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TOPIC:

FUNGI: Friends or Foes to Mankind

By
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An Inaugural Lecture delivered at the University of Lagos Main Auditorium on Wednesday, 2nd November, 2011

by

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PREAMBLE

The Vice–Chancellor, Deputy Vice–Chancellor (Management Services), Deputy Vice–Chancellor (Academic and Research), Registrar, other principal officers of the University, Dean of Science, other Deans present, members of the University Senate, academic and non-teaching staff of the University, members of the Chapel of Christ Our Light, Gentlemen and Ladies of the Press, invited guests, students of this Institution, ladies and gentlemen.

I thank the Almighty God, the God of all creation for ordaining this special day in my academic career.

I came into the University of Lagos as an undergraduate student with 'A' levels in 1983. I registered into the Botany programme in the defunct Department of Biological Sciences. A lot of questions were raised then; 'Why are you studying Botany? Why are you wasting money when you can study something "better"? What are you going to do with it? Do you want to teach in the secondary school or become an educated "babalawo"?' There is nothing wrong with the last question. However by the grace of God and the caliber of lecturers I met in the Botany programme, I found that Botany is a good and lucrative course to study, and relevant to the needs of Nigeria. The first Vice Chancellor of this great University of Lagos in 1962, Prof Eni-Njoku was a Professor of Botany and whom a student hall was named after, the Eni-Njoku hall. This is the fourth Inaugural Lecture in the Botany programme, the

previous ones were from Prof T.O.Orebanjo, Prof O.T. Ogundipe and Prof (Mrs) N.U. Uma (who supervised my Ph.D thesis). However, this is the first Lecture from the Department of Botany. My area of specialization is Mycology/ Plant Pathology/ Ethnobotany, with specific focus on the importance of Fungi in Plant Pathology, Ethnobotany and the environment.

WHY STUDY BOTANY?

Botany is the study of plants and plant products or the study of the science (Pure and Applied Science) of plants. Botany is not just about naming plants or beautifying the environment with flowers or studying forestry. For a plant to be named, the attributes, morphology, habitat, uses, phytochemical component, anatomical characteristics, ecology, growing habits and other characteristics must be known. Plants play a role in everyone's life and touch almost every aspect of human existence one way or another. Plants meet our essential basic needs of provision of oxygen (the main natural source), food, timber, furniture, drugs, fuel, shelter, clothing and biocirculation of minerals. The plants or their products form major raw materials in most industry. Plants are the only producers in the food chain, all other organism are consumers, man inclusive. Botany has several disciplines which include Taxonomy and Biosystematics, Plant Physiology, Plant Biochemistry, Phytochemistry, Ecology, Phycology or Algology, Bryology, Palynology (Paleobotany), Ethnobotany (Medicinal plants), Plant Geography, Landscaping, Horticulture, Environmental Botany, Forensic Botany, Economic Botany, Plant Breeding, Cytology, Plant Pathology and Mycology.

INTRODUCTION

WHAT ARE FUNGI?

Fungi are non-chlorophyllus living organisms. The study of fungi is referred to as **Mycology**. There are more than 3 million identified fungal species on earth. Fungi are eukaryotic, lack chlorophyll and possess cell wall in addition to cell membrane. The fungal cell wall contains chitin instead of cellulose (generally) as found in higher plants. Fungi are heterotrophic, living as saprophytes and parasites. This group of organisms undergoes extracellular digestion. Fungal diseases are mostly common in plants, accounting for up to 75%. They are not common in humans but when present could be difficult to cure. Fungi have some characteristics of plants and animals hence in 1969 it was grouped into its own kingdom, Fungi or Mycota, and separated from the plant kingdom. However, Mycology (the study of fungi) is housed in Botany. The classical classification model of Fungi by Ainsworth (1966, 1971, 1973), the first main designer of the model, is adopted here as accepted by the International Botanical Congress of 30th July, 2011. There are other classification models. Mycota can be divided into two, the Myxomycota, false fungi and Eumycota, true fungi. Fungal distribution patterns are generally similar to those of plant and animal groups in that they have distinct geographical distributions and habitat preferences. Fungi are found almost everywhere, especially ones that: (a) spoil foodstuffs (b) cause the deterioration of manufactured materials (c) are involved in circulation of organic matter in the soil or (d) cause disease in plants and/or animals. Two categories of true fungi can be recognized on the basis of their morphology, the microfungi (filamentous or colonial) and macrofungi. The microfungi can only be seen with the aided eye using microscopes. The macrofungi are visible to the natural or unaided eyes. The mushrooms are macrofungi. **Plate 1 and Plate 2** show examples of filamentous microfungi.

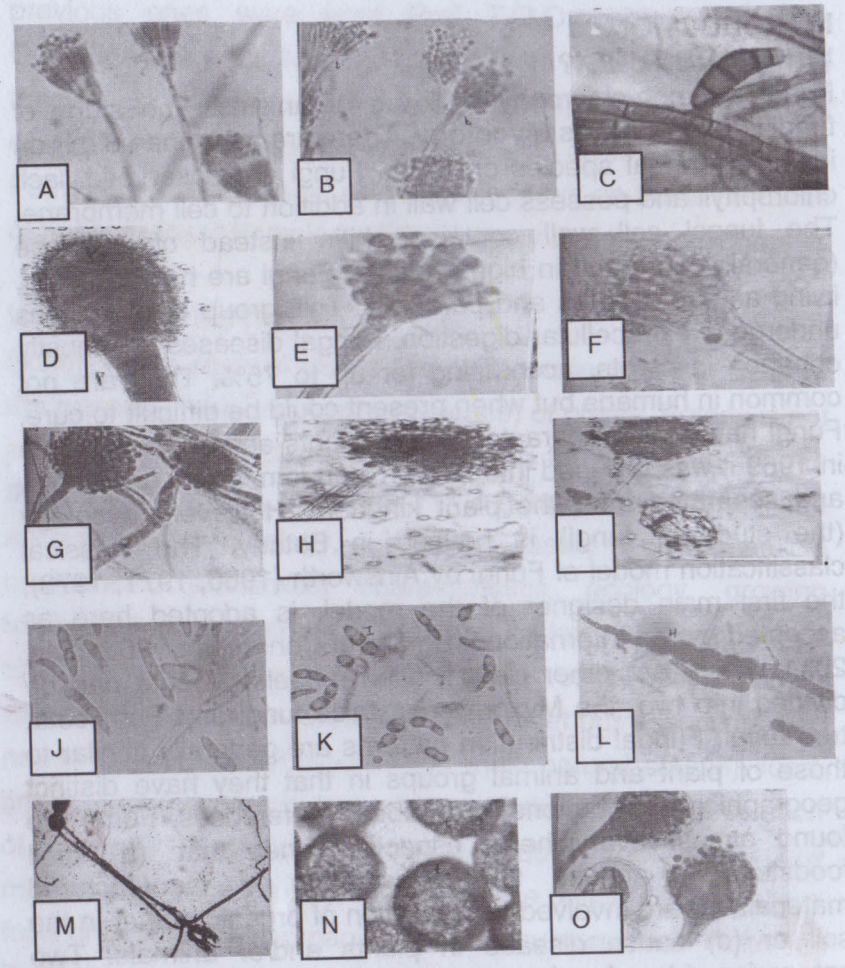


Plate 1:- Photomicrographs of some filamentous microfungi: (A) *Penicillium pinophylum*; (B) *Penicilium chrysogenum*; (C) *Curvularia* Sp; (D) *Aspergillus clavatus*; (E) *Aspergillus fumigatus*; (F) *Aspergillus japonicus*; (G) *Aspergillus wentii*; H) *Aspergillus vesicolor*; I) *Aspergillus flavus*; (J) *Fusarium solani*; (K) *Fusarium* Sp; (L) Chlamydospores of *Mucor racemosa*; (M) *Rhizopus oryzae*; (N) *Talaromyces* showing cleistothecium and (O) *Absidia blakelsiana*. Mag. X400
Source: Adekunle (1996).

Plate 2:- Some microfungi in culture plates: A) *Aspergillus niger*; B) *Aspergillus wentii*; C) *Fusarium* Sp and D) *Mucor racemosa*. Mag.X0.25 Source: Adekunle (1996).

Mr Vice-Chancellor Sir, Fungi have beneficial and non-beneficial effects on man. When the fungus is of benefit it can be referred to as a **friend**. The fungus is a **foe** when its existence is non-beneficial and detrimental to other organisms, man inclusive. The potentials of the fungus can always be annexed positively even when it is detrimental (a foe) to man and fungi become a friend.

FUNGI AS A FRIEND

In the Bible, it was recorded in Exodus that the children of Israel were fed with manna. The description and growth

pattern of manna fits the mushroom, which is a group of fungi. Mushrooms are consumed by vegetarians, especially, as a source of protein in their diet. Some mushrooms are of medicinal value. The mushroom, giant puffball, *Clavatia,* contains anti-cancer substance 'clavátin'. The consumption of this fungus, *Clavatia,* prevents stomach tumors. There are poisonous mushrooms which can kill in seconds because they contain cyanides and other poisonous secondary metabolites. The separation of edible mushrooms from the poisonous ones can be done through biochemical tests. Mushrooms can be used for biological warfare. Use of fungi by humans dates back prehistory: OTZI the iceman, a well preserved mummy of a 5,300 year old Neolithic man found frozen in the Australian Alps, carried two species of polypore mushrooms that may well have been used as binder (*Fomes fomentarius*) or for medicinal purpose (*Piptoporus betulinus*) to preserve the mummy, Otzi the iceman.

Chitosans are used in the industrial production of Plaster of Paris. The chitosans were produced from crabs and prawns. However, the quantity produced from the crustaceans does not meet the commercial needs for the production of Plaster of Paris because it takes several months to nurture a mature crab. The chitin in the fungal cell wall is now extracted through semi-solid state fermentation and converted to chitosan which can be used. It is faster and cheaper to produce chitosan from fungi than invertebrates. Fungal cultures can be produced within 3 days for this purpose.

Fungi are used extensively in food production from time immemorial. Different species of yeast are used for baking bread. The yeast, *Saccharomyces,* can be sourced from palm wine locally for this purpose. Yeast for baking is still imported in Nigeria. In some food preparations, fungi are responsible for impacting characteristic flavor of food as found in the soy sauce.

Yeast converts carbohydrate (starch of sugar) solutions to alcohol. Through the process of fermentation using yeast, fungi are used in the production of alcoholic beverages such as beer, wine, strong liquor and so on. Yeast and other filamentous fungi are also of great importance in the production of biofuel from starch and monsaccharides.

Fungi are used in the production of industrial organic acids. These acids include, glucomic acid, citric acid, fumeric acid, oxalic acid, lactic acid, aspartic acid etc. The list of organic acids and their fungal source is found in **Table 1.**

Table 1: Organic Acids from Fungi and Their Uses

Organic acids	Fungal sources	Application
Citric acid	*Aspergillus niger, Aspergillus flavus*	Used as antioxidants, food preservatives, in the production of tooth pastes, textile printing and paper making
Fumeric acid	*Aspergillus fumigatus, Fusarium sp*	Manufacture of wetting agents
Fusidic acid	*Fusidium coccineum, Mucor ramannianus*	Used as medicine in the treatment against penicillin resistant bacteria. It is an antibiotic.
Gallic acid	*Penicillium glaucum, Aspergillus galomyces*	Used in medicine to manage hypertension
Gibberellic acid	*Gibberella fujikuroi*	Used in horticulture, for promoting vegetative and reproductive growth, and in stimulating growth in pineapples
Gluconic acid	*Aspergillus niger, Penicillium chrysogenum*	Used in the manufacturing of black ink, dye stuff, and in treatment of skin diseases
Kojic acid	*Aspergillus oryzae*	Used as an insecticide and antibiotic
Itaconic acid	*Aspergillus terreus, Aspergillus itaconicus*	Used in the manufacturing of printers ink, synthetic fibres, adhesives, thickners and coatings
Succinic acid	*Aspergillus flavus, Aspergillus niger*	

Source: Onions et al., 1981

Table 2 shows list of enzymes produced from fungi. Various kinds of enzymes such as amylases, cellulases, lignases, oxidase, lipase, pectinase etc can be synthesized on commercial scale using fungi. Fungi are the main source of industrial enzymes.

