INTERNATIONAL INORGANIC CHEMISTRY CONFERENCE

Inorganic Chemistry
Technological Innovations and its Contribution in Socio-economic Development

22nd - 24th May 2018
Best Western Plus Meridian Hotel

University Of Nairobi

UPPSALA UNIVERSITET

ROYAL SOCIETY OF CHEMISTRY
KOBIAN KENYA LIMITED
ESTEC Educational Scientific & Technical Equipment Company Limited
The chemists are a strange class of mortals, impelled by an almost insane impulse to seek their pleasures amid smoke and vapor, soot and flame, poisons and poverty; yet among all these evils I seem to live so sweetly that may I die if I were to change places with the Persian king.

(JOHANN JOACHIM BECHER, 1635 - 1682)
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**Programme**

**INTEGRATIONAL INORGANIC CHEMISTRY CONFERENCE**
22ND – 24TH MAY 2018
BEST WESTERN PLUS MERIDIAN HOTEL, NAIROBI

Inorganic Chemistry Technological Innovations and its Contribution in Socio-economic Development

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Programme Manager: Mr. Charles Mirikau

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| 10.45 am – 11.15 am | HEALTH BREAK |

**Session 1** – Chair: Prof. David K. Kariuki

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| 12.00 pm – 12.20 pm | Low Temperature Synthesis and Characterization of Organically Templated Novel Vanadium Oxides. Prof. Samuel Lutta, University of Eldoret, KENYA |

| 12.20 pm – 12.40 pm | Synthesis, Characterization and Antimicrobial Activities of Nickel(III) and Copper(II) Complexes of 4,4,4-Trifluoro-1-(2-Naphthyl)-1,3-Butanedione and their Adducts. Dr. Oluwatola Omoregie, University of Ibadan, NIGERIA |

| 12.40 pm – 1.00 pm | Hydrothermal Synthesis of Different Zeolites From Kaolinite Clays Containing High Content of Quartz Through Metakaolination and Fusion Routes. Mr. Stephen Otieno, Maseno University, KENYA |

| 1.00 pm – 2.00 pm | LUNCH |

**Session 2** – Chair: Prof. Martin Onani

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| 2.20 pm – 2.40 pm | Citric Acid Functionalized Geopolymers Derived from Common Clay and Rice Husk Ash for Adsorption of Pb (II) from wastewater. Mr. Mukora Maingi, Kenyatta University, KENYA |

| 2.40 pm – 3.00 pm | Methyl Blue Dye Adsorption onto Magnetically Responsive Magnetite Pillared Kaolinite Clay. Mr. Victor O. Shikuku, Kaimosi Friends University College, KENYA |

| 3.00 pm – 3.20 pm | Green Synthesis, Characterization and Electrochemical Sensing of Silymarin by Zno Nanoparticles: Experimental and DFT Studies. Dr. Myalo Sabela, University of KwaZulu-Natal, SOUTH AFRICA |

| 3.20 pm – 3.40 pm | Fabrication of Biosensor for Bisphenol A. Ms. Linet Achieng Ogalo, University of Nairobi, KENYA |

| 3.40 pm – 4.00 pm | Environmental Assessment of Pollution in Water, Sediment, Soil and Vegetation in Nairobi National Park. Ms. Ruth Onkangi, University of Nairobi, KENYA |

| 4.00 pm – 4.20 pm | ‘PROVE’ Range of Spectrophotometers from Merck. Tonny, Merck, KENYA |
**DAY 2: WEDNESDAY 23RD MAY 2018**

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<td>ORGANOGOLD CHEMISTRY. Gold-Catalyzed and NaH-Supported Cyclization of N-Propargylated Pyrrole, Indole: Synthesis of Heterocycles with New Scaffolds. Prof. Metin Balci, Middle East Technical University, TURKEY</td>
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<td>Schiff Base Transition Metal Complexes of Aminopyridine as Potential lead Compounds in the Development of New Anti-tuberculosis Drugs. Dr. Dueke-Eze, University of Lagos, Akoka, Lagos State, NIGERIA</td>
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<td>Crystal Growth Study of a Guest-Free Microporous Metal-Organic Framework Zinc 5-tert-butyl Isophthalate (Zn(tbip)) by Atomic Force Microscopy. Dr. Samaila Jovial, Mai Idris Alooma Polytechnic, NIGERIA / Manchester University, UK</td>
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<td>10.15 am – 10.35 am</td>
<td>A Quick response and Google Analytics advancement of gold nanoparticle-based dual lateral flow immunoassay for malaria – (pLDH). Mr. Mthembu Christian, Durban University of Technology, SOUTH AFRICA</td>
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<td>10.35 am – 11.00 am</td>
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<td>11.00 am – 11.20 am</td>
<td>Session 4 – Chair: Prof. Samuel Lutta  Rapporteurs: Ruthenium(II) Oxathia Crown Ether Complexes: Synthesis, Characterization and their Application in the Detection of Mercury(II) Ions. Dr. Ruth Odhiambo, University of Nairobi, KENYA</td>
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<td>11.20 am – 11.40 am</td>
<td>C-H Functionalization of Hydrocarbons Using Iron(II) Complexes Bearing Pentadentate Polypyridyl Ligands and their Nitrosyl Derivatives. Mr. Solomon Yiga, Makerere University, UGANDA</td>
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<td>Photocatalytic Disnfection of E. Coli in Water Using Copper/Zinc Metal/Metal Oxide Photocatalyst. Dr. Vincent Madadi, University of Nairobi, KENYA</td>
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<td>Determination of Fluoride and Some Heavy Metals in Water, Blood and Urine Samples Among Some Inhabitants of Gashua, Bade Local Government Area, Yobe State, Nigeria. Mr. Musa Muhammad Mahmud, Mai Idris Alooma Polytechnic, NIGERIA</td>
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<td>12.20 pm – 12.40 pm</td>
<td>Photo Degradation of Pentachlorophenol (PCP) Pesticide Under Different Light Energies and Exposure Time on the Surfaces of Spinach Leaves. Dr. Joyce Kithure, University of Nairobi, KENYA</td>
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<td>12.40 pm – 1.00 pm</td>
<td>Naturally Substituted Brushite: Treatment of High Fluoride Waters. Ms Agatha Wagutu, Mwenge Catholic University, TANZANIA</td>
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<td>2.00 pm – 2.45 pm</td>
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<td>2.45 pm – 3.05 pm</td>
<td>In Situ Cross-Linked Chitosan-3,6-Diacetylnaphthalene Ni(II) Complexes as a Versatile Solid Catalyst. Adesoji Adedoyin, Federal University of Agriculture, Abeokuta, Ogun, NIGERIA</td>
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<td>Ultra Violet Electromagnetic Radiation Photocatalytic Treatment of Wastewater from Tea Processing Factories in Kenya. Mr. Patrick Tum, University of Nairobi, KENYA</td>
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### DAY 3: THURSDAY 24TH MAY 2018

#### 8.00 am – 8.30 am
**ARRIVAL & REGISTRATION**

#### Session 7 – Chair: Dr. Myalo Sabela
**Rapporteurs:**

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<td>Assessment of Inorganic Chemistry in the Competency Based Curriculum (CBC).</td>
<td>Mr. Franco Munene, Kenya Institute of Curriculum Development, KENYA</td>
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<td>9.15 am – 9.35 am</td>
<td>New Bis(Pyrrolylimine) Platinum (II) and Palladium (II) Complexes: Synthesis, X-Ray Structure Determination, Spectroscopic Characterization, and in vitro Anticancer Activity on Various Human Carcinoma Cell Lines.</td>
<td>Mr. Simon Mbugua, University of Nairobi, KENYA</td>
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<td>9.55 am – 10.15 am</td>
<td>Water Quality Index for Bottled Drinking Water in Kenya.</td>
<td>Ms. Jane Wanjiru, University of Nairobi, KENYA</td>
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<td>10.15 am – 10.35 am</td>
<td>PM2.5 and Road-Side Dust Pollution by Heavy Metals Along Thika Superhighway in Kenya, Sub-Saharan Africa.</td>
<td>Mr. Ernest Gachui, Jomo Kenyatta University of Agriculture and Technology, KENYA</td>
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#### Session 8 – Chair: Prof. Metin Balci
**Rapporteurs:**

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<td>11.00 am – 11.20 am</td>
<td>Characterization of Experimental Dental Cements Derived from Locally Available Aluminosilicate Materials in Kenya.</td>
<td>Dr. Olivia Osiro, University of Nairobi, KENYA</td>
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<td>11.20 am – 11.40 am</td>
<td>Water Quality Status of Selected Sources of Domestic Water in Kenya.</td>
<td>Ms. Florence Masese, University of Nairobi, KENYA</td>
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<tr>
<td>11.40 am – 12.00 am</td>
<td>Prof. David K. Kariuki, University of Nairobi, KENYA</td>
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<td>12.00 pm – 1.00 pm</td>
<td>CLOSING CEREMONY</td>
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<td>Principal, College of Biological &amp; Physical Sciences – Prof. Benard Aduda</td>
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<td>1.00 pm – 2.00 pm</td>
<td>LUNCH</td>
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Abstracts

