in Nigeria: the Journey so Far (Lap Lambart Academic Publishing, Germany, 2012)**

Professor Abalaka has published well over 80 journal articles in both national and international journals of repute, a Google Scholar with high h-index and i10-index. He is also an assessor to many national and international journals and editorial board member of various national and international journals. Professor Moses Abalaka has attended many national and international conferences and workshops. His international engagements took him to places like Indonesia, France, Italy, South Korea and the Middle East.

He is member of many professional bodies such as Biotechnology Society of Nigeria (BSN), Nigerian Society for Microbiology (NSM), National Association of Teachers of Technology (NATT), Nigeria Association of Experimental Biology (NISEB), American Society for Microbiology (ASM), World Academy of Science, Engineering and Technology (WASET) etc.

Professor Moses Enemaduku is married to Talatu Tabitha from the family of late Pa, Festus and Deaconess Christiana Sani. Their union is blessed with two children, a girl and a boy: Victory Ajifa Oyiza and David Onu Onimisi.