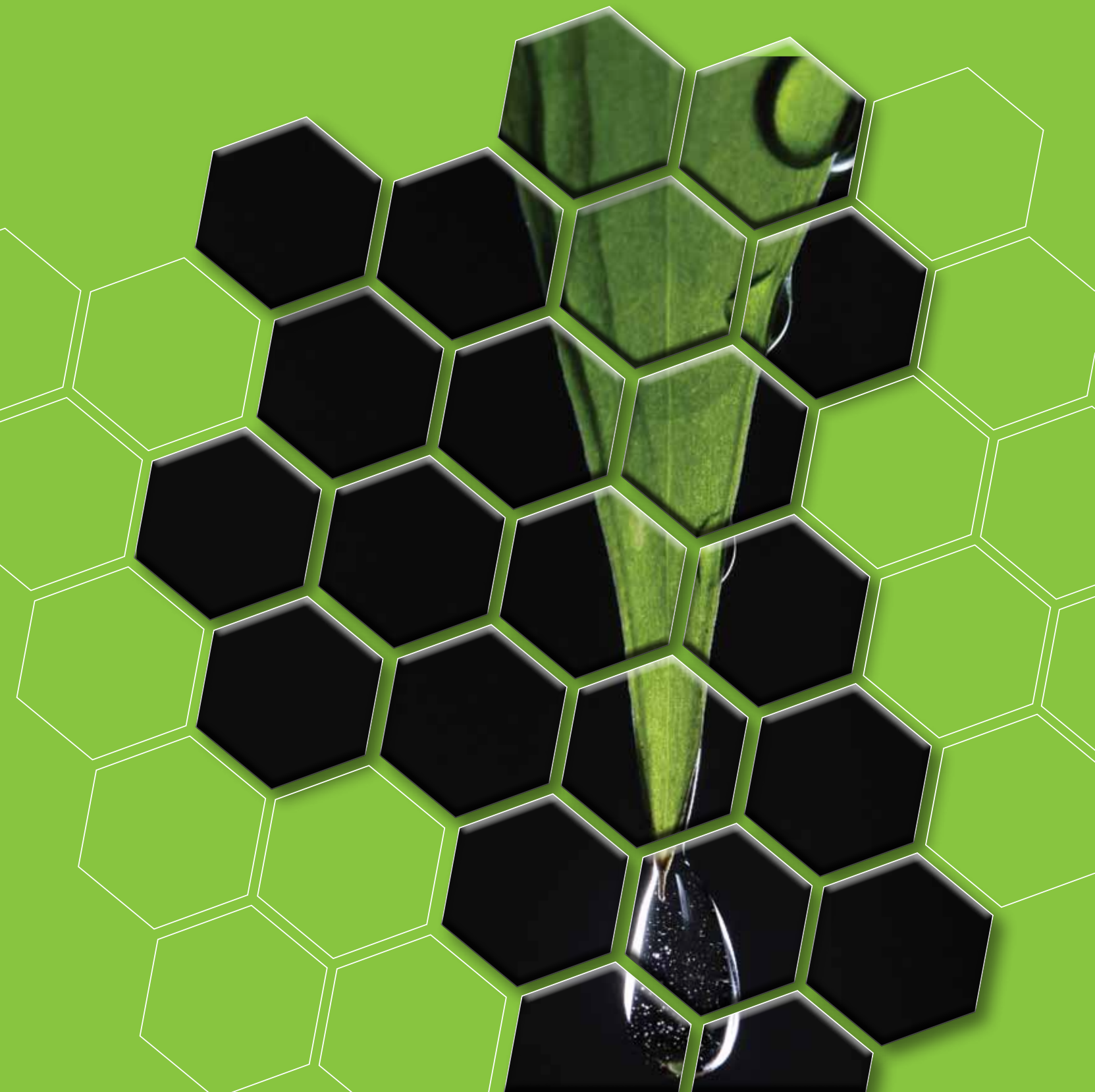
AGRONOMY



Stephen Oluwaseun Amoo
University of KwaZulu-Natal
Mentor: Prof J van Staden
Broad research area: Plant biotechnology and ethnobotany
Specific research field: Plant biotechnology, secondary metabolite production and their biological activity

Purpose of study:
The increasing population growth rates in many developing countries has resulted in the over-exploitation of our plant resources, habitat change and habitat loss, all of which have become threats to the survival of many plant species, especially the endemic ones. Many of such species are used in traditional medicine and could contain pharmacologically active compounds and/or genes useful in plant improvement or biosynthesis of new compounds. The current study involves using a biotechnological approach towards the conservation of such threatened and endemic species. The phytochemical constituents and pharmacological activities of some of these medicinal species are being evaluated in addition to investigating the effect of long-term storage