Table 2: Some Enzymes of Fungal Origin and Their Uses

Enzymes	Fungal source	Uses
β-Amylases	*Aspergillus Spp*	Production of glucose syrup, fruit process and brewing
Betagalactosidase	*Aspergillus terreus*	Used in solving digestive discomfort
Catalase	*Aspergillus niger, Penicillium Spp*	Relevant in the textile industry, used in pulping
Cellulase	*Aspergillus niger, Aspergillus fumigatus*	Fruit processing, flour production, and canned food processing
Diastase	*Aspergillus flavus, Aspergillus oryzae*	Used in tendering meat, hides and skin manufacture
Glucanase	*Penicillium emersoni*	Brewing, wheat processing
Invertase	*Saccharomyces cerevisae*	Used in the conversion of sugar to hexoses
Laccase	*Pyricularia oryzae*	Relevant in the paper industry
Ligninase	*Coprinus Sp, Fomes formentarius*	Wood degradation, wood polishing
Lipase	*Aspergillus niger, Aspergillus oryzae, Fusarium solani*	Fat modification
Oxidases	*Aspergillus niger*	Removal of oxygen from beverages and food products
Pectinase	*Aspergillus Spp*	Processing of fruits and wine
Protease	*Aspergillus Spp*	Baking and brewing, flavour production
Xylanase	*Aspergillus niger, Trichoderma reesei*	Wheat processing, baking
Zymase	*Saccharomyces cerevisae*	Ethyl alcohol production

Source: Alexopoulus, et al (2007); Hait et al (2011)

The gibbrellins are plant growth hormones but were first discovered as a product of *Gibberella fujikuroi*, a fungus, which is a plant pathogen, whose imperfect state include *Fusarium moniliforme*. A number of gibbrellins have been identified but gibberellic acid is the main one produced commercially from fungi. Gibberellins are used to promote growth in higher plants. Gibberellins are important in the commercial production of pineapples.

Fungi are used in the production of vitamins (**Table 3**). Vitamins are co-factors enabling enzymes to function properly. Most of the vitamins cannot be stored in the body hence fresh doses must be supplied constantly. One of the best sources of vitamin B complex is the yeast. The increasing recognition of the importance of adequate supplies of these vitamins in the diet has led food manufacturers to market a number of preparations of high potency, made from autolysed yeast, dried yeast or yeast extracts (Yeast are fungi).

Table 3: Some Vitamins from Fungi and Their Effect on Man

Vitamins	Fungal Source	Effect on Man
Vitamin B complex (Nicotinic acid, Anuerine hydrochloride)	Dried yeast, yeast extracts, Autolysed yeast, *Saccharomyces* Spp	Prevents night blindness, maintain good eyesight, aids overall body growth
Riboflavin (One of the B groups of vitamins)	*Nematospora gossypii, Eremothecium ashbyi*	Helps in regeneration of vision
Ascorbic acid (Vitamin c)	*Aspergillus niger*	Prevents scurvy, prevents diseases generally, helps in wound repairs
β-carotene (convert to vitamin A)	*Blakeslea trispora, Phycomyces blakelseanus*	Prevents urolitiasis
Ergosterol (Precursor of vitamin D)	*Saccharomyces, Shizosaccharomyces, Candida* Spp, *Ashbyi gossypii*	Essential for the development of bones, helps development of teeth,

Source: Bryce (1992)

Majority of fungi are saprobes. Fungi are detritus or decomposers of dead organic matter and thus facilitate the decomposition of litter and debris which accumulates overtime. Fungi facilitate the recycling of minerals in this organic matter within the ecosystem. Plant wastes, with their high cellulose content are of importance in both agriculture and horticulture (agro-waste part of bio-waste or Biological waste). The thermophilic cellulolytic fungi are active in breaking down these wastes. Before modern methods of steam and electrical heating, heating was used in frames of thermophilic processes in compositing hot beds of plant material and manure which is an important procedure in temperate horticulture. This process is the basis of the production of mushroom compost where thermophilic processes cause self pasteurization of the compost, giving a selective advantage to the implanted mushroom mycelium.

Fungi are the main group of microorganisms that produce cellulase and lignninase which the enzymes needed to biodeteriorate plant material because of the cellulose and lignin contents in the plants. Over one third of town waste (inclusive of domestic, industrial, etc) is frequently cellulose based. Processes used in managing town waste rely principally on the thermophilic cellulolytic fungi. In Singapore, electricity is generated from vegetable waste. This process relies on some thermophilic cellulolytic fungi such as *Chaetomium thermopile*, and *Humicola langinosa* to effect the major degradation of the waste. This produces gas and is pressurized to drive turbines. It is part of the mechanical and electrical process, and eventually produces the electricity.

Fungi are used for the production of single cell protein, although only the yeast properly qualifies for this term. The basic aim of single cell protein production is to speed the production of protein from inorganic nitrogen, using either a hydrocarbon such as mineral oil or a carbohydrate (starch) as sources of both carbon and energy. Fungi offer the advantage

of having a lower proportion of nucleic acids, which must be restricted in mammalian diets.

Fungi are also found in symbiotic or mutualistic relationship with higher plants referred to as mycorrhizae. The mycorrhizal relationship makes the fungi assist higher plants to get water and nutrients from the soil. On the other hand the plants through the process of photosynthesis, manufacture carbohydrates which they make available to the fungi for reproduction and development. This relationship has an impact on the life of man, because medicines are produced from myccorhizal plants, and corks used in covering wine bottles are produced from plants involved in mycorrhizal association.

Another symbiotic or mutualistic relationship is the lichen. Lichen is an association between the fungus and algae. The fungal component, usually the greater in proportion, is either an ascomycotina or basidiomycotina, while the algal component is in the cyanophyceae commonly called cyanobacteria. The algal portion contributes organic food manufactured from photosynthesis while the fungus is able to absorb water and mineral salts. Example of lichen is *Xanthoria aurecola* (a fungus) and the algal component is the *Trebouxia.* Lichens are sensitive to atmospheric pollutants like Sulphur IV Oxide (SO_2), thus are used to monitor environmental pollution. Fungi are used in the biological control of bacteria, insects and nematodes. Fungi are also biological control agents to other fungal pathogens. Arthropods, and particularly insects, are man's greatest competitors. The insects damage or destroy our crops before and after harvest, and transmit many fatal or debilitating diseases. In developing countries, insect control is often a matter of life and death especially with farmers. A number of entomogenous fungi are lethal parasites of arthropods; in most cases the fungal spores are released in enormous numbers, and can infect the host at any stage of its life cycle. The spores germinate on the host cuticle, the germ tube penetrates the cutinous exoskeleton, and branching hyphae riddle the viscera. Spore-bearing structures of the

fungus eventually emerge from the corpse, liberating fresh inoculums. The entomogenous fungi are found effective in the biocontrol of insects. **Table 4** shows some entomogenous pathogens of arthropods. The ones with the trade name are those available commercially.

Table 4: The list of some Entomogenous Fungi of Arthropods

Fungal Genus	Trade Name	Class	Principal Target
Coelomomyces		Chytridiomycetes	Mosquito larvae
Entomophthora		Zygomycetes	Aphids
Conidiobolus		Zygomycetes	Aphids
Beauvera	**Boverin**	Hyphomycetes	Colorado beetle, colding moth
Hirsutella	**Mycar**	Hyphomycetes	Citrus rust mite
Metarhizium	**Metaquino**	Hyphomycetes	Spittlebug, mosquito larvae, rhinoceros beetle, lepidopteran larvae
Verticillium	**Vertalec**	Hyphomycetes	Aphids
Verticillium	**Mycotal**	Hyphomycetes	White fly
Nomuraea		Hyphomycetes	Lepidopteran larvae
Aschersonia		Hyphomycetes	White fly, scale insects

Source: Bryce (1992)

Fungi were one of the first biological research tools in molecular biological sciences used in the advancement of DNA sequencing. The fungi involved were *Neurospora crassa*, *Physarium polycephalus* and *Saccharomyces cerevisae* used for cytological studies in molecular mycology and Molecular biology.

Fungi are important in forensic studies which is an area referred to as forensic mycology, part of forensic botany. In a case in 2008, in drug related shooting, a gunman hid himself up against the trunk of an oak tree that was growing in a cypress hedge along a quiet lane in Romford, Essex and killed an associate who had arranged to meet him in the lane. The cypress was growing sub-optimally because of intense shading by the oak and was infected with a pathogenic fungus

(*Pestalotiopsis funereal*). The gunman had been standing in deep leaf and twiggy litter, and his body and feet could not avoid contacting the cypress branches, oak trunk and the litter. The pollen grain assemblage from the crime scene was very similar to that found associated with items seized from the suspect and his associates. The spores of *Pestalotiopsis funereal* formed part of that palynomorph assemblage. They were abundant in the leaf litter and vegetative samples, and were found in a vehicle known to have been used by the gunmen and associates. In addition, spores of the fungus *Endophragmicella* species were also found in the leaf litter and the getaway car. This was a case where, although the palynological profiles of the comparator samples and exhibits were similar, the fungal spores provided additional resolution that added powerful pertinent information for the court to convict the accused gunman. **Table 5** shows the list of some fungi that has been used for forensic studies.

Table 5: Presence/Absence of fungal spores on the clothing of victim and suspect in a rape case with those in the two possible locations, investigated for Witshire Constabulary in 2009

Fungi	Suspect	Victim	Wood	Park
Asterosporium haffmannii	+	-	-	-
Bactrodesmium abovatum	+	-	+	-
Bactrodesmium betulicola	+	-	+	-
Brachysporium britannicum	+	+	+	-
Camposporium cambrense	-	+	+	-
Clasterosporium flexum	+	+	+	-
Cymadothea trifolia	_	_	_	+
Diperotheca Sp	+	_	_	_
Didymosphaeria Sp	_	+	+	_
Diplocladiella scalaroides	+	_	+	_
Endophragmiella fagicola	+	-	+	-
Epicoccum nigrum	+	+	+	+
Glomus Sp	+	-	+	-
Melanospora Sp	-	+	+	+

Fungi	Suspect	Victim	Wood	Park
Nesslia exosporioides	+	-	-	-
Periconia byssoides	+	+	+	+
Phaeotrichosphaeria brittanica	+	-	-	-
Pseudovalsella like	+	+	+	-

Source: Hawksworth and Wiltshire (2010)

Antimicrobial drugs used in the treatment of many bacterial and fungal infections in man are produced from fungi. Penicillin the mast famous antibiotic is of fungal origin, was derived from *Penicillium notatum* now genetically transformed to *Penicillium chrysogenum*. Its accidental discovery by Alexander Fleming in 1929 brought revolution to health care worldwide. Penicillin is now isolated from a number of species of *Penicillium* and *Aspergillus*. Some of the antifungal drugs are listed on **Table 6**.