Low Temperature Synthesis and Characterization of Organically Templated Novel Vanadium Oxides

Samuel T. Lutta*1, Peter Zavalij2, Natasha Chernova2 and Stanley Whittingham2
1Department of chemistry, University of Eldoret, P. O. Box 3900, Eldoret, Kenya,
2Chemistry Department and Institute for Materials Research, State University of New York at Binghamton, Binghamton, NY 13902-6000

Abstract
Layered vanadium oxides and their intercalates have attracted much research interest due to the wide variety of structures possible. However, the design and synthesis of these compounds remains a challenge to solid state chemists. New vanadium oxides with tunable properties were synthesized via a soft chemistry approach using organic molecules as structure directing agents. The compounds have been thoroughly characterized using various techniques, such as wet chemistry analysis, x-ray, scanning electron microscopy, thermogravimetric analysis, and Fourier transformation infrared spectroscopy. Those new vanadium oxides with tetrahedral vanadium centers do not show much redox activity, as that coordination is essentially non-existent in lower oxidation states. The study further supports our earlier findings that presence of organic species between the layers hinders lithium diffusion. In contrast, double sheet structures that contain almost octahedral vanadium and are stabilized by cationic pillars showing excellent reversible redox behavior.

Synthesis, Characterization and Antimicrobial Activities of Nickel(II) and Copper(II) Complexes Of 4,4,4-Trifluoro-1-(2-Naphthyl)-1,3-Butanedione and their Adducts

H. Oluwatola Omorogie
Department of Chemistry, Faculty of Science, University of Ibadan, Ibadan, Oyo-State, Nigeria

Abstract
Nickel(II) and copper(II) complexes of 4,4,4-trifluoro-1-(2-Naphthyl)-1,3-butanedione and their 2,2′-bipyridine, ethylenediamine and 1,10-phenanthroline adducts have been synthesized and characterized by infrared, electronic spectral studies, conductance, magnetic susceptibility measurements and antimicrobial studies. The conductivity measurement in nitromethane indicates that the complexes and adducts are non-electrolytes. The electronic measurements are indicative of six-coordinate octahedral for nickel(II) while the copper complexes assumed square pyramidal structure. Higher frequency shifts of asymmetric C=O + C=C stretching vibrations were observed in nickel(II) and copper(II) complexes compared to the ligand value. The nickel(II) compounds showed poor activity against the tested microbes which may be due to its poor bacteria uptake.

Hydrothermal Synthesis of Different Zeolites from Kaolinite Clays Containing High Content of Quartz through Metakaolination and Fusion Routes

Stephen Otieno*, Chrispin B. O. Kowenje
Department of Chemistry, Maseno University, P. O. Box, 333- 40105, Maseno, Kenya
*Corresponding author. stephenotieno6@gmail.com

Abstract
Different zeolites have been synthesized from clays via fusion with NaOH at 750 °C and conventional method without fusion prior to hydrothermal synthesis at crystallization temperature of 100°C. Crystallization reactions were done under static conditions with varying reaction conditions in 50 ml polytetrafluoroethylene (PTFE) bottles. The crystallography, surface area, surface morphology, elemental composition, functional groups and thermal stability of the products were analyzed using different analytical instruments. Analysis of clay material showed that it belonged to the kaolinite group of minerals with Si/Al molar ratio of 1 and having high content of quartz phase as impurity. Zeolite Na-X with Si/Al molar ratio of 1.14 was the major product when fusion method before hydrothermal crystallization was used while zeolite Na-A with Si/Al ratio of 1.2 was the major product when the conventional method of metakaolination was used. In the later method, quartz was persistent to the product phase. Zeolites with good crystallinity was obtained after 48 hours and 24 hours for Na-X and Na-A respectively. Further analysis of the surface area employing nitrogen adsorption showed that the synthesized zeolites,
except for zeolite A, had high BET surface area of over 500 m$^2$/g which are comparable to those of commercial zeolites and are better than most of zeolites synthesized from clays reported in literature.

**Opportunities and Challenges from Inorganic Chemistry for Environmental Management**

**Bernard Thole**  
*University of Malawi, Private bag 303, Blantyre 3, Malawi*  
bthole@poly.ac.mw

Natural and anthropogenic environmental contamination is a challenge to ecological and public health. There are, nevertheless, mitigation opportunities from inorganic chemistry. Employment of inorganic chemistry in resolving natural fluoride-contamination of water in Tanzania, faecal sludge sanitization and enumeration of pesticide contamination in Malawi were carried out to demonstrate role of inorganic chemistry in environmental management. The prospects and challenges encountered inform wider consideration for employment of inorganic chemistry in environmental pollution and mitigation. Raw bauxite, gypsum and magnesite filters obtained mean loading capacities of 5.6, 3.4 and 1.7 mg F$_2$/g respectively in water defluoridation. Their 500 oC-calcined composite, prepared in the ratio of their respective loading capacities, obtained a loading capacity of 11.89 mg F$_2$/g with critical bed depth (Z$_o$) of 7.71 cm and an operating line, ђ = 5 x 10$^{-5}$ - 0.0113∂ + 0.929 where ђ is adsorbent exhaustion rate and ∂ is empty bed residence time. The quality of treated water fell short of WHO standards on sulphates and iron but met requirements for concentrations of Cl$^-$, Al$^3+$, Ca$^{2+}$, Mg$^{2+}$ and Fe$^{2+}$. In faecal sludge treatment, hydrated lime reduced E. coli count to below detectable limit within 1 h at pH > 11 (dosage: 7% to 17% w/w, depending on faecal sludge alkalinity), urea treatment took 4 days (2.5% wet weight urea), and lactic acid fermentation required 1 week (10% wet weight). In environmental monitoring, Carbaryl residues in water were above Australian guideline (0.003 mg/L) and Canadian guideline (0.09 mg/L) for drinking water in both seasons. Cypermethrin residues in water were above United States Maximum Residual Limit (US MRL), (0.05 µg/L), WHO limit (0.05 µg/L) in both seasons. The soil samples exceeded the US MRL guideline value (0.05 mg/Kg) in the rainy season only. The prospects and challenges in employment of inorganic chemistry in environmental pollution and mitigation should consider sorption capacities of natural substances, residual treatment contaminants and opportunities in environmental standards monitoring availed by inorganic chemistry.

**Key words:** bauxite, composite, defluoridation, faecal sludge, gypsum, magnesite, pesticide, water.

**Citric Acid Functionalized Geopolymers Derived from Common Clay and Rice Husk Ash for Adsorption of Pb (II) from wastewater**

**F. M. Maingi, M. M. Ng'ang'a, H. Mwangi and H. M. Mbuvi**

*Department of Chemistry, Kenyatta University, P.O. Box 43844-00100, Nairobi, Kenya. Correspondence E-Mail: mukoramaingi@yahoo.com*

**Abstract**

Due to population growth, accelerated industrialization and technological advancements, the quantity of wastewater generated and resultant pollution is on an increasing trend. Consequently, pursuance of sustainable materials and technologies for wastewater remediation is vital. Use of adsorption as a method of water treatment is preferable due to its simplicity and use affordable materials. Exploring the use of geopolymers as adsorbents for wastewater treatment is beneficial because they can be synthesized hydrothermally and possess amorphous surface for adsorption. Existing literature indicates that clay contain both silica and alumina while rice husk ash contains substantial amounts of silica. This study reports synthesis of citric acid functionalized geopolymers GP-1C and GP-2C using different clays and rice husk ash. The geopolymers were characterized using FT-IR, EDXFS, SEM and XRD. Gravitational column sorption experiment using Pb (II) ions were done and increased adsorption was observed upon functionalization as well as when SiO2/Al2O3 ratio increased. The mean percentage uptake of 85.02 ± 0.76 and 87.24 ± 0.30 was achieved at pH of 4.0 using GP-1C and GP-2C respectively. Sorption experimental data best fitted into modified Langmuir Freundlich isotherm model. Geopolymer GP-1C and GP-2C recorded adsorption capacities of 50.61 and 58.97 mg/g respectively. The removal efficiency was evaluated on monocomponent synthetic wastewater system. Based on the results obtained, citric acid functionalized geopolymers produced from common clay and rice husk waste displayed promising potential in removal of heavy metal ions from the aqueous solutions. The successful use of geopolymers as a raw material in adsorption and the high metal ions uptake capacities demonstrated by the geopolymers provide an opportunity for these materials to be used as adsorbents for removal of heavy metals in industrial wastewater.