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Ponnusamy Baskaran
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Mentor: Prof J van Staden
Broad research area: Plant biotechnology
Specific research field: In vitro studies, genetic improvement and secondary product analysis in imperitive medicinal plants in South Africa

Purpose of study:
Important South African medicinal plants such as *Merwilla plumbea (Lindl.)* Speta*, Drimia robusta* (Baker), *Eucomis autumnalis* (Mill.) *Chitt, Alepidea amatybica* (Eckl.) and Zeyh and *Agapanthus praecox* (Willd) were selected for in vitro experimental studies. In vitro techniques are being developed for the high-frequency rapid propagation of these species. Seeds were decontaminated and pretreated with GA_3 and subsequently transferred to different media for in vitro germination. Different explants of *M. plumbea*, *D. robusta*, *E. autumnalis*, *A. amatybica, A. praecox, Coleonema pulchellum* (I.Williams) and *Buxus macowanii* (Oliv.) were obtained from in vitro seedlings and field grown plants are being used. Various concentrations and combinations of plant growth regulators (PGRs), amino acids and additives are being investigated for high-frequency rapid micropropagation, organogenesis and somatic embryogenesis. Different concentrations and combinations of auxins are being examined for adventitious root formation from different explants. In vitro regenerated plants and adventitious roots will be used to test for the presence of active ingredients and pharmacological activity.

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Alana Den Breeyen
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Mentor: Dr C Lennox
Broad research area: Post harvest pome diseases
Specific research field: Incidence and epidemiology of bull's eye rot of apples in the Western Cape

Purpose of study:
Bull's eye rot (BER) can be caused by different species of *Neofabraea* including *Neofabraea malicorticis, Neofabraea perennans* and *Neofabraea alba.* In South Africa three 'outbreaks' of BER were recorded in the 1960s, the 1980s and recently in 2008/2009. *Neofabraea alba* was identified as the main pathogen of bull's eye rot of stored apples from Ceres and Grabouw. Although bull's eye rot is one of the major postharvest decays of apples in the US and the UK, very little is known about the causal agent, distribution, incidence and epidemiology of BER in orchards and under storage conditions in South Africa.

Fruit can be infected in the orchard at any time during the growing season, and spores or incipient infections remain latent until the development of symptoms after three to five months of postharvest storage. Initial small, brown circular lesions become larger and are flat to slightly sunken, dark brown, often with concentric light brown and tan rings giving it a target appearance, hence the term bull's eye. Rotted tissues are relatively firm and fruiting bodies are often present in older lesions under humid conditions as wet, cream-coloured masses. Lesions occur most frequently at lenticels but they also occur at wounds and around the stem or calyx.

Neofabraea alba is associated with dead bark on *Malus spp.* as a harmless saprophyte, or causing anthracnose of leaves and twigs, and rot of apples and pears. Symptoms are more severe in years with frequent rainfall just before or at harvest because conidia are rain-dispersed, and preharvest rains reduce the resistance of the fruit to infection. Infected fruit left on the orchard floor contribute

to an increase in inoculum. There is a dearth of information on the ability of *N. alba* to produce cankers on apple trees. Determining whether *N. alba* can form cankers on apple trees in South Africa and under which conditions is important as cankers are a potential source of inoculum for infection in the orchards. Further knowledge on the distribution and epidemiology of the BER in the orchards will lead to improved and targeted control recommendations for pome fruit producers and packhouses in South Africa

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Ashwell Ndhlala

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Mentor: Prof J van Staden

Broad research area: Plant biotechnology

Specific research field: Pharmacological properties of a Zulu herbal mixture: *Imbiza ephuzwato*

Purpose of study:

Imbiza ephuzwato is a traditional herbal tonic made from a mixture of extracts of roots, bulbs, rhizomes and leaves of 21 medicinal plants and is used in traditional medicine as a multipurpose remedy. The aim of the project was to compile and investigate the bioactivity and mutagenic effects of the herbal mixture as well as the extracts of the 21 plant species used in its preparation. Petroleum ether (PE), dichloromethane (DCM), 80% ethanol (EtOH) and water extracts of the 21 plants were evaluated against two Gram-positive, two Gram-negative bacteria and a fungus *Candida albicans.* The extracts were also evaluated for their inhibitory effects against cyclooxygenase (COX-1 and -2) and acetylcholinesterase AChE enzymes. Mutagenic effects of the water extracts were evaluated using the Ames test. *Gunnera perpensa* and *Rubia cordifolia* were the only plant species used to manufacture *Imbiza ephuzwato* that had water extracts which showed good antibacterial activity. The extracts of *Gunnera perpensa* (EtOH), *Hypericum aethiopicum* (DCM) and *Urginea physodes* (EtOH) showed the best antifungal activity. The water extracts of *Hypericum aethiopicum, Gunnera perpensa, Drimia robusta, Vitellariopsis marginata, Scadoxus puniceus* and *Momordica balsamina* showed percentage inhibition of COX-1 that was over 70%. For COX-2 enzyme the water extracts of *Gunnera perpensa, Cyrtanthus obliquus, Momordica balsamina* and *Tetradenia riparia* exhibited inhibitory activity above 70%. Water extracts of *Gunnera perpensa, Cyrtanthus obliquus, Vitellariopsis marginata, Asclepias fruticosa* and *Watsonia densiflora* showed good AChE inhibitory activity (> 80%). The Ames test results revealed that all the water extracts of the 21 plant species used to make *Imbiza ephuzwato* were non-mutagenic towards the *Salmonella typhimurium* TA98 strain for the assay with and without S9 metabolic activation. In contrast, *Imbiza ephuzwato* showed mutagenic effects after exposure to S9 enzyme mixture. The observed activities of some plant extracts, if supported by other confirmatory tests, may justify their inclusion in the make-up of *Imbiza ephuzwato* herbal mixture as well as their use in traditional medicine. Further studies aimed at investigating possible synergistic effects as a result of mixing plant extracts are necessary. The reported mutagenicity in *Imbiza ephuzwato* could be as a result of interaction of biomolecules in the heterogeneous mixture, yielding compounds that are converted to mutagenic agents by xenobiotic metabolizing enzymes. It is therefore important to carry out further studies aimed at identifying and eliminating the sources of the mutagenic compounds in the heterogeneous mixture.

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Patrick B Njobeh

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Mentor: M Dutton

Broad research area: Food, environment and health research

Specific research field: Significance of mycotoxins

Purpose of study:

Mycotoxins are diverse range of harmful secondary metabolites produced by fungi in various food and feed commodities at different stages in the field, during processing, transportation and storage. Generally, the fungi mainly associated with mycotoxin production belong to the *Aspergillus, Penicillium* and the *Fusarium* genera that often contaminate and compromise food safety and quality. Exposure to mycotoxins by animal and man is mainly via ingestion of contaminated foods, but exposure can also occur via inhalation and when dermal exposures are involved. The mycotoxin problem is worldwide, but the situation in most countries located within the tropics and sub-tropical regions is more than double that of the rest of the world. This is mainly due to ecophysiological and socio-economic situations. This research is devoted to reviewing such important mycotoxins as aflatoxins (AF), fumonisins (FB) and ochratoxins (OT) in the African context, while attempting to provide an update on the current state of occurrence of these mycotoxins in different commodities, the degree of human and animal exposure, and associated health implications. A review on the control strategies from the African perspective that takes into

account some of the challenges and needs in mycotoxin analyses is also provided.

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Marie Chrystine Solofoharivelo

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Mentor: JT Burger

Broad research area: Plant sciences

Specific research field: miRNAs involved in abiotic and biotic stresses in grapevine

Purpose of study:

MicroRNAs (miRNAs) belong to classes of a small RNA regulator of gene expression, of about 21 nucleotides in length that were discovered recently. These miRNAs down-regulate gene expression by base pairing to their target RNAs that lead to mRNA degradation or translation inhibition. In plants, different processes are found to be regulated by miRNAs from basic plant metabolism, development and responses to various environmental stresses. Using microarray and deep sequencing technologies, we are looking at differential expressions of miRNAs as well as their target genes in *Vitis vinifera* (grapevine) subjected to various stresses. Data are analysed using diverse bioinformatics tools to generate a profile of differentially expressed miRNAs that will be correlated with the expression profile of putative target genes of these miRNAs. Results obtained will further help to unravel the complex molecular mechanisms underlying plant interactions with its environment in the hope to improve grapevine resistance to biotic and abiotic stresses.

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Dirk Stephan

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Broad research area: Plant virology

Specific research field: Virus tools for grapevine

Purpose of study:

Grapevine (*Vitis vinifera*) is the world's, and South Africa's, most valuable fruit crop. In South Africa there is a planted area of over 100 200 ha, of great economic importance. Grapevine improvement strategies can help to select superior cultivars. For the selection it is of great importance to gain insight into the function of specific grapevine genes. One procedure is the application of plant viruses as tools to silence endogenous plant genes in a procedure called virus-induced gene silencing (VIGS). VIGS leads to a functional knock-down of plant genes in a sequence specific manner and allows assumptions of gene function. The Vitis Laboratory at Stellenbosch University is establishing and testing such a VIGS system for grapevine as the complete genome sequence of that valuable crop plant is available, but efficient tools to identify gene function are still missing.

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