Table 6: Groups of Antibiotics (antibacterial and antifungal) of *Fungal Origin and Uses*

Antibiotics	Fungal Source	Uses
Cephalosporins e.g Cephaloridine	*Cephalosporium* Spp	Broad spectrum antifungal agents
Chloromycetin	*Myxogastres* Sp	Control of certain bacteria and fungi
Griseofluvin	*Penicillium griseofluvum Khuskia oryzae*	For systemic treatment of fungal infections of skin, hair and nails. Eg ringworm, athlete foot
Echinocandins	*Aspergillus nidulans*	Wide spectrust agents against opportunistic infections
Penicillin	*Penicillium chrysogenum*	Broad spectrum antibacterial agents against Gram-positive bacteria
Streptomycin	*Streptomyces griseus*	An antibacterial / agent against gram negative bacteria

Source: Adapted from Vashita and Sinha (2005)

The ergot of Rye (a temperate plant) caused by a fungus *Claviceps purpurea* produces a useful alkaloid, first isolated in 1918 and reported in 1932. During childbirth, these alkaloids

are used medicinally to hasten labour (induce labour). In addition, these alkaloids have been used for the treatment of migraine, lowering blood pressure and post mortem heamorrhage. For this purpose the ergot fungus (**Plate 3**) is cultivated commercially on rye in Eastern Europe, Spain and Portugal. A derivative of ergot known as lysergic acid (LSD) is used in Experimental Psychiatry. Some of the ergot alkaloids include ergotamine, ergometrine, ergocrystine, ergocystinin and ergonovin.

Plate 3:- The fungus *Claviceps purpurea*: A) Sclerotium of *C.purpurea* on the *Secale cereale* (Rye) plant, instead of ovary; B) Stroma of *C.purpurea* growing out of the sclerotium. Source: Alexopoulus *et al* (2007).

FUNGI AS A FOE

Fungi become a foe of man when their effect is non-beneficial or detrimental or harmful to man directly or indirectly. Fungi are known to cause more than 120,000 diseases of plants. Fungi account for most plant diseases known to man. Fungal diseases affect crops on farm and in storage, ornamentals in our flower gardens and homes, forest trees that can yield timber, furniture in homes and offices. Fungi cause up to 70% disease of plants. **Table 7** shows some list of fungal diseases of plants in Africa. Control measures of these plant diseases include Regulatory, Cultural, Biological, Physical, Chemical, and Breeding resistant varieties. The best control method is

the Integrated Control Measure which uses all (combines) the methods available or applicable to a disease.

Table 7: Major Fungal Diseases in Various Crops in Africa

S/N	Crop	Fungal causal agent	Disease
1	CEREALS *Zea mays* (Maize) Family: Gramineae	*Fusarium* Sp *Diplodia* Sp *Sclerophthora macrospora,* *Colletotrichum graminicola,* *Peronosclerospora sacchari* , *Physoderma maydis* *Gibbrella* Sp *Ustilago maydis*	Cob rot Cob rot Downy mildew Anthracnose Downy mildew Brown spot Stalk rot Smut
2	*Triticum persicum* (African wheat) Family: Gramineae	*Ustilago* Sp *Tilletia caries* *Fusarium* Sp *Helminthosporium sativum*	Smut Common bunt Head scab Spot blotch
3	*Sorghum bicolor* (Guinea corn) Family: Gramineae	*Drescheslera* Sp *Sphacelotheca sorghi* *Claviceps microcephala* *Fusarium moniliforme* *Colletotrichum graminicola*	Seed rot Smut Ergot Seed rot Stalk/Red leaf
4	Pennisetum purpureum (Millet) Family: Gramineae	*Claviceps fusiformis* *Dreschslera* Sp *Sclerospora gramicola* *Sphacelotheca destruens*	Ergot Seed rot/Seedling blight Green ear Head smut
5	*Oryza sativa* (Rice) Family: Gramineae	*Pyricularia oryzae* *Magnaporthe grissea* *Gaeumannomyces graminis* *Cercospora oryzae* *Drechslera oryzae* *Thanatephorus cucumeris*	Rice blast Rice blast Take-all disease Narrow brown leaf spot Brown spot Sheath blight

6	LEGUMES *Phaseolus vulgaris* (Beans) Family: Papilionaceae	*Colletotrichum lindemuthianum* *Phaeoisaripsis griesola* *Uromyces appendiculatus*	Anthracnose Angular leaf spot Rust
7	*Vigna unguiculata* (Cowpea) Family: Papilinaceae	*Colletotrichum lindemuthianum* *Ascochyta phaseolorum* *Cercospora cruenta* *Sphaceloma* Sp *Botrytis* Sp	Anthracnose Leaf blight Leaf blight Scab Scab
8	*Arachis hypogeal* (Ground nuts) Family: Papilionaceae	*Cercospora pensonata* *Peronospora pisi* *Ascochyta pisi* *Mycosphaerella pisi* *Botrytis cincinera* *Cercospora pisi* *Aspergillus flavus* *Uromyces pisi* *Puccinia arachidis*	Tikka disease Downy mildew Leaf and Pod spot Leaf spot Grey mould Cercospora leaf spot Seed rot, Brown rot Rust Rust
9	*Glycine max* (Soybeans) Family:	*Peronospora manshurica* *Phakospora pachyrrhizi* *Sclerotinia scleritiorum* *Cercospora sojina* *Colletotrichum truncatum* *Diaporthe phaseolorum*	Downy mildew Rust Stem rot Frog eye leaf spot Seedling blight, Anthracnose Stem canker, Pod and stem blight
10	OILSEED *Gossypium anomalum* (Cotton) Family: Malvaceae	*Aschochyta gossypii* *Colletotrychum gossypii* *Verticilium* Spp *Rhizoctonia solani* *Fusarium oysporium*	Seedling blight Seedling blight, Ball rot Wilt Damping off New cotton wilt
11	*Theobroma cacao* (Cocoa)	*Armillaria mellea* *Phytophtora capsici* *Phytophtora palmivora*	Armellaria root rot Black pod

	Family:	*Crinipellis perniciosus* *Glomerella cingulata* *Verticilum dahlae* *Botryodiplodia theobromae*	Black pod of cocoa Witches broom Anthracnose Sudden death Pod rot
12	*Elaeis guineensis* (Oil palm) Family: Palmae	*Ceratocystis paradoxa* *Pythium Sp* *Cercospora elaedis* *Ganoderma boninense* *Ganoderma lucidum* *Fusarium oxysporium* *Ustilago scitaminea* *Ustulina deusta*	Black rot of seedling Damping off Necrotic spot Basal stem rot Ganoderma Butt Vascular wilt Smut Charcoal stump rot
13	*Cocos nucifra* (Cococnut) Family: Palmae	*Phytophtora palmivora* *Ganoderma lucidum*	Phytophthora bud rot Ganoderma wilt
14	*Sesamum indicum* (Sesame) Family:	*Cercospora sesamicola* *Alternaria sesame* *Fusarium solani* *Macrophomina phaseolina*	Brown leaf spot Leaf spot Wilt Charcoal rot, Stem rot
15	TUBERS *Discorea rotundata* (White yam) Family: Discoreaceae	*Colletotricum gloesporioides* *Curvularia pallescens* *Curvularia eragrotides* *Rhizoctonia solani* *Aspergillus tamari* *Botryodiplodia theobromae* *Penicillium oxallicum* *Sclerotium rolfsii* *Mucor circinelloides*	Anthracnose Leaf spot Zonate leaf spot Stem rot Tuber dry rot Tuber dry rot Tuber dry rot Soft rot Soft rot
16	*Manihot esculenta* (Cassava) Family: Euphobiaceae	*Fusarium oxysporium* *Vertucilium dahlae* *Uromyces* Spp *Colletotrichum gloesporioides* *Phyllostica manihoticola* *Alternaria* Spp *Sclerotium rolfsii*	Fusarium root rot Verticilium root and stem rot Rust Apical leaf spot Basal leaf spot Basal leaf spot

		Phaeoramularia manihotis *Scytalidium* Spp *Colletotrichum gramicola* *Rhizomorpha subcorticals* *Diplodia manihoti*	Root rot White leaf spot Black root and stem rot Anthracnose Shoe sting root rot Diplodia root and stem rot
17	*Ipomea batatas* (Sweet Potatoe) Family: Convovulaceae	*Helicobasidium mompa* *Alternaria* Spp *Ceratocystis fimbrata* *Penicillium* Spp *Cercospora batatas* *Macrophomina phaseolina* *Phomopsis phaseoli* *Fusarium solani* *Fusarium oxysporium* *Botrytis cinerea* *Pythium* Spp *Pyrenochaeta terrestis* *Coleosporium ipomoeae* *Albugo ipomoeae-paduratae* *Sclerotium rolfsii*	Violet root rot Alternaria leaf spot, stem blight, Black rot Blue mold rot Cercospora leaf spot Charcoal rot Dry rot End rot, Root rot Storage rot Wilt, Surface rot Gray mold rot Mottle necrosis Pink rot Red rust White rust Southern blight
18	FRUITS/ VEGETABLES *Lycopersicum esculentus* (Tomato) Family: Solanaceae	*Alternaria solani* *Fusarium oxysporium* *Phytophthora palmivora*	Early blight Fusarium vascular wilt Late blight
19	*Allium cepa* (Onions) Family: Amarylidaceae	*Alternaria porri* *Urocystis cepulae*	Purple blotch Smut
20	*Abelmuscus esculentus* (Okra) Family: Malvaceae	*Verticilium* Spp *Rhizoctonia esculentus* *Pythium* Spp *Fusarium* Spp	Verticilium wilt Fruit rot Damping off Fusarium root and stem rot
21	*Capsicum annum*	*Verticilium dahlia* *Vertcilium psalliotae*	Verticilium wilt Fruit soft rot

	(Pepper, 'Tatase') Family: Solanaceae	*Fusarium oxysporium* *Fusarium moniliforme* *Colletotrichum capsci* *Macrophomina phaseolina* *Phytophthora* Spp *Peronospora tabicina* *Oidopsis sicula* *Botrytis cinerea* *Sclerotium rolfsii* *Alternaria alternata*	Fusarium wilt Fruit soft rot Anthracnose Charcoal rot Damping off Downy mildew Powdery mildew Gray mold, Fruit rot Southern blight Fruit rot
22	*Corchorus olitorius* ('Ewedu') Family: Tiliaceae	*Rhizoctonia solani* *Sclerotium rolfsii* *Curvularia* Spp *Cercospora* Spp *Macrophomina phaseolina* *Ustilago maydis* *Pythium aphanidermatum* *Fusarium equiseti* *Penicillium oxalicum* *Rhizomucor pusillus*	Soft rot Foot rot, Wilting Black leaf spot Circular leaf spot Charcoal rot Smut White rot Storage rot Blue mold White wet rot
23	*Amaranthus virides* (Green, Spinach) Family: Amaranthaceae	*Chaonephora cucurbitarium* *Phomopsis amaranthicola* *Colletotrichum spinaceae* *Alternaria Spp* *Curvularia Spp* *Phytophthora megasperma* *Cercospora beticola* *Pythium ultinum* *Peronospora effuse* *Fusarium oxysporium* *Phyllostica Spp* *Phoma nebulosa* *Aecidium capsicum* *Albugo occidentalis* *Entyloma elisii*	Shoot rot Shoot rot Anthracnose Green mold Green mold Leaf, stem rot Cercospora leaf spot Damping off Downy mildew Fusarium wilt Leaf spot Phoma blight Red rust White rust White smut
24	*Musa* Spp (Banana, Plantain) Family: Musaeceae	*Colletotrichum musae* *Armillaria mellea* *Phyllacora musicola* *Mycosphyarella fijensis* *Rosellina bunodes* *Cercaospora hayi*	Anthracnose Armillaria corn rot Black cross Black Sigatoka, Black leaf streak