**Key words:** Adsorption isotherms, Functionalization, Geopolymers, Wastewaters, Adsorbents.
Methyl Blue Dye Adsorption onto Magnetically Responsive Magnetite Pillared Kaolinite Clay

Victor O. Shikuku1, Trilochan Mishra2
1Kaimosi Friends University College, P.O. Box 385-30509, Kaimosi, Kenya
2CSIR-National Metallurgical Laboratory, Jamshedpur 831007, India
Email: vshikuku@kafuco.ac.ke

Abstract
In this study, kaolinite clay was modified with magnetic magnetite particles (Fe3O4@MC) by co-precipitation using ferrous and ferric chloride as iron precursors in order to ameliorate its capacity for methyl blue (MB) dye adsorption from synthetic wastewater. The kaolinite and Fe3O4@MC were analyzed using X-ray diffraction (XRD), BET surface area analysis, vibrating sample magnetometer (VSM) and scanning electron microscopy (SEM). The BET surface area after chemical treatment increased from 14.616 to 26.913 m2/g. The saturation magnetization of Fe3O4@MC was found to be 6.22 emu/g and the exhausted adsorbent recoverable by a simple magnet. The preliminary results were fitted to non-linear Langmuir and Freundlich models and were best described by the Langmuir isotherm. The Langmuir monolayer maximum adsorption densities (Q0) were 2.683 and 3.666 mg/g for clay and Fe3O4@MC, respectively. The improved adsorption capacity is consistent with the increased BET surface area after pillarization. Fe3O4@MC can be used as a low cost adsorbent for removal of MB dyes from water

Key words: Methyl blue, kaolinite, magnetite, adsorption

Green synthesis, characterization and electrochemical sensing of silymarin by ZnO nanoparticles: Experimental and DFT studies

Deepali Sharma, Myalovenkosi I. Sabela, Suwardhan Kanchi, Krishna Bisetty, Adam A. Skelton, Bahareh Honarparvar
4Discipline of Pharmaceutical Sciences, School of Health Sciences, University of KwaZulu-Natal, Durban 4001, South Africa
4Department of Chemistry, Durban University of Technology, Durban 4000, South Africa

In the present study, a systematic approach was used for the green synthesis of zinc oxide nanoparticles (ZnO NPs) with an average size of 4-8 nm using Carica Papaya seed extract. The prepared ZnO NPs were characterized using X-ray diffraction (XRD), Transmission electron microscopy (TEM), UV-visible spectroscopy and Fourier transform infrared spectroscopy (FTIR). The composition of the extract was identified using gas chromatography-mass spectrometry (GCMS), which revealed the role of oleic acid as an important capping agent in the synthesis of ZnO NPs. To investigate the electrochemical application, the synthesized ZnO NPs were further tested for sensing activities of silymarin by integrating them with multivalled carbon nanotubes (MWCNTs) on the glassy carbon electrode (GCE). The electrochemical signals obtained from MWCNTs/ZnO NPs/GCE were 2-fold higher than MWCNTs/GCE and bare GCE. Electrochemical detection using our applied protocol with the developed MWCNTs/ZnO NPs composite could detect 122 mg of silymarin in the 160 mg quoted concentration, in the commercial Milk Thistle tablet, confirming an efficiency of detection that is approximately 76%. To understand the electrochemical sensing of silymarin by ZnO NPs at the molecular level, the interaction of silymarin with ZnO model clusters, (ZnOn with n=3 and 4 was investigated using density functional theory (DFT) using B3LYP functional and 6-311+G/LanL2DZ basis set in terms of interaction energies and stabilization energies derived by second order perturbation energies. The strategy for the electrochemical detection of silymarin applied in present work serves as a systematic benchmark to assess the electrochemical biosensing of potential biomolecules in the presence of different metal oxide NPs.

Fabrication of Biosensor for Bisphenol A

Linet Achieng Ogalo
University of Nairobi, P.O. Box 30197 – 00100, Nairobi

Abstract
Plastics which are among the widely used household products in Kenya are synthesized with the help of Bisphenol A (BPA). BPA gives the plastics a clear look and a rigid shape. Despite the BPA's usefulness in the synthesis of plastic products, it is also known to have toxic effects to human health and its levels should be monitored. In order to come up with a detection mechanism for the substance, a polymer /enzyme composite was prepared. Polyaniline also called PANI was prepared both chemically and electrochemically. A PGSTAT
12 potentiostat operating on the cyclic voltammetry (CV) mode was employed for electrodeposition of PANi in which, 1 mM 2, 2'-Azinobis [3-ethylbenzothiazoline-6-sulfonic acid] (ABTS was used as surfactant. All synthesized films were characterized in hydrochloric acid using the cyclic voltammetry technique. Biosensor construction was done by drop-coating 10µL aliquots of Horseradish Peroxidase (HRP) enzyme / phosphate buffer (pH 7) mixture on to the PANi films. The polymer/enzyme composite was air dried for 30 minutes before use. During biosensor testing, the PANi-HRP modified electrodes were placed in 10mL phosphate buffer (pH 7) to which 5 µL aliquots of 1milli molar addition, stirring was allowed for 2 min followed by CV recording. Cathodic peak currents were monitored as a function of concentration of BPA at a potential window of 0V to -0.1V. Cyclic voltammograms obtained for the BPA scans showed a consistent peak at -0.35V, which was observed to be characteristic of BPA. A plot of peak currents as a function of BPA concentrations ranging from $5 \times 10^{-12}$ to $1 \times 10^{-9}$ moles gave straight line graphs, showing decrease in cathodic peak height with increase in concentration of BPA in the -0.1V to 1.0V window, an observation which may indicate inhibition of the enzyme. The extent of inhibition was found to be directly correlated to the increase in BPA concentration. This correspondence of peak height with concentration indicated that the biosensor could be used for the detection Bisphenol A. In this project, attempt is made to develop a biosensor for analysis of Bisphenol A, ($C_{15}H_{16}O_2$). More research can be done to application on real samples.

Environmental Assessment of Pollution in Water, Sediment, Soil and Vegetation in Nairobi National Park

Ruth Onkangi¹, Fredrick D.O Oduor¹, J. M. Wanjohi¹, Peter N. Mwangi², Dr. V.O Madadi³

¹Department of Chemistry, University of Nairobi, P.O Box 30197-00100, Nairobi
²Bio-diversity Research and Monitoring Division, Kenya Wildlife Service, P.O. BOX 40241-00100, Nairobi

Abstract

The Nairobi National Park (NNP) serves as a flagship of conservation in Kenya, having been the first protected area to be gazetted in Kenya and the first protected area to be engulfed by a fast-growing city making it the only urbanite National Park in the world today. Conservation in NNP mirrors conservation in Kenya. Management practices as well as challenges experienced in NNP will soon trickle and flood the wilderness parks as human population increases and colonization of idle lands correspondingly rises. If conservation fails in NNP then this will cascade to other protected areas sooner or later, and if conservation wins in NNP then the survival of other parks in the wave of future developments fringing them is guaranteed. To ensure conservation wins, threats to its sustenance need to be assessed and addressed, the park faces increased habitat fragmentation to pave way for development, climate change and invasive species as well as pollution are the major threats antagonistic to its survival. This study sought to establish the extent of pollutant load in the park, the damage wrought and plausible remedies to thwart associated effects. Samples were collected in various sites along the river Mbagathi which flows through the park and in various watering points in the park. Samples of vegetation, sediments and soils within the park area, park areas neighbouring industries and hotels located at the park boundary were also collected and subjected to analysis. The parameters being tested include chemicals that are persistent, bio-accumulative or toxic: these being; nutrients (phosphates and nitrates), fluoride, chlorides, and Heavy Metals (Pb, Zn, Cr, Cd, and Hg), physiochemical parameters tested for include: COD, BOD, pH, DO, ORP, Salinity, temperature, Conductivity, TSS and TDS. Biological analysis on coliforms, macroinvertebrates in water samples was also done. The results obtained, recommendations made are to back maximum complementarity for conservation of this unique ecosystem.

Key words: Water Quality, Pollutant Load, Seasonality, NNP

‘PROVE’ Range of Spectrophotometers from Merck

Tonny Samuel
Merck Group

Abstract

‘Whether you’re analyzing waste water, drinking water or processed water, the three most important requirements of a spectrophotometer are simplicity, security and durability. Intuitive, innovative and preprogrammed for the broadest range of test kits, Spectroquant® Prove makes water analysis smoother than ever’
ORGANOGOLD CHEMISTRY: Gold-Catalyzed and NaH-Supported Cyclization of N-Propargylated Pyrrole, Indole: Synthesis of Heterocycles with New Scaffolds

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Abstract
Compounds classified as heterocyclic probably constitute the largest and most varied family of organic compounds and they are well presented among pharmaceuticals. As part of our ongoing research program on the design and synthesis of heterocycles with new skeletons we developed new methodologies. The key feature of this methodology was the synthesis of N-propargyl pyrrole, indole, and benzene derivatives. Gold-catalyzed or NaH-supported cyclization of these compounds resulted in the formation of compounds given in Fig 1.

Fig 1. Structures of some synthesized compounds.

