

PAN AFRICA CHEMISTRY NETWORK BIODIVERSITY CONFERENCE REPORT

University of Nairobi, 10-12th Sept 2008

The presentations were interesting and diverse, highlighting some of the global challenges facing the world – energy, food, water, health - all of which have an African dimension, requiring local solutions. These should provide a challenge to the Chemistry academic community– it is not all bad news - how can we improve our basic understanding of the underlying science and develop innovative scientific solutions?

The topics covered included global and African plant biodiversity; natural products as inspiration for crop protection and medicines; biofuels; the management of biodiverse ecosystems; exploiting genetic variation in crops and animals; environmental monitoring; analytical chemistry and waste management.

The speakers discussed a number of important issues facing Africa that will be critical to address if we are to use resources sustainably and thereby maintain the biodiversity of the continent. At the same time, there are also many positive opportunities for chemists to take a lead in helping to better understand and solve these issues, which range from improving agricultural productivity to more efficient biofuel production; accurate environmental analysis and waste management.

The symposium started with a puppet show from the Chanuka Express based on the poor use of pesticides on a farm. This show reflected some public concerns on the use of chemicals in the environment, especially in the use of agriculture. It is apparent from some of the presentations, notably that of Professor Kishimba, that African farmers may not have access to the latest products and that there are still issues with the safe use of cheap generic crop protection chemicals and disposal of old stocks. We must recognise that chemists in general have a responsibility to engage with the public and demonstrate that Chemistry can be a key component of technological solutions to some of the major issues facing the African continent and not just one of the problems.

Summary of the Presentations

(given by Steve as 'rapporteur' to the conference attendees in the closing session)

The first presentation from **Sebsebe Demissew** (National Herbarium, Addis Ababa, Ethiopia) gave us an excellent overview of the huge range of plant diversity in Africa and the importance of this diversity as a resource, particularly in agriculture. We heard about the 'ecological services' plants provide us in terms of clean air and healthy soils and the practical uses of plants. Local examples included an Ethiopian variety of low caffeine coffee and Tef, a grain crop that has found a market in the west for gluten-free diets. Of course there are many challenges to understanding and exploiting sustainably the full range of plant biodiversity, not least the need to ensure there are sufficient trained botanists in the future.

Tony Hooper (Rothamstead, UK) focused on the role of plants in pest control, particularly semiochemicals and pheromones and their use in an innovative African application of a push-pull strategy with pests and beneficial insects. The successful project described had already involved 5000 African farmers.

Mkabwa Manoko (University of Dar es Salaam, Tanzania) highlighted the concentration of biodiversity in Africa and the need to protect 'higher biodiversity areas' and 'biodiversity hotspots'. Threats include population growth, changing land-use and the spread of exotic

species. Mkabwa also raised an important issue about how we ensure local communities share in the benefits of discoveries from their biodiversity. This created a lot of discussion around biopiracy, intellectual property control and strategies for exploitation of discoveries.

Zhou Leocadih (Fort Hare University, South Africa) described the need to effectively coordinate different stakeholders in managing biodiverse ecosystems, specifically in the Kruger National Park. This is also reflected in other ecosystems, where farmers, communities, government and industry all need to play a part.

Bezabih Merhatibeb (NABSA, University of Botswana) gave an overview of the analytical service offered by NABSA to other academic groups in Africa, particularly NMR. This was a great example of how building up a centre of excellence in one location can benefit the whole scientific community and help to develop valuable research networks. This was exemplified in examples of natural product discovery where NABSA had been able to identify structures of interest.

Firew Mekbib (Haramaya University, Ethiopia) showed the critical role that farmers play in managing and conserving crop diversity – in this case sorghum, the ‘camel crop of cereals’. He gave some interesting examples of how farmers can associate different sorghum varieties with their end-use properties (food, feed and wood) and have built up their own local seed bank and a ‘folk taxonomy tree’. In doing so, they have been able to moderately increase yields without significant use of fertiliser crop protection chemicals. However, 60% of the ecosystems on which we depend have been degraded. How do we protect and manage these ecosystems and access local knowledge about the biodiversity they contain before it is lost?

Jacob Midiwo (University of Nairobi, Kenya) highlighted ‘neglected diseases’ as an acute problem facing Africa, but also an opportunity for chemists to develop local treatments from plant-derived natural products. Examples included anthelmintics where over 500 plant species may have some potential. Some plants contain very high levels of the active natural products and so offer opportunities for field treatments. There are 300-500 million cases of malaria each year, with 80% in Africa and over 3000 children dying each day as a result. Jacob admitted trying to tackle Malaria was like ‘shooting a moving target’ given the ease with which resistance has developed. There are opportunities to use Herbal Combination Therapies (as opposed to Artemisinin Combination Therapies). Jacob’s approach to natural product discovery used bioassay-guided fractionation.