		Deightoniella torulosa *Botryosphearia ribis* *Uromyces musae* *Drechslera musae-sapientum* *Sclerotina sclerotium* *Verticilium theobromae* *Junghuhria vincta*	Black root rot Diamond spot Damping off Fruit rot Leaf rust Leaf spot Sclertinia fruit rot Cigar-end Corm dry rot
25	*Ananas comosus* (Pineapples) Family: Bromeliaceae	*Colletotrichum ananas* *Chalara paradoxa* *Ceratocystis paradoxa* *Curvularia eragrostidis* *Phytophthora cinnamomi* *Phytium Spp* *Ceratocystis paradoxa* *Aspergillus flavus* *Botryodiplodia theobromae* *Ceratocystis paradoxa* *Penicillium funiculosum* *Rhizopus oryzae*	Anthrcnose Butt rot Butt rot Leaf spot Phytophthora heart rot Root rot White leaf spot Aspergillus fruit rot Botryodiplodia fruit rot Fruit black rot Leathery pocket Rhizopus fruit rot

Relatively, a few fungal species cause diseases in man. Fungal diseases are not common in man but when they occur can be difficult to cure. Fungal parasites of man can be divided into dermatophytes, agents of deep mycoses, and fungi which cause allegies. Dermatophytes, are fungi which cause diseases of the skin of man and other animals. The disease they cause is termed dermatomycoses which include ringworm, athlete foot, eczema, skin rashes, nail infections etc. Some of the common dermatophytes include *Trichophyton* and *Microsporium* causing skin infections, *Tinea capitis* cause ringworm and *Taphrina* Spp, cause eczema.

Deep mycoses are disease of the human body which affects tissue below the outside the skin. This is usually chronic. The pathogenic *Aspergillus* and *Penicillium* belongs to the group of fungi that cause mycoses. *Aspergillus* causes the disease called Aspergollosis, that usually infect weak lungs. Other fungi that causes mycoses include *Blastomyces, Histoplasma, Geotrichum,* etc. Some of these fungi are confined to the skin and the mucous membrane around the skin and the mouth. It may grow deeper and attack the gastro intestinal track as found in *Blastomyces braziliensis* which cause the mycoses of the mouth very prevalent in South America especially, Brazil.

Airborne fungi or the air spora of an environment can cause allegies, irritation and mycoses of human bodies. The air spora of the hospital ward, agricultural farmland, bedroom, toilets, eating places, and living rooms, interior of a car or vehicle, factory, workshop are very important to human health. Some fungi are opportunistic and are present in the air spora. They include *Absidia, Mucor,* and *Rhizopus*, which are injurious to neuropenic persons and cause ketoacidic diabetes. These groups of fungi also invade arterial walls and can lead to anaemia. They also cause brain damage or mental disorder especially *Rhizopus* and *Mucor.* Some fungi that cause allegies include *Alternaria, Cladosporium, Penicillium, Aspergillus fumigatus, Curvularia* etc. *Alternaria* and *Cladosporium* can trigger asthmatic attack while *Curvularia* cause irritations in the eye when the conidia are excess in the air spora.

Some fungi are also harmful as a result of toxins they produce on food like seeds, grains, meat, milk, egg, and contaminated processed food. These toxins are called mycotoxins and are usually carcinogenic. Examples of mycotoxins are listed on **Table 8.**

Table 8: Some Mycotoxins from Fungi and their Effects

Toxins	Fungal Origin	Effect on Man and Other Animals
Aflatoxin	*Aspergillus flavus*	Aflatoxicoses, Chronic liver cancer
Citreoviridin	*Penicillium* Spp	Cardia beri-beri
Citrinin	*Penicillium citrinum*	Kidney degeneration
Fumonisms	*Fusarium moniliforme*	Oesophageal cancer, blind staggers, Neurotoxic
Luteoskyrin	*Penicillium* Spp	Nervous and circulatory disorders
Ochtratoxins	*Ochraceus verrucosum Aspergillus* Spp	Liver and Kidney necrosis, organ degeneration, transmitted to man through food chain
Patulin	*Penicillium expansum*	Causes edema, bleeding in lungs, induces cancer, paralysis of motor nerves
Vomitocin	*Fusarium* Spp	Causes diarrhea, bleeding and death
Zearalanone	*Fusarium* Spp	Causes disorder in the genital system

Source: Agrios (2007)

Bioaccumulation of the mycotoxin in the human system leads to acute degenerative conditions of the liver, lungs and kidneys leading to cancer. There is a limit to which toxins are allowed in food. The most common mycotoxin is the aflatoxin produced by *Aspergillus flavus* and *Aspergillus fumigatus*. The aflatoxin was first isolated from contaminated groundnuts exported from Nigeria to Britain in the sixties. Limits are set at 0.003μg/litre or μg/Kg of aflatoxin which can be tolerated in a produce. Fungi also produce toxins called phytotoxins, against higher plants. Phytotoxins are non-specific, incite few or none of the symptoms that are incited by the pathogen and, as it is in most cases, show no relation between toxin production and pathogenicity. Examples of phytotoxins are Lycomarasmin, Collectin, Tentoxin and others are included on **Table 9**.

Table 9: Some Phytotoxin produced by fungi

Phytotoxin	Fungal Source	Host	Mechanism of Action in Plants
Altenuene	*Alternaria tenuis*	Tobacco	Inhibits glutamine synthase activity
Collectin	*Collectotrichum fuscum*	*Digitalis*	Disrupts cell permeability
Diaporthin	*Endothia parasitica*	Chest nut	Necrosis of the conducting vessels
Fusicoccin	*Fusicoccum amygdali*	Almond peach	Possesses growth regulatory properties causes stomata to open
Hm-T toxin	*Helminthosporium maydis* raceT	Maize	Swelling of mitochondria, alters membrane permeability
Lycomarasmin	*Fusarium oxysporium*	Tomato	Causes streptogenin deficiency, injures permeability of leaf cells
Ophiobolin A	*Helminthosporium oryzae*	Rice	Disrupts negatively phenol metabolism
Piricularin	*Pyricularia grisea*	Rice	Increases respiration, inhibits the enzyme peroxidase, catalase
Tentoxin	*Alternaria tenuis*	Cassava	Reduction in chlorophyll, inhibits photophosphorelation
Victorin	*Helminthosporium victoriae*	Oat	Damages permeability, increases respiration

Source: Mehrotra and Aggarawal (2007)

Mr Vice-Chancellor Sir, I have highlighted some of the beneficial and non-beneficial effects of fungi directly and in-directly on man. However, man has been able to turn most of the non-beneficial effect to beneficial or combat the harmfulness of fungi and make them 'friendly' to man. This has been possible because of the improved modern biotechnological techniques available. New pesticides, fungicides, antibiotics, fungal resistant plant varieties through genetic engineering are now available. Control measures of fungi are thus available commercially because of modern equipment.

MY HUMBLE CONTRIBUTIONS TO KNOWLEDGE

My research efforts cut across fungi as friends or foes, and making them a friend of man in situations of being a foe. The summary of my contributions is as follows:

Post-harvest Seed pathology

My Ph.D research work was on stored (Post -harvest) melon seeds (*Cucumeropsis mannii* Naud-holl) 'Egusi bara' under the supervision of Prof (Mrs) Uma. The healthy melon seeds (shelled)is beige (off white) and when diseased has assorted colours: creamy white, yellow-brown, dark-brown, reddish brown, grey, green, transparent and black wholly or spotted. Melon seeds are used in making the traditional 'egusi' soup in Nigeria. **Plate 4**

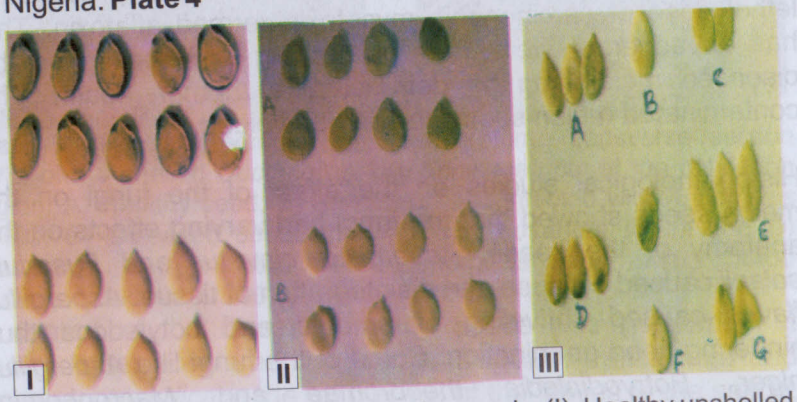


Plate 4:- Healthy and diseased melon seeds: (I). Healthy unshelled (A) and shelled (B) seeds of *Cucumeriopsis mannii*; (II). *Citrullus vulgaris* healthy unshelled (A) and shelled (B) seeds; (III). Diseased melon seeds showing some characteristic colour symptoms. Mag.X0.25 Source: Adekunle (1996).

It was found that the diseased melon seeds were more expensive and sometimes preferred because they were sweeter. This was investigated. Melon seeds were collected from the various states of Nigeria monthly for 15 months. It was discovered that the different colours were due to the presence of different fungi in the melon seeds. Nineteen

pathogenic fungi including eight species of *Aspergillus*, two species each of *Penicillium* and *Fusarium* and one each of *Absidia, Botryodiplodia, Curvularia, Macrophomina, Mucor, Rhizopus* and *Talariomyces* were isolated. I discovered that the fungi caused biochemical changes in the melon seeds, deteriorating and reducing their quality. The fungi all increased the carbohydrate (glucose) contents of the diseased seeds. This accounted for the sweetness of the seeds (Adekunle, 1996). All the fungi except *Aspergillus wentii* yielded slight increase in the protein content of the seeds. The quality and quantity of oil in the infected melon seeds were adversely affected by the lipase enzyme produced by the fungi. I discovered that the strains of *Aspergillus flavus* and *Aspergillus wentii* isolated from the melon seeds produced a lethal dose of carcinogenic mycotoxin termed aflatoxin. This has an adverse effect, thus purchasing and consuming the diseased melon can be detrimental to human health. The contaminated melon seeds should be avoided.

Histopathological studies on the effect of the fungi on the melon seeds showed that the fungi had varying effects on the anatomy of the seeds. *Aspergillus clavatus* and *Fusarium solanii* caused collapse and disintegration of tissue. *Aspergillus flavus* caused shriveling of embryo and cotyledons thus hindering seed germination. Some of the fungi like *Aspergillus niger*, *Botryodiplodia theobromae* and *Macrophomina phaseolena* produced black deposits, while others like *Fusarium solanii* produced oil globules within the tissue. **(Plate 5)**.