The gold-catalyzed reaction of pyrrole and indole oximes having N-propargyl group transferred the oxime functionality intramolecularly from one carbon atom to another carbon atom via 7-endo-dig cyclization process. This transformation is unprecedented in the literature and was named as oxime-oxime rearrangement.

Fig 2. Oxime-Oxime Rearrangement

Schiff Base Transition Metal Complexes of Aminopyridine as Potential lead Compounds in the Development of New Anti-tuberculosis Drugs

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Abstract
Treatment of tuberculosis (TB) still remains an important and challenging problem because of a combination of factors including increasing number of multi-drug resistance to the existing tuberculosis drugs and co morbidity of TB with HIV. The World Health Organization recently reported TB as one of the leading cause of death from infectious disease especially in Africa. Discovery of new compounds with anti-tuberculosis (anti-TB) effect and possibly with mechanism of action different from those of well known TB drugs is highly desirable. Schiff base metal complexes represent major investigational compounds. Complexes of Co(II), Ni(II) and Cu(II) were synthesized by refluxing aminopyridine derivatives and various transition metals. 1H, 13C NMR, IR, electronic absorption and elemental analysis confirm the formation of the ligands. The metal complexes were also characterized on the basis of various spectroscopic techniques. The compounds were screened against a library of microbial for their anti-TB activity using the proportion method and isoniazid (INH) as a reference compound. The complexes showed enhanced in-vitro anti-tuberculosis activity against Mycobacterium tuberculosis H37RV compared to the free ligands and the reference compound (INH). Co(II) complex containing the nitro substituent exhibited significant anti-TB activity with an MIC of 0.05 µg/mL. The results demonstrate that compounds with metal ion can display strong anti-TB activity making them suitable as lead compound in the development of new TB drugs.

Keywords: Drug discovery, Anti-tuberculosis, Schiff bases metal complexes, aminopyridine
Crystal Growth Study of a Guest-Free Microporous Metal-Organic Framework Zinc 5-tert-butyl Isophthalate (Zn(tbip)) by Atomic Force Microscopy

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Abstract
Zn(tbip) is a novel guest-free Microporous metal-organic framework (GFMMOF) composed of Zn-based secondary building units (SBUs), [Zn(NO3).6H2O], and 5-tert-butyl isophthalate (tbip2-) ligands has been synthesised and characterised structurally robust with an extraordinary thermal stability. The Powdered X-ray diffraction pattern of the sample indicated that a monophasic sample had been prepared, which is very similar to the theoretical pattern of Zn(tbip). The scanning electron microscopy (SEM) revealed that the crystals have elongated hexagonal prism morphology with crystals sizes ranging from 700 μm to 1 nm. Thermogravimetric analysis (TGA) showed that the crystal is thermally stable up to 450 °C and is guest molecule free. Solid-state NMR also proved that the crystals are guest-free. Single crystals were determined by single crystal X-ray diffraction (SXRD). Ex-situ atomic force microscopy (AFM) investigation on the elongated hexagonal prism of Zn(tbip) surface provided information concerning the crystal growth mechanism of the material. Multilayer anisotropic growth features were observed in the AFM micrographs, indicating much more rapid growth of the crystals in the direction parallel to the channel system than perpendicular to it. The cross-sectional analyses of the height images reveal that most of the growth steps are within the 45 – 50 nm and indicated that the extended structural units are stabilised on the crystal surfaces. This work demonstrates the use of AFM to provide new information on the crystal growth a non-cubic MOF, Zn(tbip).

Keywords: Metal-Organic Framework, Microporous, Topology, Crystal Growth, Atomic Force Microscopy.

A Quick Response and Google Analytics Advancement of Gold Nanoparticle-Based Dual Lateral Flow Immunoassay for Malaria – (pLDH)

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Abstract
A rapid dual lateral flow diagnostic assay fabricated with quick response (QR) barcodes was developed to improve the quality control of malaria diagnostic tests, as well as to enhance systems for transferring data from survey studies among community healthcare workers at a point-of-care facility and centralized laboratories. The lateral flow kit has been modified with QR technology encoded with Google Analytics information for the detection and real-time tracking of Plasmodium lactate dehydrogenase (pLDH). The QR barcode was fabricated by attaching two QR barcodes which were encoded with websites that were linked to Google Analytics. The optical and structural properties of gold nanoparticles (AuNPs) were studied using UV-visible spectroscopy, transmission electron microscopy and a Biodot XYZ. The anti-mouse IgG antibody was used as a secondary antibody to act as a control and anti-pLDH. The antibody binding with pLDH antigens shows a test line indicating a positive test in the presence of phosphate buffer as a mobile phase. The diagnostic kit for the rapid detection of pLDH was developed and validated for the detection of malaria antigens at the lowest detectable recombinant concentration of 10 ng ml-1. The diagnostic kit was incorporated with quick QR barcodes for positive, negative and invalid tests readable with a smartphone. These QR barcodes successfully allowed us to track the precise location of the test through Google Analytics.

Keywords: Quick response, Google Analytics, Plasmodium, Immunoassay.

Ruthenium(II) Oxathia Crown Ether Complexes: Synthesis, Characterization and their Application in the Detection of Mercury(II) Ions

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Abstract
Ruthenium(II) complex of oxathia crown ethers was synthesised and characterised using NMR, Mass Spectrometry and UV-visible spectroscopy. The complex was used in the detection of mercury(II) ions using a competitive binding assay with different concentrations of mercury(II) ions. The results showed that the complex is effective in detecting mercury(II) ions in aqueous solutions.

Keywords: Ruthenium, Oxathia crown ethers, Mercury(II) ions.
Abstract

The presence of toxic metal ions such as mercury (II) in the environment poses great danger to humans due to their non-biodegradability and bioaccumulation. Their environmental detection requires the development of simple, highly sensitive and selective analytical methods such as artificial chemosensors and, thus, the design and synthesis of such sensors with high affinity and selectivity have been given a lot of attention. Mercury (II) is known for its mutagenic and teratogenic effects, hence the need for its detection and removal from the environment. In the present study, a series of oxathiacrown ether ligands (Fig 1) bonded to a [Ru(bpy)$_2$]$^{2+}$ complexing unit were synthesized, characterized and their recognition ability towards mercury (II) metal ions investigated by spectroscopic and electrochemical methods. The complexes display microanalytical, NMR and mass spectral data consistent with their formulations. They exhibit electronic absorptions associated with d$_{π}$-π* transitions at ca. 454 nm and strong MLCT luminescence bands in the range 608–611 nm. The cyclic voltammograms of the complexes display three reversible ligand-centered reduction waves between -1.6 V to -2.1 V and one reversible metal-centered oxidation wave at ca. 1.0 V respectively. The ability of the complexes to recognize mercury (II) ions was investigated using UV-Vis absorption, luminescence, 1H NMR and cyclic or differential pulse voltammetric titrations. All the complexes were able to detect the presence of mercury (II) ions on the absorption and luminescence timescales. In particular, complex 2 gave a selective change in the UV/Vis absorbance making it possible to detect mercury (II) down to a detection limit of 68 ppm. The binding constants and limits of detection of the complexes were calculated, with values ranging from 4.37 to 5.38 and 1.43 x 10$^{-3}$ to 6.8 x 10$^{-5}$ for log $K_s$ and LOD respectively.

Fig 1: Ligands L1 – L4

Key words: Mercury (II) ions, oxathiacrown ether ligands, ruthenium (II) bipyridyl, luminescence

C-H Functionalisation of Hydrocarbons Using Iron(II) Complexes Bearing Pentadentate Polypyridyl Ligands and their Nitrosyl Derivatives

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Abstract

The catalytic functionalization of hydrocarbons is one process where catalysts are desperately needed. This is because hydrocarbons are intrinsically inert in nature and present a formidable challenge during their transformation to other compounds. Yet, hydrocarbons are the most abundant and inexpensive organic chemicals in nature and typically make up 50% of petroleum. However, such an abundant resource is presently so difficult to utilize. In comparison to noble metals, iron has achieved very little success in catalytic functionalization of hydrocarbons due to factors associated with its electronic environment. Yet, from the cost point of view, iron would be the metal of choice. However, the properties of iron complexes towards any chemical processes can be tuned through variation of their supporting ligands, thus making it applicable in a variety of catalytic conversions. It is against this background that we sought to design a special class of pentadentate N-donor chelate ligands which, when metalated with a cheap metal like iron would form a series of iron complexes of the type [(L)Fe(solv)]$^{2+}$. The new Fe(II) complexes are based on the pentadentate ligand 1,1-di(2-pyridyl)-N,N-bis(2-pyridylmethyl) methanamine (N4Py) modified by quinolyl or phenyl pyridyl moieties on the amino function. These complexes were characterized by X-ray crystallography, NMR, UV-Visible, infrared spectroscopy and cyclic voltammetry. Application of the complexes in catalytic oxidation of hydrocarbons was attempted and the potential of these complexes to coordinate oxygen (O$_2$) was mimicked by employing nitric oxide (NO) to form nitrosyl complexes [(L)Fe( NO)]$^{2+}$. This work provides is a promising milestone in the attempt to utilize unreactive hydrocarbons.