Charles Wambebe (International Medical Research in Africa, Abuja, Nigeria). 67% of new medicines launched between 1981-2002 have a plant origin but less than 10% of African plants have been explored. Charles, like some other speakers, expressed concern that there was equitable sharing of benefits from folk medicines and that a system of professional governance and code of ethics was put in place. The challenge for developing medicines from natural sources as pure drugs along the classical pharma pipeline model is that it is long and very expensive and would need a licensing partner. What are the opportunities and challenges for development of ‘herbal remedies’ instead? Issues to address include safety, quality (analytical fingerprints) and ethical review. Charles did have a successful example in the form of Niprisan, isolated from sorghum, which had been licensed to a US company (XeChem) and was being used as a sickle-cell treatment, with a share of the benefits fed back to the originating community *via* royalties to his institute.

Lawrence Manguro (Maseno University, Kenya) also talked about bioassay-guided fractionation as a way of identifying sesquiterpenes as antifungal agents.

Jua Kali is the collective name for the various small businesses that are common in many Kenyan towns, including metal workshops, car repair, etc. **Shadrack Mule** (University of Eastern Africa, Baraton, Kenya) described his research into the heavy metal pollution that can result. It reflects the difficult balance Africa has to face between promoting economic growth and the potential environmental impact if this is not achieved sustainably.

John Clough (Syngenta, UK) described the approach used by Syngenta to discover and develop new crop protection chemicals, with particular emphasis on natural products as a valuable source of new leads. Syngenta partners fully with Chinese researchers to identify natural product leads. We often use microorganisms as a source of natural products. This wasn't mentioned by African presenters and may be an untapped opportunity? John included an overview of the *in vivo* screens and the many factors that chemists have to balance in designing and optimising a modern agrochemical – including efficacy, safety to users and environment and cost. A typical project could involve the synthesis of several thousand analogues and it could take more than 10 years to go from a lead to the market. Only a few of the most successful projects make it that far. Syngenta's azoxystrobin (world No. 1 fungicide) and mesotrione were highlighted as examples.

Jeremy Woods (Imperial College, UK) started off a series of talks on biofuels with an overview of the issues. This is a topic of tremendous importance and opportunity for Africa. Huge rises in petrol prices are driving the interest in biofuel. To supply oil-based products to Africa costs \$70bn. The cost to some countries is crippling – for example, Tanzania spends 40% of its foreign exchange on oil. The sustainability of biofuels is key, but how do we measure this? Criteria should include water use, soil quality, carbon stocks, impact on biodiversity and use of waste. Destruction of forest has the biggest negative impact. Non-tillage agriculture has a positive impact. Other factors for scientists to consider are the radiation-use efficiency of particular crops and the opportunities presented by significant yield and productivity gaps, comparing crops grown elsewhere in the world.

Henry Mutembei (ILRI, University of Nairobi, Kenya) is looking at the genetics of cattle with a view to optimising productivity of milk and meat in specific, but diverse environments. In doing so, the benefits will be to help tackle farmer poverty, reduce pressure on resources and meet the growing demand for meat and dairy products in diets – by 2020, both will have increased by >100%. Henry is using IVEP as a breeding tool.

J. S. Nantango (Makerere University, Uganda) has been measuring the genetic diversity of trees and trying to understand gene flow within, and between, forests with a view to conservation. This was an interesting example of really trying to measure biodiversity at a local and regional level.

John Ochola (ICIPE, Kenya) is bio-prospecting for insect-selective toxins from scorpion venom, Insects and arthropods make up > 50% of creatures on the planet, so there is a great untapped opportunity to find new bioactive molecules. One of John's novel approaches was to tag scorpion venom peptides to baculovirus to deliver them to insects.

C. S. Shonhiwa (Finealt Engineering, Zimbabwe) gave an energetic presentation on the opportunities presented by jatropha in biodiesel production. This may be just the sort of technology that could be adopted in Africa to reduce the reliance on oil imports. Jatropha (apparently the national plant of Zimbabwe!) will grow on poor quality land and provides higher yields of oil per hectare than most other oil crops (up to 12t/Ha). Issues to be addressed before

jatropha can meet the fuel demands of a country like Zimbabwe include an effective infrastructure, establishing new strategies for pest control and methods for the analysis and quality control of the biodiesel product.