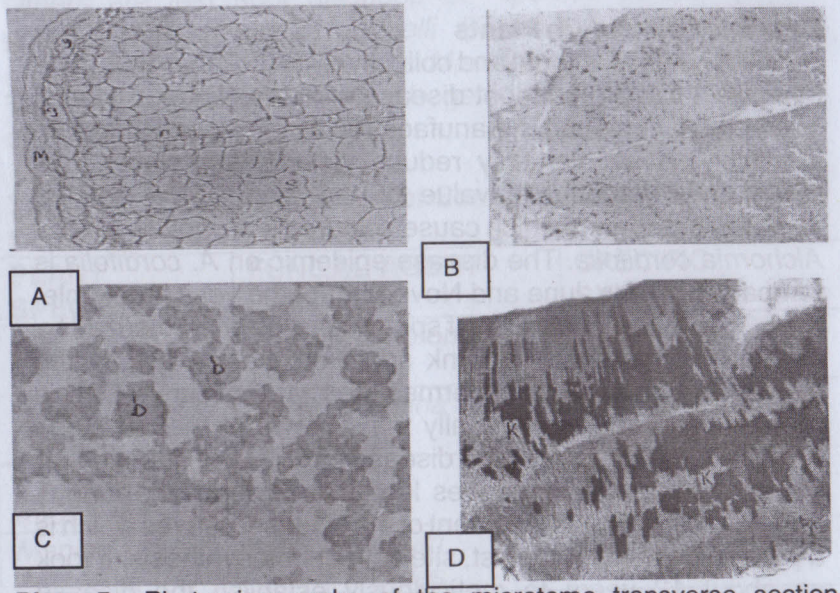


Plate 5:- Photomicrographs of the microtome transverse section (T/S) of the shelled *Cucumeropsis mannii* seed cut at the cotyledon region: A) Healthy seed; B) Diseased seed infected with *Aspergillus flavus*; C) Diseased seeds infected with *Fusarium solani* and D) Diseased seed infected with *Aspergillus niger* Mag. X400 Source: Adekunle, (1996); Adekunle and Uma (1997).

A control of the diseased melon seeds was performed. It showed that powdered dry leaf of *Ocimum gratissimum* and *Azadirachta indica* at the ratio of 1:2 of the leaves to the seeds, prevented infection of melon seeds for six months and promoted 100% germination. It was discovered experimentally that melon seeds were best preserved in the unshelled form at 40°c and a relative humidity of 55%.

The fungal disease of other seeds in Nigeria was studied by my research team which comprises colleagues and my post graduate students. The other seeds include millet (Adekunle and Ofodile, 2000), Sorghum, *Cucumis melo* variety *agrestis* ('Egusi wewe', Adekunle and Oluwo, 2008). These were first reports of these seed rots of fungal origin.

Leaf Spot Disease in Plants

I worked as an individual and collectively (in collaboration) with other scientist on leaf spot disease of some Nigerian plants. The leaf is where food is manufactured by the plants, therefore any blemish will certainly reduce yield of the plants thus reducing the economic value of the plants. We isolated *Taphrina deformans* which cause coloured leaf spot disease of *Alchornia cordifolia*. The disease epidemic on *A. cordifolia* is rampant between June and November of the year (Adekunle, *et al*, 2005). The coloured leaf spot disease is characterized by the initial appearance of pink spots on the leaves, as the disease progresses, an intermediate stage occurs which is brownish red and it eventually turns brown at the old stage (**Plate 6**). The colours of the disease brought the attention for the study. It made the leaves look like flowers. The fungus reduces the chlorophyll content of the diseased leaves which is a pigment in the chloroplast, site of the photosynthesis. It took us about 12 years to meticulously establish the disease pattern.

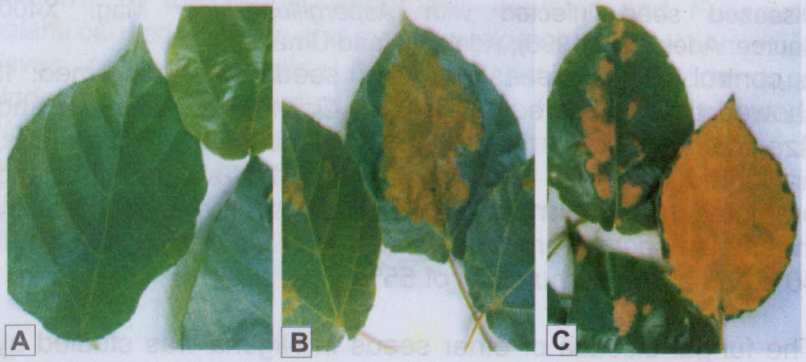


Plate 6:- Coloured leaf spot of *Alchornea cordifolia*: (A) Healthy leaves; (B) Diseased leaf spot showing the brown stage and (C) Diseased leaf showing the pink stage Mag X0.10 Source: Adekunle, et al (2005).

Others are leaf spot diseases of *Ipomea batatas* (Sweet potato), *Thomatococus danielli* ('Ewe moi-moi'), *Panicum maximum* (Guinea grass), and *Manihot esculenta* (Cassava). **Table 10** shows the list of pathogenic fungi causing leaf spot on plants we studied.

Table 10: Leaf Spot Disease of Some Plants and their Fungal Causal Agents

PLANT SPECIES	FUNGAL AGENT	SPECIFIC SYMPTOM
Alchornia cordifolia	*Tarphrina deformans*	Coloured leaf spot
Ipomea batatas	*Macrophomina phaseolina*	Black leaf spot
Panicum maximum	*Phyllachora boniriensis*	Tar leaf spot
Manihot esculenta	*Colletotrichum gloesporioides*	Apical leaf spot

Source: Adapted from Adekunle and Uma, 2000; Adekunle, 2005; Samuel and Adekunle, 2011

The knowledge of the various morphological and anatomical effects as well as infection process of a disease is very important in determining the disease control. Hence, we studied the histopathology of the fungus *Colletotrichum gloesporioides* on *Manihot esculenta* (Cassava) leaves (Adekunle and Uma, 2000). The fungus causes cassava apical leaf spot. We discovered that *C. gloesporioides* conidia germinated after 3-5 days post inoculations, produced appressorium 4-6 days, while penetration of the pathogen was through the upper epidermal cells. Fungal growth in the host cells was intercellular. The disease led to disintegration of the leaf cells, initial symptom of the disease, chlorosis, was noticed 10 days post inoculations and the affected areas became necrotic within the following 10 days. We also worked on the histopathology of fungi on *Glycine max* (Soy bean) seeds (Adekunle and Edun, 2001).

Antifungal Activity of Plants against Plant and Human Pathogens

Several studies were carried out on the purification of the antifungal principle from Nigerian plants. The active antifungal ingredient was tested on human fungal pathogens (dermatophytes) as well as on plant pathogens. It is always necessary to develop new natural drugs because of resistance to existing drugs by microorganisms like fungi. A survey of medicinal plants used in the treatment of skin rashes, eczema, athlete foot and ring worm in the South western, Nigeria was carried out. A medicinal plant list of 520 plant species with antifungal properties was documented (see **Table 11**). Phytochemical properties of some of the plant extracts were investigated and were found to contain, flavonoid, saponins, terpenes and tannins with fungicidal properties on dermatophytes such as *Epidermophyton floccosum, Mucor mucedo* (opportunistic), *Microsporium audonii,* and *Trichophyton verrucosum* (Adekunle, 2000 a and b; Adekunle, 2001; Adekunle, *et al*, 2005; Adekunle and Ikumapayi, 2006; Sowemimo, *et al.*, 2011).

Table 11: List of some medicinal plants used in treating fungal related skin diseases in Lagos State of Nigeria

Scientific Name	Vernacular Name Yoruba	Family	Plant Part Used
1. *Acalypha wilkesiana*	'Ewe lara Pupa'	Euphobiaceae	Leaves
2. *Ageratum conizoides*	'Ewe Adidin'	Guttiferae	Leaves
3. *Alchormes cordifolia*	'Egbo Ipa'	Euphobiaciae	Bark
4. *Allophylus africanus*	'Soko'	Sapindaceae	Leaves
5. *Aloe vera*	'Ahan Erin'	Liliaceae	Stem
6. *Alternanthera sessilis*	'Rekureku'	Amaranthacene	Leaves
7. *Amaranthus hybridus*	'Efo Tete'	Amaranthaceae	Leaves
8. *Annona senegalensis*	'Epo Ogorj'	Annonaceae	Bark
9. *Aregemone mexlcana*	'Ahon Ekun'	Paparaceae	Leaves, Bark
10. *Aristolochia ringens*	'Egbo Akoigun'	Aristolochiaceae	Leaves, Stem
11. *Asparagus*	'Aluki'	Asparagaceae	Bark
12. *Azoditolochia indica*	'Dogoyaro'	Meliaceae	Leaves
13. *Baphia nilida*	'Irosun'	Papilioniaceae	Leaves
14. *Brochystegia eurycoma*	'Epo Eku'	Caesalpinaceae	Leaves
15. *Caloncoba echicata*	'Ntueri'	Flacouniaceae	Leaves

Scientific Name	Vernacular Name Yoruba	Family	Plant Part Used
16. *Calortopis procera*	'Bomu Bomu'	Asleipiadaceae	Bark
17. *Carapa procera*	'Ireke'	Meliaceae	Leaves
18. *Carica papuya*	'Ewe Ibepe'	Caricaceae	Leaves
19. *Cassia alais*	'Asunwon	Caesaliniaceae	Leaves
20. *Cassia toria*	Oyingbo'	Caesalpiniaceae	Leaves
21. *Chasmantheradependers*	'Ako Rere'	Menispermaceae	Leaves
22. *Combrelum mlcrathum*	'Ato'	Combrefaceae	Leaves
23. *Crotolaric retusa*	'Ewe Okan'	Papilionaceae	Leaves
24. *Croton lobatus*	'Alatunnse'	Euphipbiaceae	Leaves
25. *Curcuma longa*	'Ewe Eru'	Zingibaceae	Leaves
26. *Cymbopogun citratlis*	'Gangamau'	Ponceae	Leaves
27. *Daniella oliverll*	'Ewe Tl'	Caesalpiniaceae	Leaves
28. *Dioclea reflexo*	'Ekan Iya'	Papilionaceae	Leaves
29. *Entada africana*	'Ewe Arin'	Mimosaceae	Leaves
30. *Euphorbia caterfora*	'Ayunre'	Euphobiaceae	Bark
31. *Jatropha curcas*	'Epo Opori'	Meliaceae	Leaves
32. *Khaya senegalensis*	'Ewe Lapalapa'	Cucurbitaceae	Leaves
33. *Lannea welwitschll*	'Ewe Oganwo'	Papilionaceae	Leaves, Stem
34. *Lonchocarpus sericeus*	'Orira'	Sterculiaceae	Bark
35. *Mansonla alttlsima*	'Elu'	Meliaceae	Leaves
36. *Mella azedarach*	'Ofun'	Rubiaceae	Leaves
37. *Mitragma stipulota*	'Ewe Oyinbo'	Rubiaceae	Leaves
38. *Morinda lucida*	'Abura'	Cucurbitaceae	Leaves, Bark
39. *Mormodica foetida*	'Oruwo'	Cucurbitaceae	Leaves
40. *Mormodica charactia*	Ewe Ejunrin'	Bignoniaceae	Leaves
41. *Nweboudia laevis*	'Ejinrin Weere'	Labiatae	Leaves
42. *Oclimum gratissimum*	'Akoko'	Rosaceae	Leaves
43. *Parinari macrophylla*	'Ewe Efinrin Gidi'	Piperaceae	Leaves
44. *Peperromia pellusida*	'Abere'	Papilionaceae	Leaves
45. *Pergularia extensa*	'Rinin'	Plumbaginacease	Leaves
46. *Piliostlgma recticularun*	'Ewe Jo Oyin'	Hyperrricaceae	Leaves
47. *Plumbagoz zeylanica*	'Abafe'	Papilionacease	Leaves
48. *Psorospernum rebrifugum*	'Ewe Inabir'	Rhizophoraceae	Leaves
49. *Pterocarpus crinaceus*	'Legun Oko'	Euphobiaceae	Leaves, Bark
50. *RhizophorarRacemosa*	"Osun Dudu'	Rhizophoraceae	Leaves
51. *Ricinus communis*	'Ewe Egba'	Euphobiaceae	Leaves
52. *Ratorzoipu vomitoria*	'Ewe Lara Pupa'	Apocynaceae	Leaves
53. *Smilax krailssiana*	'Asofeiyeje'	Smilacaceae	Leaves
54. *Sarcocephales esculentus*	'Ekan Magbo'	Rubiaceae	Leaves, Bark
55. *Sida acuta*	'Ewe Egbesi'	Malvaceae	Leaves
56. *Tephrosia densiflora*	Ise Ketu'	Papilionaceae	Leaves
57. *Terminalisa avicenoides*	'Lakuta'	Combretaceae	Leaves
58. *Tetracera alnifolia*	'Ewe idi'	Dillenaceae	Leaves
59. *Tetrapleura tetraptera*	'Ewe Opon'	Mimosaceae	Leaves