Photocatalytic Disnfection of E. Coli in Water Using Copper/Zinc Metal/Metal Oxide Photocatalyst

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Abstract
Metal oxides are attracting special attention of scientists due to their easy mode of formation and multifunctional behaviour in terms of physical, magnetic, optical and chemical properties. In particular, transition metals and their compounds have found wide range of application including as catalysts in chemical industry, and in formation of interstitial compounds and alloys. Metal/mixed metal oxides have also received wide applications as catalyst because of their high surface area and reactive sites. Hence, there is increasing interest to explore metal/mixed metal oxides as catalyst in various organic reactions and environmental applications. In this study we investigated application of copper/zinc oxide photo catalytic activity in inactivation of E. Coli in raw water under natural sunlight. Enhanced inactivation of both E. Coli and other coliforms was observed in water treated with copper/zinc Metal oxide compared to the control samples and samples under pure SODIS experiments. The results revealed the potential of improving SODIS water disinfection efficiency by combing it with the metal/metal oxide photocatalyst.

Key words: Metal/Metal Oxides, photocatalysis, water disinfection

Determination of Fluoride and Some Heavy Metals in Water, Blood and Urine Samples among Some Inhabitants of Gashua, Bade Local Government Area, Yobe State, Nigeria

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Abstract
The research area was in Gashua, Bade Local Government Area, Yobe State, Nigeria. The levels of fluoride, cadmium, arsenic, lead, iron and nickel were determined in sachet and borehole water samples. The levels of fluoride, cadmium, arsenic, lead, iron and nickel were also determined in blood and urine samples with respect to age groups and gender. Sample collection and preparations were carried out using standard procedures. The concentrations of all the studied metals were determined using atomic absorption spectroscopy (A.A.S). The concentration of fluoride was observed to be higher in the male subjects when compared to the female subjects. It was also observed that the concentration of fluoride was significantly higher in the urine samples when compared to the blood samples. From the present study the concentration of iron ranged from 0.11 to 2.13 mg/L, 0.01 to 1.42 mg/L arsenic, 0.01 to 2.13 mg/L cadmium, 0.01 to 1.77 mg/L nickel and 0.02 to 2.13 mg/L lead. Results from the present study showed that the mean concentrations of arsenic in the borehole water samples from the different wards in Gashua ranged from 0.87 to 2.98 mg/L; 0.44 to 0.77 mg/L lead, 1.04 to 2.13 mg/L nickel, 0.12 to 0.35 mg/L cadmium and 2.56 to 5.56 mg/L iron. The values obtained from the borehole water samples were higher than the WHO standard value of 0.05 mg/L arsenic, 1.0 mg/L iron, 0.01 mg/L lead, 0.07 mg/L nickel and 0.005 mg/L cadmium for drinking water. Information from this research showed the possible factors that may result in gender metal accumulation. The concentrations of all the study metals in the urine and blood samples were significantly higher than the WHO limits. Data obtained from borehole water samples showed that, the borehole water might be a contributing factor to blood/urine metal accumulation. Information from this research also showed the possible factors that may result to higher concentrations of all the metals in urine (both recent and past exposure) when compared to blood (only recent exposure). Data obtained from the present research indicate that the concentrations of all the metals in the blood and urine samples increased with increase in age group. This fact could be explained by the tendency of heavy metals to accumulate in the human body (bioaccumulation of heavy metals) with time, indicating that metal accumulation is age dependent.

Photo Degradation of Pentachlorophenol (PCP) Pesticide under Different Light Energies and Exposure Time on the Surfaces of Spinach Leaves

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Abstract
The aim of the current study was to investigate the photo-degradation of pentachlorophenol by incandescent light bulbs and fluorescence light on the surface of spinach leaves. Most of the research that has previously been done in pesticides show that insecticides, herbicides and fungicides tend to persist in the environment mainly in the soil, water, or air, for a long duration of time. Therefore, it is necessary to determine their possible degradation using different light sources and intensities at different exposure times. The research was done by applying 0.01g of, each pesticide on 5cm by 5cm spinach leaf surfaces. The applied pesticide on each surface was shaken thoroughly for five minutes and thereafter exposed to 40w and 100w incandescent bulbs, 9w and 40W fluorescent bulbs at 2, 4, 6, 8 and 10 minutes after which the set-ups were allowed to stabilize for an hour. The stabilized set-ups were washed with 3ml of analytical grade acetone and were analyzed for pesticide level using HEWLETT PACKARD Gas chromatography/Mass spectrophotometer. The procedure was done in duplicate for statistical purpose and the data obtained was recorded, analyzed and interpreted using Microsoft Excel 2013 and Minitab.
software. The research found out that the photo-degradation of pentachlorophenol depends on the light intensities, surface of exposure, temperature, among other factors. The fluorescent bulbs emitted less heat as compared to incandescent bulbs thus; photo-degradation in fluorescent bulbs had lower values as compared to incandescent bulbs. For example, the 40w fluorescent bulb degraded 100µg of pentachlorophenol at 2 minutes to 95.41528µg, while the 40W incandescent bulb degraded the same amount of pentachlorophenol at 2 minutes to 94.36925µg. This is attributed to the fact that fluorescent bulbs emit less heat as compared to incandescent bulbs and as a result photo-degradation in fluorescent tubes occurred due to the presence of light only, while in incandescent bulbs it occurred due to the presence of both heat and light. Also, at high temperatures a high number of photons are emitted which are responsible for chemical reactions hence high rates of degradation for the 100w bulb. Rate of degradation was obtained using the formula: 
\[
\ln(A_t) = -kt + \ln(A_0)
\]
Where \( A \) is the concentration of the pesticide molecule at time \( t \), \( t \) is the exposed time, \( k \) is the rate constant of degradation and \( A_0 \) is the initial concentration of the pesticide. In this case, first order kinetics was followed based on the high regression values obtained by the plotted graphs of natural logarithms of concentration versus time. The half-lives of pentachlorophenol molecules on the various exposure times ranged between 4.820554 seconds to 152.9089 seconds for the incandescent bulbs and 0.902431seconds to 108.2948 seconds in fluorescence bulbs. This was also dependent on the light intensity, surface of exposure and radiation time.

**Key words:** Photo-degradation, pentachlorophenol, light intensity, rate

**Naturally Substituted Brushite: Treatment of High Fluoride Waters**

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**Abstract**

Dicalcium phosphate dihydrate (CaHPO4·2H2O - Brushite) adsorbent, naturally doped with trace amounts of Mn and Sr was prepared from crab shells by wet chemistry method. The adsorbent was characterized using XRD, EDX, FT-IR and tested for treatment of ground and surface water contaminated with varying levels of fluoride (5-70 mg/L) in comparison with traditionally used bone char. Results indicated that doped brushite performed exceptionally well with highest adsorption capacity 13.6 mg/L compared to 2.6 mg/L for bone char. Varying pH and temperature did not significantly affect the adsorption capacity. Adsorption characteristics were fairly modelled by non-linear Langmuir isotherm and pseudo second order kinetics. The quality of treated water improved significantly with high pH reduced to an acceptable range of 7-8 and color tint reduced to a large extent. The results of this study have demonstrated the effectiveness and feasibility of Mn and Sr doped brushite for the removal of fluoride ions and color tint from field waters in its natural environment without changing the conditions of temperature and pH, given that most waters polluted with high fluoride have high pH (8-9.5).

**In Situ Cross-Linked Chitosan-3,6-Diacetylnaphthalene Ni(II) Complexes as a Versatile Solid Catalyst**

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**Abstract**

Chitosan has been shown to be a very promising support for the immobilization of catalytic metals. In this study, 3,6-diacetylnaphthalene-2,7 diol (DAND) was used to crosslink chitosan (Chit-DAND) which was used in-situ to synthesize metal complex of Ni(II) [Chit-DAND-M] (Fig 1). The complex was used to catalyze the oxidation of methanol to formaldehyde using molecular oxygen as oxidant. The Chit-DAND and M-Chit-DAND were characterized by spectroscopic (FT-IR, AAS and UV-Visible), XRD and SEM analyses. Application of these complexes for the oxidation of methanol afforded formaldehyde with improved yield under mild reaction system. Comparing the reactivity of the various heterogenous based catalyst, the optimum reaction condition for the catalytic oxidation of methanol was achieved at a reaction time of 60 min using [Chit-DAND-Ni(II)] at a temperature of 66 °C.