Continuing the biofuel theme, **Paolo Vieira** (Universidade Federal de Sao Carlos, Brazil) highlighted the key role plants play in providing us with a number of important products, including biofuels. He presented a number of interesting facts – e.g. there are approx 20,000 edible plant species, but <20 of them provide 90% of the world's food supply. Plants can also be used to provide dyestuffs, textiles, bioplastic, fragrances and oils for fuel and other applications. In Brazil, 46% of fuel comes from renewables (biomass & hydroelectric). Paolo gave some pros and cons of the main biofuels – ethanol, butanol and biodiesel vs hydrogen. There are many opportunities for chemists, for example an efficient catalytic process to convert glycerol (a by-product of biodiesel production) to hydrogen. In the US, 36bn gallons of ethanol will be needed by 2020 on current assumptions, over half of this will have to be derived from cellulosic sources, so robust technologies will need to be developed.

Shem Wandiga (University of Nairobi, Kenya) was the first speaker to focus on water as a critical component of all ecosystems. Only 1% of the world's water supply is fresh. Poor water supply and quality lead to disease (cholera and malaria) and serious problems for agriculture. Growing population (particularly in urban areas) leads to increased water demand and larger volumes of waste. Deforestation can affect water retention and quality. In addition, climatic volatility can lead to an increased incidence of drought or floods. Prof Wandiga's group have been measuring water pollutants (including phosphorus and PCBs) in a number of locations. In Lake Victoria, fish stock collapse, algal blooms and eutrophication are just a few consequences of the increasing contamination of the water. The latter has led to water hyacinth choking up some parts of the lake shore. Detailed analysis and understanding should eventually allow chemists like Prof Wandiga to identify the main sources of contamination (mainly human sewage) and propose solutions.

Michael Kishimba (University of Dar es Salaam, Tanzania) presented a shocking example of pesticide pollution in Tanzania, where a warehouse containing obsolete chemicals had collapsed leading to a very high level of local contamination. Unfortunately, the low purchasing power of African farmers mean they often resort to using cheaper crop protection chemicals and sometimes those that have been withdrawn in other countries. Improper training and handling are issues as well as adequate disposal. Despite this, it was encouraging to find that analysis of pesticide residues in food were within limits in the majority of cases, although sometimes these limits were set higher than EU MRLs. There was an animated discussion in the Q&A around the costs and benefits of using DDT for vector control in the fight against malaria.

Georgina Mwansat (APLORI, Nigeria) has used research into bird diversity as an indicator of general biodiversity. Georgina's presentation also raised some good general points about the value in using research centres for local education, providing socio-economic or community benefits and for the development and training of scientists. APLORI (and other scientific centres of excellence in Africa) was a good example of this.

Crispin Kowenje (Maseno University, Kenya) reported a novel zeolite-trapping methodology he had developed for ammonia analysis, for use in environmental monitoring. Analytical science was strongly represented at the conference - there are many opportunities for the development of new and improved environmental analytical techniques.

Nafthali Muriithi (Kenyatta University, Kenya) discussed the potential use of municipal waste as a resource, a key issue as urban populations continue to increase. Issues with making this a reality include the heterogeneous nature of domestic and industrial waste (including medical waste); the lack of suitable collection and processing infrastructure and an absence of government policy. There was a possibility nutrients for agriculture could be obtained from biomass ash.

Hayder Abdelgader (Agricultural Research Corporation, Sudan) has researched the impact of insecticides on beneficial/predatory insects, highlighting so-called 'soft' pesticides which have a lower overall impact on the wider agricultural ecosystem. Other approaches to Integrated Pest Management could include joint use of natural enemies and pesticides.

Steve Lancaster (BP and the Foundation for Analytical Science & Technology in Africa, UK) has set up a charitable foundation to source and install GC-mass spec equipment for African universities and to train staff in their use. He was involved in the 2nd installation at Jomo Kenyatta University during the week of the conference. His talk provided an excellent case study in the use of analytical science to detect, monitor and ultimately control an environmental pollutant – in this case diclofenac which is used to promote growth in cattle in India but has been finding its way into vultures and has decimated their population with knock-on effects in related ecosystems (e.g. a rise in rat populations). The project described involved the development and validation of a robust GC-MS methodology and then provision of a monitoring service for diclofenac.

E Muleya (Midlands State University, Zimbabwe) reported a study to monitor the effluent from a battery manufacturer and then development of a lime precipitation method for effluent treatment that removed most of the heavy metal contaminants. The contamination of the water before treatment was having a knock-on impact on the quality of drinking water supplies.

Engdawork Admasu (Bahir Dar University, Ethiopia) has been involved in the analysis of nutrients and non-essential metals in the whole milk of cows. Fortunately, toxic heavy metals were generally below acceptable levels. There was variation between different breeds and regions. Interestingly, lead was higher relative to other metals because leaded petrol is still widely used in Ethiopia.