Scientific Name	Vernacular Name Yoruba	Family	Plant Part Used
60. *Trema quineesis*	'Ewe Aridan'	Moreaceae	Leaves
61. *Trema artentalis*	'Afe'	Moreaceae	Leaves
62. *Vernonia amygdalina*	Afefe' 'Ewuro'	compositae	Leaves

Source: Adekunle (2001)

The antifungal activity of four Nigerian chewing sticks from the stem or root of *Anogeissus schimperi* ('Ayin'), *Distemonathus benthmianus* ('Ayan'), *Vernonia amagdalina* ('Orin ewuro', bitter leaf) and *Zanthoxylum xanthoxyloides* ('Orin Ata') was also investigated. This experiment was set up to further scientifically support the use of chewing sticks in dental care by the Nigerian natives. It was found that the extracts of these chewing sticks were potent against fungi used (Adekunle and Odukoya, 2006).

Another study was carried out on the time of leaf harvest (in a 24 hour rhythm) and antifungal activity of *Acalypha wilkesiana* ('Lara pupa') leaf extracts (Adekunle, *et al.* 2011). *Acalypha wilkesiana* is used to treat skin rashes in babies ('Ela'). The Nigerian traditional medicine practitioners believe that plants sleep at night hence discourage people from harvesting the plants in the night between 7pm-5am for their medicinal purpose. However, our study discovered that the best period of harvest of the *Acalypha wilkesiana* leaf was 3am. The leaves harvested at 3 am had the highest concentration of corilagin and geranin which are the antifungal active ingredients hence had the highest zone of inhibition on the fungi. There was a definite change in the antifungal activity of extracts of *A. wilkesiana* leaves harvested at different times of the day (3am, 6am, 9am, 12noon, 3pm, 6pm, 9pm and 12 midnight). The least activity was recorded from leaves harvested at 12 noon. Our report did not agree with the claims of the Nigerian natives to harvest plants for medicinal purpose only during the day light (**Table 12**) in the case of *Acalypha wilkesiana* leaf.

TABLE 12: Antifungal activity of Crude Extracts from the Leaf of *Acalypha Wilkesiana* Harvested at different Times Within a 24 Hour Regime

Fungi		ZONE OF INHIBITRION (MEAN ± S.E mm') PRODUCED BY EXTRACTS							
Extracts or solution time of harvest		*Aspergillus flavus*	*Aspergillus fumigatus*	*Aspergillus niger*	*Candida albicans*	*Microsporium audonii*	*Penicillium chrysogenum*	*Rhizopus sp*	*Trichoderma viride*	*Trichophyton mentagrophyte*
Control (distilled water)		0.00 ± 0.00 a	0.00 ± 0.00 a	0.00 ± 0.00 a	0.00 ± 0.00 a	0.00 ± 0.00 a	0.00 ± 0.00 a	0.00 ± 0.00 a	0.00 ± 0.00 a	0.00 ± 0.00 a
Fulcin		18.60 ± 0.49 b	18.50 ± 0.23 b	18.50 ± 0.8 b	17.50 ± 0.11 b	18.40 ± 0.16 b	18.60 ± 0.86 b	18.60 ± 0.23 b	18.40 ± 0.57 b	18.60 ± 0.65 b
Nystatin		17.50 ± 0.38 b	17.60 ± 0.65 b	17.60 ± 0.92 b	17.70 ± 0.65 b	17.80 ± 0.95 b	17.60 ± 0.97 b	17.65 ± 0.49 b	17.40 ± 0.88 b	17.60 ± 0.83 b
3am	Boiled water	17.60 ± 0.16 b	18.50 ± 0.67 b	17.90 ± 0.32b	18.00 ± 0.49 b	18.60 ± 0.45 b	17.50 ± 0.31b	17.00 ± 0.19by	17.90 ± 0.14b	18.70 ± 0.27 b
6am	Boiled water	14.90±0.17 h	15.20±0.2 9e	14.30±0.22 e	14.80±.21e	15.10±0.60 e	15.90±0.24 e	15.80±0.4 9e	14.90±0.71 e	15.40±0. 65e
9am	Boiled water	14.20±0.22 g	13.10±0.1 3g	13.80±0.92 g	14.70±0.61 g	13.90±0.67 g	13.70±0.38 g	13.90±0.4 5g	13.30±0.28 g	13.60±0. 75g
12pm Noon	Boiled water	11.20±0.34 h	12.70±0.2 5gh	12.10±0.44 gh	11.80±0.72 h	12.40±0.31 gh	12.80±0.89 gh	11.60±0.5 2h	11.80±0.54 h	11.40±0. 71h
3pm	Boiled water	14.60±0.20 km	13.70±0.1 8k	13.40±0.78 k	14.80±0.53 m	14.10±0.41 km	14.30±0.54 km	14.70±0.4 3m	14.60±0.95 km	14.50±0. 46

6pm	Boiled water	14.50±0.59 k	14.10±0.7 1km	14.80±0.12 m	14.20±0.58 km	14.30±0.21 km	14.50±0.49 km	14.90±0.5 5m	14.90±0.93 m	14.80±0. 32m
9pm	Boiled water	14.90±0.26 m	14.70±0.3 1m	15.40±0.32 mp	15.30±0.82 mp	15.60±0.74 mp	15.30±0.84 mp	14.60±0.2 6km	15.70±0.36 mp	15.50±0. 94mp
12am mid-night	Boiled water	15.80±0.86 p	16.70±0.4 4p	16.30±0.78 p	16.70±0.21 py	16.80±0.14 py	15.80±0.88 p	16.30±0.4 3p	15.80±0.62 p	15.60±0. 83p

*Mean of 3 replicates for 3 years

Samples with similar letters show no significant difference at P=0.01, Samples with different letters show significant difference at p=0.01

Source: Adekunle *et al.*, 2011

The efficacy of preserving plant seeds against fungi using wood ash of some tropical trees in Nigeria was also carried out (Oguntade and Adekunle, 2010). The wood ash of nine Nigerian trees, *Khaya grandifolia, Nauclea diderrichi, Piptadeniastrum africanum, Mangifera indica Mansonia altissima, Triplochiton scleroxylon, Ceiba pentandra, Terminalia superba* and *Terminalia ivorensis* were used to preserve seeds (beans, maize and melon). The seeds stored with ashes of *Nauclea diderrichi* and *Piptadeniastrum africanum* were the most effective stopping fungal growth and eliminating weevils. The wood ashes used compared favourably with the orthodox fungicides benlate. The woodash of these plants contained flavonoids and tannins which stop fungal infection and preserve the seeds.

Environmental Hygiene

I conducted a study on the environmental hygiene of the University of Lagos Akoka campus. The fungal flora (airspora) of the air in 21 eating places on the University of Lagos Akoka campus (Adekunle, 2001) was investigated using culture plate method for a period of six months. I found that no two sites had identical types of fungi. Twenty-six sporulating fungal species were isolated. Some of the fungi isolated (*Aspergillus flavus, Alternaria, Curvularia and Fusarium solani*) are known to cause allergies, asthma, eye irritations and also could be opportunistic in nature causing diseases (mycosis) in man. Sanitary conditions in the eating places on campus were quite poor, they were neither washed with disinfectant nor fumigated before or during the survey (**Table 13**).

Biological Control of Plant Pathogen and Plants

Studies were carried out on the biological control of the fungus *Ceratocystis paradoxa* causing black seed rot in oil palm sprouted seeds using another fungus *Trichoderma* species. It was found that four species of *Trichoderma*: *T.viride, T. polysporum, T. hamatum* and *T.autoviride* had the ability to control the growth of *C.paradoxa* in culture plates. Volatile metabolites of each of the *Trichoderma* spp were collected in

sterile Potatoe dextrose agar plates and then inoculated with *C. paradoxa*. Lyophilized and non-lyophilized phytotoxins produced from the *Trichoderma* species were investigated against *Ceratocystis paradoxa* mycelial growth at different concentrations in vitro. The lyophilized phytotoxin exhibited better control of *C. paradoxa* compared with non-lyophilized and control treatment (using benlate). Using gas chromatography- mass spectrometry, column fraction isolated from *T.viride* Rf value 0.51 was deduced to be **1,2benzendicaboxylic acid (Figure 1).** *Trichoderma viride* is therefore a potential biocontrol agent for the oil palm seedling disease caused by *Ceratocystis paradoxa* (Eziashi *et al*, 2006 a and b; Eziashi, 2008; Eziashi *et al,* 2010). This is a major contribution to the development of oil palm plantations in Nigeria.