**Key Words:** Chitosan; 3,6-diacetylnaphthalene-2,7 diol; Heterogenous catalyst and Oxidation
Ultra Violet Electromagnetic Radiation Photocatalytic Treatment of Wastewater from Tea Processing Factories in Kenya

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Abstract
Wastewater from black tea (Camellia sinensis) processing factories is characterized by a persistent brick-red colour that conventional treatment works is unable to remove. In this research work, photocatalytic decolourization of the persistent brick-red colour of black tea processing wastewater was investigated. A total of 48 wastewater samples were collected from three black tea processing factories in the western Kenya tea growing highlands, physico-chemically characterized and subjected to UV electromagnetic radiation while on zinc oxide-coated surface. A prototype photocatalytic reactor. An amount of 500 cm³ of each wastewater sample was put in the prototype Photocatalytic reactor to give a sample solution a height of approximately 2 cm. This was illuminated with -l Ultra Violet electromagnetic radiation at a wavelength of 365 nm and intensity 3.0 mW/cm² for a total of 180 mins. These experiments were repeated using Solar light of intensity 1.4 mW/cm² in place of the Ultra Violet electromagnetic radiation. Analytes of 5 cm³ were drawn every 15 minutes and analyzed using Ultra Violet/Visible spectrophotometer at λ = 410 nm. The photocatalytic treatment of the wastewater was found to reduce physico-chemical parameters as follows; TOC, COD, Turbidity, TSS and TDS by 74.8 %, 58.5 %, 45.1 %, 59.07 % and 41.53 % respectively, increased pH from 5.6 to 6.8 and decolourization by 82% of the brick-red colour in 3 hrs using UV electromagnetic radiation. Solar radiation produced higher efficiency of decolourization of 3% above UV electromagnetic radiation. On average decolourization of 61% Solar and 58% UV radiation was achieved in 60 minutes. Solar radiation intensity used was 47% lower than that of Ultra Violet electromagnetic radiation.

Keywords: Camellia sinensis, Photocatalysis, Zinc oxide, Solar, Ultra Violet Radiation,

EDXRF and Multivariate Statistics in Source Identification of PM2.5

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Abstract
The study of atmospheric particulate matter (PM2.5) is of great significance for air quality and climate monitoring. PM2.5 is particulate mass of particles with aerodynamic diameter ≤ 2.5 µm. When inhaled adverse human health effects results in death, high mortality and long unproductive man-hours. Increase in urban population means increased human exposure to air pollution, thus increasing health related expenditure. To help in mitigating the scenario, a good understanding of sources of particulate pollutants is important for facilitation of control strategies. A combination of EDXRF analysis and statistical multivariate receptor models has proven effective in identification and apportionment of air pollutants. EDXRF is a non-destructive and versatile technique that allows multi-elemental analysis. Receptor models such as PMF are gaining popularity because they are aimed at quantifying the contribution of sources based on the composition of the source chemical profiles. Its uniqueness as opposed to principle component analysis is the guarantee of non-negative results. Sampling was conducted at an urban background site at the Electrical Engineering building, UoN, using an Andersen
Pesticides Handling Practices by Stockists and Farmers, and Suspected Toxicity In Kisumu County, Kenya

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Abstract
Pesticides are chemical or biological substances that are designed to kill or retard the growth of pests interfering with the growth of crops, shrubs, trees, timber and other vegetation desired by humans. Exposures to these chemicals occur through inhalation of vapour, ingestion/oral and dermal/contact. Their effects to human differ depending on the degree and duration of exposure. The aim of this study was to evaluate pesticides handling practices stockists and farmers, and self-reported toxicity symptoms in Kisumu County. Stratified and convenience sampling technique were employed for purposes of selecting the sample size of the study. For the pesticides outlets, the County was sub-divided into 7 strata. A structured survey was used in the study and a questionnaire was administered to the respondents to collect primary data. The other source of primary data was by observational checklist. Results indicated that 82% of pesticide handlers changed clothing before and after pesticide exposure where 14% did it occasionally, and 4% never changed their clothes. There was significant association between participants’ age and availability of washing area (χ² = 37.325; p < 0.00). There was significant association between changing of clothing before and after pesticides exposure and the level of education (χ² = 14.682; p < 0.01) and position at work (χ² = 9.168; p < 0.01) and hours of working (χ² = 10.311; p < 0.03). 88% of handlers always had a place to wash hands next to where they store or handle pesticides. Skin itching, coughing and sore throat were significantly associated with skin and respiratory diseases respectively (RR > 1). It was observed that skin diseases resulting from itching, and respiratory diseases as a result of coughing and throat irritation can be reduced by 63%, 57% and 79%, if exposure to pesticides is reduced by use of appropriate PPEs. It was recommended that employers should train the pesticide handlers on effective use of PPEs and their provision made mandatory.

Assessment of Heavy Metals and Nutrient Contamination in Sugar Factory Effluent

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Abstract
The main purpose for conducting this research was to determine the amount of heavy metals, nutrients drained into R. Sare from Sony Sugar factory effluent. Water pollution being a state at which water is unfit for human, animals and plant within the eco-system. This has caused a serious concern globally due to the deterioration of both the quality and quantity of water. This has been linked in one way or another to the heavy metals and nutrients from various industries. The water samples were collected in triplicate from twenty sites along the effluent drainage system during the wet season of April (2017) and dry season of July (2017), analyzed for physico-chemical parameters, nutrients and heavy metals. Heavy metals were done using atomic absorption spectrometer. Phosphate concentration recorded a value ranging from 0.66±0.18 mg/L to 6.14±3.15 mg/L. The concentration of lead, copper, zinc, cadmium and chromium ranged between 0.11±0.015 ppm to 1.26±0.77 ppm, 0.01±0.00 ppm to 0.63±0.03 ppm, ND to 2.85±0.08 ppm and ND ppm to 0.0038±0.00 ppm respectively. From the analysis it was evident that the concentration of most of heavy metals was below the permissible level recommended by the WHO with an exception of lead and cadmium that recorded much higher concentration above the WHO limit.

Assessment of Heavy Metals Contamination in Lake Elementaita Drainage Basin

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Abstract
The future of Lake Elementaita, Kenya, hangs in the balance between environmental conservation and exploitation of the catchment resources for agricultural and industrial development. In the recent past the Lake has experienced water quality deterioration that is likely to lead to adverse ecological effects of the lake biodiversity. This study aimed at determining the impact of human activities in the catchment on contamination of heavy metals namely; cadmium, copper, lead and zinc. Water, sediments and soil samples were collected from seven sites in the Lake drainage basin to determine the extent of physico-chemical parameters and heavy metals concentrations. Samples for heavy metals determination were digested using aqua regia solution followed by perchloric acid and analyzed by Atomic Absorption Spectrometer, while physico-chemical parameters were analyzed using portable meters. Water pH ranged from 6.94 to 10.84, TDS from 0.07 g/L to 4.21 g/L, TSS from 0.01 g/L to 0.07 g/L, while electrical conductivity ranged from 0.14 mS/cm to 8.40 mS/cm. Heavy metals concentrations in water ranged from 0.04 mg/L to 3.14 mg/L, whereas the levels in sediments ranged from bdl to 134 mg/kg and from 2.78 mg/kg to 86.95 mg/kg in soil samples. Except for zinc, the levels of the rest of the metals in water were above WHO recommended limits for drinking water suggesting that the water is not safe for life. The results revealed that human activities are contributing to heavy metals contamination in Lake Elementaita drainage basin and management effort is required to
control contamination to protect the lake ecosystem and biodiversity.

Tris-Cyclometalated Iridium (III) Complexes: Synthesis, Characterization and Selected Applications

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Abstract
Luminescent tris-cyclometalated Ir (III) complexes have gained considerable attention owing to their remarkable and unique photochemical, electrochemical and structural properties. As such, they find use in diverse fields such as photocatalysis, organic light emitting diodes, pH sensors, etc. Photoredox catalysis, which utilizes visible light, has become an emergent powerful tool for organic transformations through single-electron transfer (SET) processes and occurs under mild conditions promoting green and sustainable chemistry. A photosensitizer absorbs visible light and transfers excited-state electron to acceptors (inert PC generates oxidant/reductant in situ leading to chemical transformations). The study reports the synthesis and subsequent utilization of 2-naphthyl-1-pyridine tris-homoleptic complexes as photoredox catalysts in dual functionalization of alkenes (oxytrifluoromethylation) and selective oxidation of alcohols to carbonyls. Trifluoromethyl group is commonly found in pharmaceutical compounds due to its ability to enhance polarity and membrane permeability as well agrochemicals, while carbonyls are important in pharmaceutical industries.