Table 13: Occurrence of isolated fungi in twenty-one eating places sampled for six months on the University of Lagos Campus

	Fungi	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	*Absidia cylindrosporoides*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	*Alternaria alternate*	+	+	+	+	+	-	-	+	-	-	+	-	-	+	+	+	+	-	-	-	-
3	*Aspergillus flavus*	+	+	+	+	-	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	-
4	*Aspergillus fumigatus*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-
5	*Aspergillus niger*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-
6	*Aspergillus oryzae*	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+	-	-	-
7	*Aspergillus tamari*	+	+	-	+	+	-	+	+	+	-	+	+	+	+	+	+	+	+	+	-	-
8	*Aspergillus wentii*	+	+	-	+	+	+	+	-	+	+	+	-	+	+	+	+	+	+	-	-	-
9	*Bipolaris maydis*	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
10	*Cladosporium cladosporoides*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+
11	*Curvularia lunata*	+	+	+	+	+	+	+	+	+	+	+	-	+	+	-	+	+	-	+	-	+

12	*Curvularia inequalis*	-	-	+	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	+	-	-
13	*Fusarium solani*	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	+
14	*Mamamria echinobotryoides*	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-
15	*Mucor hlemalis*	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
16	*Nectria ventricosa*	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
17	*Neurospora*	-	-	+	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+	-	-	-
18	*Paeciliomyces farinose*	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19	*Pencillium canescens*	-	-	-	+	+	+	-	-	+	+	+	+	-	-	+	-	-	-	-	-	+
20	*Pencillium chrysoegnum*	-	-	+	+	+	+	+	+	+	+	+	+	-	-	+	+	-	-	+	+	+
21	*Pencillium digitatum*	-	-	+	+	+	+	-	+	-	+	+	-	-	-	-	-	+	-	-	+	+
22	*Pencillium pinophylum*	-	-	+	+	+	+	-	+	-	+	+	-	-	-	-	-	+	-	-	-	+
23	*Phoma eupyrema*	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	*Rhizopus oryzae*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	+	+	-	-
25	*Trichoderma*	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	viride																					
26	*Zygorhychus moelleri*	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	No. of Sterile fungal colonies	3	2	2	-	2	3	4	-	5	3	4	4	-	3	3	3	4	3	3	2	2
Total	No. of fungal colonies	76	63	95	127	105	105	90	71	105	98	175	217	86	100	107	116	84	71	68	25	48

KEY: + = Isolated;- = Not isolated; 1 = Amina Hall Buttery; 2 = Aunty's Corner; 3 = Bamboo Box; 4 = Business Admin. Buttery; % = Education Bukateria; 6 = Engineering Bukateria; 7 = Engineering Burtery; 8 = Eni Njoku Buttery; 9 = George's Restaurant; 10 = Guest Houses; 11 = Henry Carr Buttery; 12 = Jaja Hall Buttery; 13 = Law Faculty Buttery; 14 = Madam TInubu Buttery; 15 = Makama Bida Buttery; 16 = Mariere hall Buttery; 17 = Matthew's Bukateria; 18 = Moremi Hall Buttery; 19 = QSS Fast Food Centre; 20 = Sharon Restaurant; 21 = Subsidy Restaurant

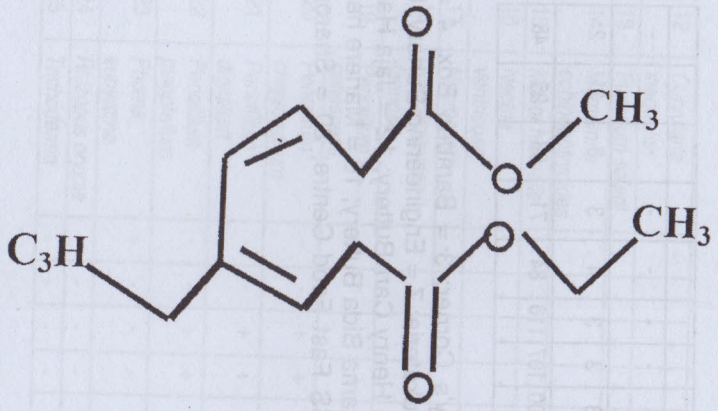


Figure 1:- The structure of **1,2 benzendicaboxylic acid** a biocontrol agent isolated from the fungus *Trichoderma viride* on oil palm seedling. Source: Eziashi (2008); Eziashi *et al* (2010).

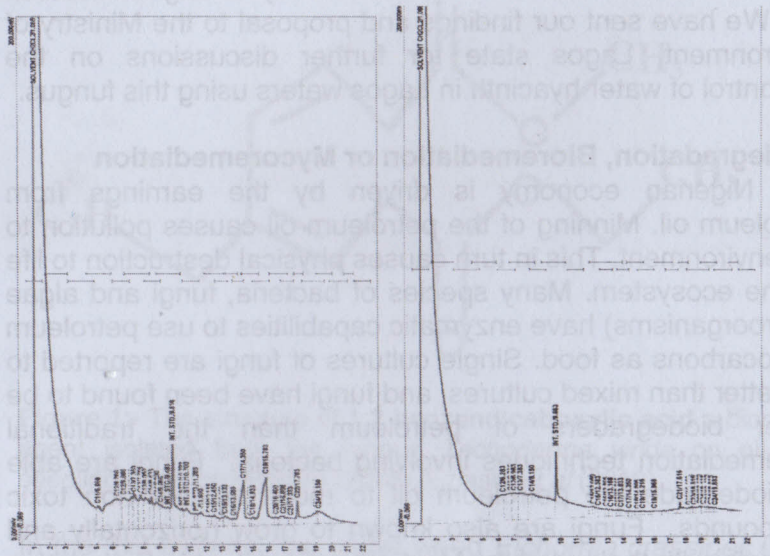
In the mid eighties, the water weed *Eichornia crassipes* (water hyacinth) appeared in the Lagos lagoon especially around Badagry area of Lagos. Water hyacinth became a nuisance along the Nigerian coastline and thus drew the attention of the federal and state governments. A lot of methods were used to curb the menace of this weed but they were fruitless. The weed comes yearly when the salinity of the lagoon is low to a level and it is usually between October and February. Some scientists imported fungi from outside the country known to destroy the weed but these fungi did not control the weed in Nigeria. In 2002, I set out with other colleagues in the Department of Biochemistry, Prof Gbenle, Dr Osuntoki and Dr Okunowo, to study the fungal pathogens of water hyacinth. This effort led to the isolation of a pathogenic fungus called *Myrothecium roridum* (Okunowo *et al*, 2008, 2010 a&b).This fungal pathogen is able to destroy the water hyacinth, 'eat up' the whole plant, within 5 days post inoculation on the leaves. The fungus can thus control the water hyacinth. The fungal action is systemic and host specific. On further investigation we isolated and purified a phytotoxin and mycoherbicide from

M. roridum. With this discovery in 2006, we won the Faculty Best Researcher's Award at the University of Lagos research fair. We have sent our findings and proposal to the Ministry of Environment, Lagos state for further discussions on the biocontrol of water hyacinth in Lagos waters using this fungus.

Biodegradation, Bioremediation or Mycoremediation

The Nigerian economy is driven by the earnings from petroleum oil. Minning of the petroleum oil causes pollution to the environment. This in turn causes physical destruction to life on the ecosystem. Many species of bacteria, fungi and algae (microorganisms) have enzymatic capabilities to use petroleum hydrocarbons as food. Single cultures of fungi are reported to be better than mixed cultures, and fungi have been found to be better biodegraders of petroleum than the traditional bioremediation techniques involving bacteria. Fungi are able to biodegrade the petroleum oil to much smaller non toxic compounds. Fungi are also known to grow horizontally and vertically with their mycelia. Most reports on the biodegradation or bioremediation using fungi have been mainly on fungi isolated from soil or aquatic environment. Other sources of fungi in biodegrading petroleum oil include, cow dung, phyloplane, poultry litter, keratin, hair, nails, osmophilic solutions and mushroom as a fungus. We conducted a research to source fungi capable of biodegrading petroleum oil from some Nigerian oilseeds such as soybean, maize, melon, *Detarium senegalense*, *Treculia africana*, and *Irvingia gabonensis* ('Ogbonno'). We discovered that the pathogenic fungi isolated from the oil seeds were capable of biodegrading the petroleum oil within 40 days. The oilseeds contain triacylglyceride which is the vegetable oil hydrocarbon and it is biodegradable by the pathogenic fungi. This group of fungi was also able to biodegrade the hydrocarbon in the petroleum oil (Adekunle and Oluyode, 2005; Adekunle and Adebambo, 2007; Adekunle and Oluyode, 2011). **Figure 2** shows the Gas chromatogram of the fungus *Paeciliomyces* isolated from *Treculia africana* which biodegraded the hydrocarbons in the petroleum crude oil compared to the control (crude oil without

fungi), using up some carbon atoms (C_{12}-C_{24}) after 40 days of incubation.



A B

Figure 2:- Total hydrocarbon chromatogram content for the growth of *Paecilomyces* Sp in Mineral salt solution and crude oil after 40 days incubation: (A) Chromatogram of the control, without the fungus (B) Chromatogram of the experimental, with the fungus. Peaks C_{12}-C_{24} were completely absent, except C_{21} that was only reduced in the experimental. Source: Adekunle and Adebambo (2007); Adekunle and Adeniyi (2011).

We also used some Nigerian mushrooms (macrofungi) in the biodegradation of petroleum products (Adekunle *et al*, 2011). A collection of mushrooms in the Lagos area was made for up to 4 years (**Plate 7**). The mushroom, *Ganoderma lucidum* and *Ganoderma applanatum,* biodegraded petroleum crude oil, diesel, spent and unspent engine oil. The gas chromatogram showed that *Ganoderma lucidum* used up some carbon atoms (C_3-C_{24}) after 40 days of incubation. The mycelium of these mushroom are able to breakdown organic pollutants like the polycyclic aromatic hydrocarbons (PAH) found in petroleum oil. The mushroom mycelium releases enzymes that breakdown

long polymer chains into their basic subunits, such as sugars which can then be absorbed through hyphal walls.

Plate 7:- Mushrooms used in the biodegradation process (Collected in Lagos State): A) *Ganoderma lucidum,* B) *Pleurotus species,* C) *Ganoderma applanatum,* D) *Polyporus sulphureus,* E) *Polyporus versicolor,* F) *Lycoperdon pyriforme,* G) *Paxillus species,* H) *Pholiota squariota,* I) *Mycena galericulata,* J) *Macrolepiota species,* K) *Pleurotus ostreatus,* L) *Boletus edulis,* M) *Ganoderma adspermum,* N) *Corticum gigantean,* O) *Polyporus perplexus.*
Source: Adekunle et al (2011)

Other Drug Discovery from Fungi or Plants Infected with Fungi

The potential of alkaloids from *Panicum maximum* floret infected with the fungus *Tilletia ayresii* in the control of uterine contraction was investigated using bioassay guided fractionation technique. Our aim of conducting this research was to discover cheaper and easily accessible drugs of Nigerian origin (from Nigeria or tropical plant) for controlling uterine contraction, which led to expulsion of placenta and subsequent control of bleeding after childbirth. The only source of the uterine contraction drug, ergometrine or ergot alkaloids before our study was from ergot of rye, a temperate plant that cannot grow in the tropics, Nigeria inclusive. Hence, it is imported with scarce foreign exchange. Ergot of rye is an infected rye floret by the fungus *Claviceps purpurea*. *Claviceps purpurea* infects the ovary of its host, rye, just as *Tilletia ayresii* infects the ovary of its own host, *Panicum maximum* (Guinea grass), a tropical plant found in Nigeria. We discovered an alkaloid as the active ingredient responsible for the uterine contraction in rats, from infected *Panicum maximum* floret purified extract (Kanife, 2011). This discovery has been registered as a patent with the National office of Technology Acquisition Promotion agency (NOTAP), See **Plate 8.**

Plate 8:- *Panicum maximum* florets. (A) Healthy florets (B) Infected florets with the fungus *Tilletia ayresii*. Source: Kanife (2011)

Fungal Taxonomy and Biodiversity

One of our most recent research is the isolation and documentation of dermatophytes (fungi associated with human skin) from patients in tertiary health institutions in Lagos State within a 2 years study. Most of the documented dermatophytes are reports from America and Europe. We also examined their drug resistance to existing orthodox drugs. One of the problems of curing dermatophytes is correct identification (fungal taxonomy) to determine the appropriate type of medication to employ. Currently, there is no single drug with broad spectrum activity that can be antagonistic to all the species of dermatophyte within the human population. There are only 3 genera of identified dermatophytes with up to 30 species in literature. We reported 10 new species with several new strains using morphological (light and electron microscopy SEM), DNA sequencing methods and resistance to antifungal agents. **Plate 9** shows human mycosis: infections of the nail, feet, skin and other parts of the human body, and also the photomicrographs of fungi isolated.