Assessment of Selected Micronutrients in Common Beans in Kenya

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Abstract
Health growth of plants and human beings depends on availability of small amounts of specific micronutrients and their assimilation into the respective systems. Human beings and animals receive these critical health species through the food chain and their deficiency results in ‘hidden hunger’. We report Mn, Fe, Cu and Zn concentrations in common beans in Kenya which were assessed using Total Reflection X-ray Fluorescence (TXRF) instrumentation. Beans are the third most important staple food and most important legume in Kenya and are taken in almost every household. In this study fresh bean leaves and seven (7) species of dry grains were collected from small scale farmers in Machakos and Kiambu. They were well packed in clean polyethene bags and delivered to the laboratory, where they were powdered and prepared for analysis. Analysis involved dissolving ≈45 mg of the powdered sample in 2.5 ml Triton X100 solution and using Sc as the internal standard. Average concentrations of the four elements were compared to known recommended quantities and Mn deficiency was observed in four species while Zn was deficient in all the species. Fe concentrations were above the sufficiency range for all the species but not to toxic levels. Cu concentrations were within the sufficiency range in 28.6% of the samples.

New Bis(Pyrrolylimine) Platinum (II) and Palladium (II) Complexes: Synthesis, X-Ray Structure Determination, Spectroscopic Characterization, and in vitro Anticancer Activity on Various Human Carcinoma Cell Lines

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Abstract
The synthesis, characterization and anticancer tests of new Schiff base ligands; (E)-N-((1H-pyrrol-2-yl)methylene)phenyl)methanamine; PC-BA and (E)-N-((1H-pyrrol-2-yl)methylene) thiophen-2-yl)methanamine; PC-S1, and their trans-platinum (II) and palladium (II) complexes; PC-BA-Pt, PC-BA-PdMe and PC-S1-Pt is hereby described. Spectroscopic characterization was performed by various techniques (H-NMR, FTIR, UV–vis, GC-MS and CV). Crystals suitable for X-ray analysis were grown and solved for both ligands. The ligands crystallizes in P 21/n monoclinic space system for PC-BA and C 2/c space system for PC-S1. The compounds were evaluated for anti-cancer activity in vitro using MTT assay on MC-7 breast cancer cells, A2780 human ovarian cancer cell lines.
**Key words:** Pyrrolylimine, Crystal structures, Platinum (II) and palladium (II) complexes

Anticancer activity

**Abstract**

Molecular chaperone Heat Shock Protein 90 (Hsp90) represents an interesting chemotherapeutic target for cancer treatments, as it plays role in cancer proliferation. This work aimed to identify novel Hsp90 inhibitors as anticancer agents. Repurposing of FDA approved drugs was carried out using a relaxed complex scheme an in silico method. FDA approved drugs were screened from DrugBank data base. Two drugs; 5-4-[4-(5-cyano-1H-indol-3-yl)butyl]piperazin-1-yl-1-benzofuran-2-carboxamide known as vilazodone and (3R,4S)-1-(4-fluorophenyl)-3-[(3S)-3-(4-fluorophenyl)-3-hydroxypropyl]-4-(4-hydroxyphenyl)azetidin-2-one known as ezetimibe were identified as novel potent inhibitors of Hsp90β. Docking and molecular dynamic studies of these drugs revealed a second binding pocket. Vilazodone showed strong binding in the second pocket suggesting it to be an allosteric inhibitor. The role of water in Hsp90-drug interaction was investigated. Water was observed to mediate the interaction of some drugs with Hsp90. However, in some cases, water did not mediate the interaction between Hsp90-drugs complex. The identified drugs are further recommended for pre-clinical and clinical evaluation. The study also recommends on the sensitivity of the relaxed complex scheme and the inclusion of water during molecular docking.

**Water Quality Index for Bottled Drinking Water in Kenya**

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**Abstract**

Water quality is defined on the basis of the presence of some physical, chemical and microbial parameters found in the water. If these parameters exceed the set limits, the water may cause adverse negative health issues to the consumers. The Kenya Bureau of Standards (KEBS) and the World Health Organization (WHO) have set standards and guidelines for most of the major water parameters. However, these guidelines do not specifically gauge the water quality depending on the levels of these parameters. A water quality index (WQI) in which various parameters are modelled into a mathematical equation is the most effective way of determining and reporting the water quality. A study was carried out to assess the water quality index of bottled water commonly found in Nairobi. 31 samples from different bottling companies were obtained and the index calculated based on six parameters (pH, F-, conductivity, Na, Ca, and K). 10 (32.3%) of the samples had a WQI of 0-25 rated as excellent water quality, 17 (54.8 %) of the samples had a WQI of 26-50 rating as good water quality, 1 (3.2%) of the sample had a WQI of 51-75 rating as poor water quality, while 2 (6.5%) of the samples had a WQI of 76-100 rated as very poor quality water. Only 1 (3.2 %) sample had WQI >100 and is considered unsuitable for consumption. Based on the six parameters analyzed, it can be concluded that most of the bottled water brands were of good quality and only one brand is considered unfit for consumption. The major parameter affecting the WQI was the fluoride ion which is toxic if maximum limits are exceeded.
PM$_{2.5}$ AND ROAD-SIDE DUST POLLUTION BY HEAVY METALS ALONG THIKA SUPERHIGHWAY IN KENYA, SUB-SAHARAN AFRICA

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Abstract

This study assessed the level of heavy metal in roadside dust and PM$_{2.5}$ pollution along Thika superhighway in Kenya. Thika superhighway is one of the busiest roads in Kenya. Triplicate road dust samples collected from 12 locations were analysed for lead (Pb), chromium (Cr), cadmium (Cd), nickel (Ni), zinc (Zn), and copper (Cu) using flame atomic absorption spectrophotometry. PM$_{2.5}$ samples were collected on pre-weighed Teflon filters using a BGI personal sampler and the filters were then reweighed. The filters were then analysed for elemental pollutants using an X-ray fluorescence. The ranges of metal concentrations were 39–101 μg/g for Cu, 95–262 μg/g for Zn, 9–28 μg/g for Cd, 14–24 μg/g for Ni, 13–30 μg/g for Cr, and 20–80 μg/g for Pb. The concentrations of heavy metals were generally highly correlated, indicating a common anthropogenic source. The results showed that the majority of the measured heavy metals were above the background concentration, and in particular, Cd, Pb, and Zn levels indicated moderate to high contamination. Though not directly comparable due to different sampling timeframes (8 h in this study and 24 h for guideline values), PM$_{2.5}$ for all sites exceeds the daily WHO PM$_{2.5}$ guidelines of 25 μg/m$^3$. Elemental analysis of the filters showed present of several toxic heavy metals. This poses a health risk to people using and working close to Thika superhighway, which is not in line with the sustainable development goals (SDGs) 3 and 11. PM$_{2.5}$ levels were higher for sites closer to Nairobi. This study provides some evidence of the air pollution problem arising from vehicular traffic in developing parts of the world and gives an indication of the potential health impacts. It also highlights the need for long-term sampling studies to fully understand spatiotemporal patterns in air pollution within developing countries.

Keywords: PM$_{2.5}$, Heavy metals, Roadside dust, Air pollution, Health, Vehicular emission, Atomic absorption spectrophotometer, Geoaccumulation, Contamination factor, Africa

Characterization of Experimental Dental Cements Derived from Locally Available Aluminosilicate Materials in Kenya

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Abstract

An evaluation of locally available alkali-activated aluminosilicates (geopolymers) and clinker was carried out for the purpose of establishing a substitute material for development of atraumatic restorative treatment (ART) cements. Materials were obtained from local Portland cement manufacturers. Compositional analysis was carried out by Graphite Furnace Atomic Absorption Spectroscopy (GFAAS), X-ray Fluorescence (XRF), X-ray diffraction (XRD) and Fluoride Selective Electrode meter while Laser diffraction was used for particle size analysis (LDPSA) after sieving through a 53µm sieve. Geopolymers and clinker (0.5-1g) were mixed with freeze-dried poly(acrylic-acid) (0.1-0.2g) and aqueous tartaric acid (0.15-0.25mL) to produce cements whose setting time and compressive strength in 100% humidity was assessed after 1, 3 and 7d. Mineral trioxide aggregate (MTA) and glass ionomer cements (GIC) were used as controls. Geopolymers, clinker and MTA were found to contain varying ratios of SiO$_2$ (18-74wt%), CaO (1-65wt%), Al$_2$O$_3$ (2-27wt%) and similar diffraction peaks of CaCO$_3$, 2CaO.SiO$_2$ and 3CaO.SiO$_2$. MTA was found to contain Bi$_2$O$_3$ (16-33wt%) and Pb (1-2wt%), while geopolymers and clinker contained <0.001wt% Pb. Two geopolymers contained F- (5.99- 43.33µg/g). LDPSA reported an average particle size of 45 µm or less. The average mixing time was 1min while setting time ranged from 1.5-8min. All cements except those based on kaolin softened in distilled water at earlier time points but seemed to harden again after 28d. However, the kaolin cements exhibited the lowest CS (<5MPa) while one of the clinkers had CS of 14MPa after 28d.