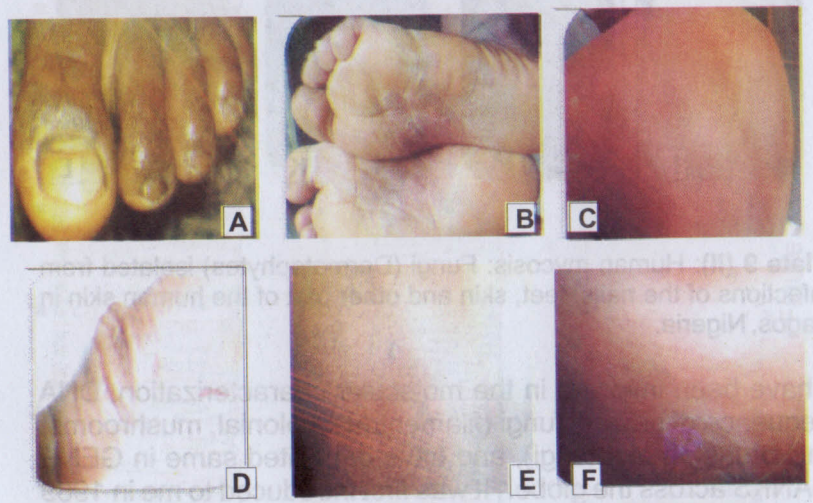


Plate 9 (I): Human mycosis: Fungal infections of the nails, feet, skin and other parts of the human skin, in Lagos Nigeria.

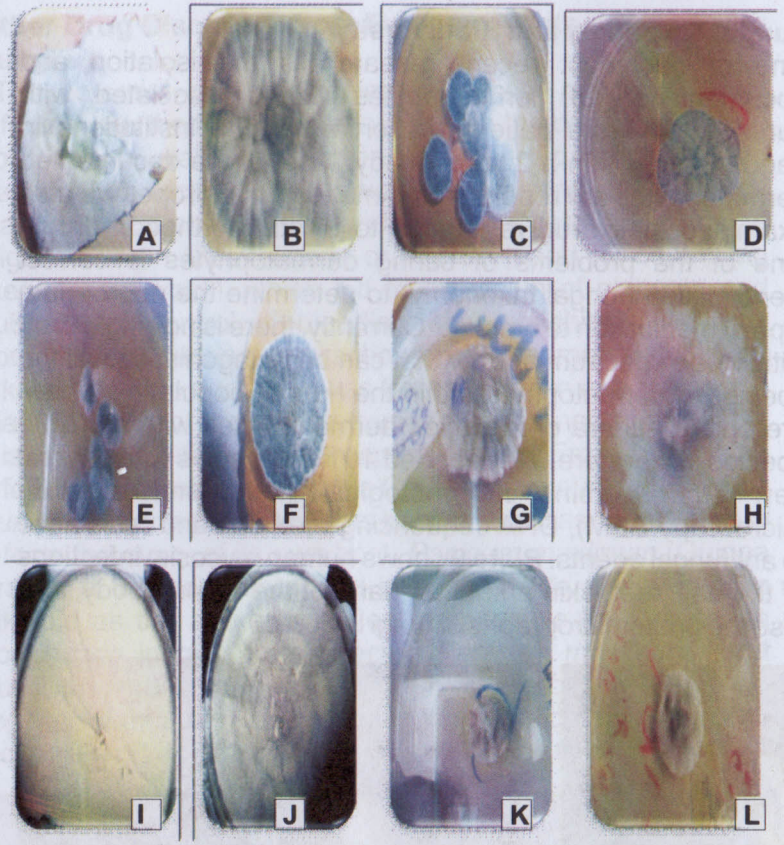


Plate 9 (II): Human mycosis: Fungi (Dermatophytes) isolated from infections of the nails, feet, skin and other part of the human skin in Lagos, Nigeria.

I have been involved in the molecular characterization, DNA sequence of several fungi (filamentous, colonial, mushrooms, microfungi, macrofungi), and have deposited same in GENE BANKS across the globe. It was first introduced to me in 1989 by Dr A. T. Owolabi of the University of Calabar when he came back from a post doctoral study in Germany. The DNA sequence which is a biotechnological tool is the most accurate

data to identify a fungus. Some of the sequence data of some fungi we worked on are found in **Figure 3**.

Figure 3a: The raw sequence data of some fungal isolates

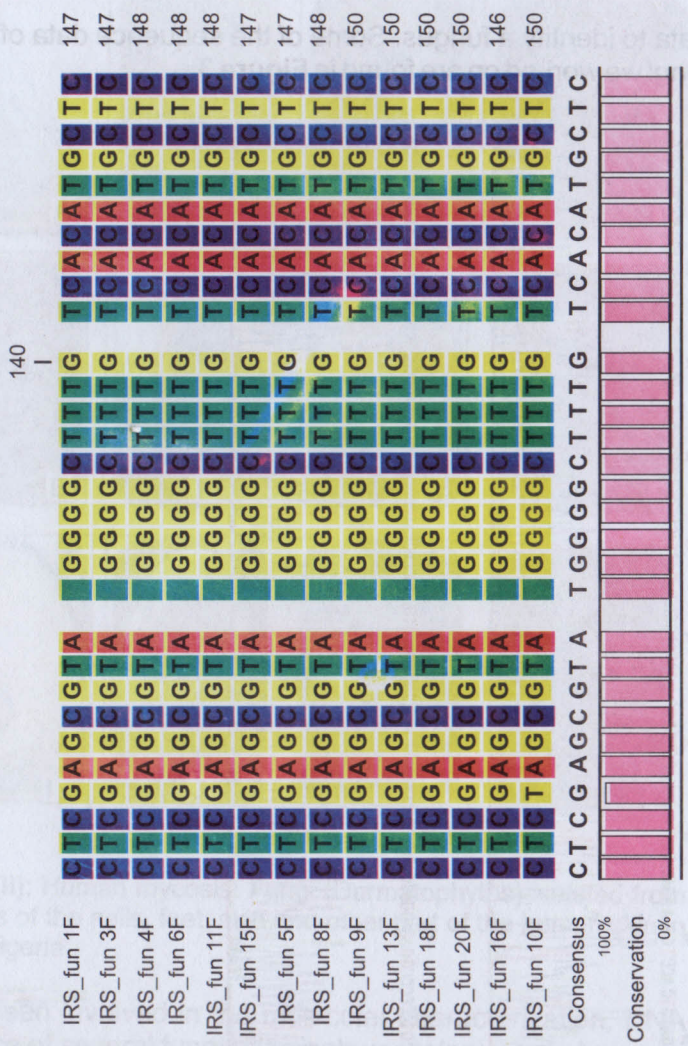


Figure 3b:- Sequence alignment for some fungal isolates using "ITS" primer.

My current research include biotransformation of biowaste to valuable products (Biofuel- bioethanol, biodiesel, biogas production) using fungi, yeast. The shelf-life and effect of fungi on local coloured dyes used in dying Nigerian native clothes

like 'Aso oke', 'Adire' is also being investigated. This is to improve on the preservation of these dyes and to add value to the native cloth. In addition, I am also investigating the semantides (DNA sequence) of Nigerian mushrooms. The use of Nigerian mushroom (macrofungi) in the cure of cancer, and malaria is another area my research is on in ethnobotany. I am equally involved in the investigation of fungal diseases of phytoplanktons (Plant pathology of phytoplankton or algae) in coastal areas of Rivers and Bayelsa States, Nigeria. I am also studying the aquatic fungi from some Nigerian streams that can be used in the biodegradation of industrial effluent.

Mr Vice-Chancellor Sir, in conclusion, these are my contributions in mycology, making fungi friends of man voluntarily or compulsorily scientifically. Fungi are indeed friends to humans. Other aspects of my contribution to research efforts in plant science will be out of context in this inaugural lecture.

RECOMMENDATIONS

1. The tropical Africa has more diversity of fungi than the temperate world, hence the need to establish fungi collection centre in Nigeria. There is only one recognized fungi collection centre in Africa, situated in South Africa, established in 1885. A fungal collection centre is necessary because confirmation of fungal identification which is absolutely essential in the study of fungi cannot be done here. Cultures are usually sent to America or United Kingdom. It used to be free, but now fungal confirmation attracts heavy fees (in foreign currency). The usefulness of the culture collection centre cannot be over emphasized.

2. Encouragement of research through financial reward will definitely encourage researchers in their work. We can learn from the South African model whereby a published paper in specified journal is rewarded with about R10,000 (about ₦200,000) per article to the University by the Federal Government. It is credited into the researchers account managed by the University. The researcher then draws from this fund for other researches and is also scored points. This has enhanced research in South Africa. I am convinced that it is possible in Nigeria, even with a lower amount than the ₦200,000 per article.

3. There is an urgent need to establish a functional central laboratory for research in the University. I know that the construction of a building for this purpose is ongoing and the University is commended for this. Equipments needed for research such as electron microscope (SEM and TEM), NMR spectrometer, modern Gas chromatography / Mass spectrometre etc, which can be used across disciplines. By having a functional central laboratory we will have more research output that will promote the University of Lagos further than we can imagine.

4. It is necessary to promote and establish functional scholarship awards for post-graduate studies in all disciplines, no discipline is minor. There should be manpower training and retraining programmes sponsored by the State and Federal Governments for academics. There is need to build human capital needed for the survival of the Nigerian University system, instead of recycling. If not, a day will come when there will be nothing to recycle.

5. The need to build accommodation for both members of staff and students cannot be over emphasized. One of the greatest problems in Lagos is accommodation, and there is so much competition for the little accommodation within the city. Mr. Vice Chancellor, Sir, friends and alumni of the University can be approached to assist in building more campus accommodation for members of staff and students. In addition acquisition of land for members of staff around and within the city will also help. All this will definitely increase productivity of students and staff.

6. Research in Science without electricity is impossible. I appreciate the effort of the University in providing electricity. However, I strongly recommend that the University of Lagos generates its own electricity and cease to depend on public power supply that could be very epileptic. I am sure it is possible the University generate its own electricity at a cheaper cost to the public supply, and also contributes or sells to the public. The University can generate electricity from gas (setting up a turbo engine); from water by creating artificial fall (the University is surrounded by water); from vegetable waste (Lagos generates huge amount of waste that can be annexed) fungi will be useful in this regard. Solar panels can be provided to some building or the roof is converted to solar panels as is done in Japan. This can be done gradually but consistently until result is achieved.

ACKNOWLEDGEMENTS

Mr Vice-Chancellor Sir, I am grateful to the Almighty God, the Maker of heaven and earth, the Owner of the Universe for spearing my life and making all achievements possible. Praise to His Holy name, Amen.

My appreciation goes to my parents Late Pa Simon Peter Oladeleola Adekunle and Mrs Comfort Apelara Adekunle for having thought it wise for me to be educated, for their love and support financially, physically and spiritually. I thank God for my parents-in-law Dr Adedayo and Mrs Roseline Abijo who accepted me as a son rather than a son-in-law. They have made life very easy for me. This is greatly appreciated.

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My thanks go to my M.Sc and Ph.D project supervisor Prof (Mrs) N.U.Uma who shaped my path in mycological research. I also acknowledge Prof D.I. Nwankwo who was my project supervisor during my BSc degree programme. When I became a lecturer, he gave me useful advice on how to conduct

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