Keywords: Clinker, Geopolymer, Atraumatic Restorative Treatment, Cement formulation

Water Quality Status of Selected Sources of Domestic Water in Kenya

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Abstract
In Kenya, water scarcity is a major issue due to destruction of water catchment, poor management of water supply and contamination of national water resources. The government’s long-term objective is to ensure that all citizens have access to safe drinking water. Although the government has increased the budget for improving access to water, many citizens still do not have access to potable water. The study analysed contaminants from selected sources of domestic water in the counties of Machakos, Nakuru, Kiambu and Nairobi. The following physico-chemical parameters were investigated – pH, conductivity, total suspended solids (TSS) and total dissolved solids (TDS), dissolved oxygen (DO), chemical oxygen demand (COD), anions (Cl- and PO₄³⁻), E. Coli and total coliforms. Water samples were collected from eight sampling sites in dry and wet seasons and analysed following standard methods. pH values varied from 6.3 – 9.1 in the dry season, and 6.9 – 9.5 in the wet season, conductivity from 244.0 – 5758.0 µS/cm in the dry season and 141.0 – 2004.0 µS/cm in the wet season, TDS from 113.0 – 5,824.0 mg/L in the dry season and 82.0 – 183.0 in the wet season, temperature from 24.1 – 25.2˚C in the dry season and 25.3 – 25.8˚C in the wet season, TSS from 0.00 – 0.01 mg/L in the dry season and 0.01 – 0.02 mg/L in the wet season, COD from 112.0 – 255.0 mg/L in the dry season and 90.6 – 154.0 mg/L in the wet season, DO varied from 2.8 – 4.2 mg/L in the dry season and 3.1 – 4.2 mg/L in the wet season, nitrates from 2.5 – 19.6 ppm, phosphates from 0.03 – 2.24 mg/L, while E. Coli varied from 13 – 4,300 CFU/ml. The values obtained for most parameters were within WHO and National Environment Management Authority (NEMA) guidelines for domestic water, except for two sites (Athi River and Portland), where pH, TDS and conductivity exceeded the guidelines. Most sites had biological contamination indicating anthropogenic contamination, rendering water unsafe. The water needs to be decontaminated to safeguard human health.

Keywords: Domestic water quality, Physico-chemical parameters, Nutrient levels and Biological contamination

Catalysis as a Technology of the Future
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Abstract
Catalysis is regarded as the technology of the future. Senior scientists such as Prof Dr Wolfgang Herman long realised this potential. Catalysis is relatively the only scientific art that combines economic and ecological values as close as possible. It is no surprise that the two principles drive the world. The technical advances in the production, storage, and conversion of energy lie in the catalytic processes for example, ammonia synthesis, olefin polymerization, ethylene chlorination and hydroformylation among others. The industrial mimicking of natural catalysis or bio-catalysis is emerging with great commercial value. The world is conscious of the safeness of chemical reactions and the future is dictated by how green any adopted reaction is. Notably, some copper(II) complexes have been employed as biocatalyst models of the copper enzyme Galactose Oxidase (GO). This is an important enzyme in the oxidative transformation of primary alcohols to corresponding aldehydes with a consequent reduction of dioxygen to a peroxide i.e. hydrogen peroxide. This catalytic transformation involving enzyme models has been suggested to transpire via the formation of the mononuclear Cu-O₂ species. Several similar examples of these micro machines exist in the literature but some new and potential potent copper complexes will be discussed.

Fig 1: X-ray crystal structure of 1 at 50% probability level with hydrogen atoms omitted for clarity
The Place of Inorganic Chemistry in the Competency Based Curriculum (CBC)

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Abstract
Kenya Institute of Curriculum Development is an autonomous government agency established by an Act of Parliament, The KICD Act, 2013. It is mandated to develop curriculum and curriculum support materials for all levels of Education in Kenya below the university. The government of Kenya is currently carrying out education reforms to align education to the dictates of Kenya vision 2030, aspirations of the 2010 constitution and the 21st learning skills and competencies. The process is guided by the National Education Philosophy summarized in the statement “Education and Training for Social Cohesion as well as Human and Economic Development” and the national goals of education. Key to education reforms is curriculum reform. KICD has developed a competency-based curriculum for Early Years Education (EYE). It is undergoing a second phase of piloting in all schools this year in readiness for a national roll out in grade 4 come January 2019. The Vision of the CBC is “An engaged, empowered, and ethical citizen contributing to make a socially, economically, and politically stable society”, and the Mission is “Nurturing every learner’s potential”. The CBC is being implemented in a 2+6+3+3 structure of education as contained in the Basic Education Curriculum Framework (BECF). This structure will gradually replace the current 2+8+4 basic education structure. The BECF proposes that the minimum number of years for a university degree be 3 instead of the current 4 years. The BECF stratifies education into Early Years Education (5 years); Middle School (6 years), and Senior School (3 years). Currently Inorganic Chemistry is taught in secondary school from from 1 to 4 and constitutes more than 80% of the Chemistry content taught at this level compared to Organic Chemistry. In the CBC, Inorganic Chemistry will be taught from grade 7 in lower secondary, under a new learning area called Integrated Science. Learners interested in studying Inorganic chemistry beyond grade 9 will have to choose the Science, Technology, Engineering and Mathematics (STEM) pathway at Senior School. It is envisaged that STEM will absorb 60% of the total students’ population while Social Sciences will absorb 25% and the Arts and Sports pathway, the remaining 15%. The content for Inorganic Chemistry will still be about 80% of the total chemistry content in both lower secondary and senior school. The CBC to be rolled out in 2019 at grade 4 will progress by grade annually, phasing out the current curriculum which will see the cohort in class 4 do the Kenya Certificate of Primary Education (KCPE) in 2022 and Kenya Certificate of Secondary Education (KCSE) in 2026. The terminal assessment of the CBC will be done in 2027. The first cohort of CBC will therefore join the university in 2028 for a minimum of 3 years degree course. This is the cohort joining grade 4 in 2019. A Competency Based Assessment Framework (CBA) is being finalized by the Kenya National Examinations Council (KNEC).

Fluoridation of Locally Formulated Dental Cement and Investigation of Fluoride Dissipation to Assess Suitability in Dental Restoration

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Abstract
High levels of fluoride exposure result to dental fluorosis, a detrimental health effect. Intake of optimally recommended levels of fluoride on the other hand is instrumental in combating dental caries. It is therefore important that the modes adopted to administer fluoride into human system do not expose human teeth to extreme levels of fluoride. In this study, Clinker from three cement companies in Kenya and alkyl activated slag, pumice and kaolin are separately fluoridated using calcium fluoride and fluorspar. The ratio of fluoridation of dental cement formulation to calcium fluoride and fluorspar used in this study is 1:0, 1:1 and 2:1 respectively. The setting times and fluoride dissipation rates for each formulation was then investigated. The average setting times for the formulations was found to be approximately 7-9 minutes. Currently these formulations are under fluoride dissipation rates study. Dental cement made from each formulation has been immersed into 10 – 20 ml of deionized water, artificial saliva and Tris buffer media and are being incubated at temperatures of 35 and 37oC. The artificial saliva, Tris buffer and deionized water used are at pH of 5, 7 and 9. The pH values were selected to concur with human teeth surroundings pH variations. The concentration of fluoride released in day 1, 7, 14 and 28 after immersions will be measured using the fluoride ion selective electrode. Keywords: Fluorspar, fluoride dissipation, dental cements, dental fluorosis, dental caries

Synthesis and Photophysical Properties of Porphyrin Based Compounds for Application in PACT for Water Treatment

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Abstract
Photodynamic Antimicrobial Chemotherapy (PACT) is one of the emerging green technologies for water treatment that uses the mutual presence of light, oxygen and suitable photosensitizer to generate a toxic species that is effective against pathogenic microbial organisms.
The two most favorable features of PACT in decontaminating water are its effectiveness against all microbial pathogens and the fact that there are no reported cases of antimicrobial resistance to PACT. A suitable photosensitizer plays a key role in PACT. It is one that is stable, safe, selective and activatable with light of suitable wavelength. Porphyrin photosensitizers are highly colored structures having four pyrrole units linked through methene bridges to form porphyrin macrocycle. They have important biological and photophysical properties that make them attractive candidates for use as photosensitizers in PACT. The objective of this study, is the synthesis and analysis of novel meso substituted metallo porphyrin photosensitizers that can be used in PACT for water treatment. Using procedures adopted in literature, meso-substituted pyrenyl porphyrins were synthesized. Purification of the synthesized porphyrins was done using column chromatography using hexane and ethyl acetate as the eluting solvent to provide purified porphyrin in good yield. Metalation of the purified porphyrin was done by adopting procedures from literature to synthesize the corresponding metallo-porphyrin. The spectral and photophysical properties of the synthesized porphyrins is discussed.

Synthesis and Photo-Physical Studies of Structurally Modified Meso Si-Porphyrin Dye for application in Water Treatment for Domestic Use

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Abstract
Economic and societal developments anticipated by Kenya’s Vision 2030 require high quality water supplies and improved sanitation available to all. While accessibility to clean water and sanitation is one of the main indicators of Sustainable Development Goals, getting quality water still is a major problem the world is grappling with. Chlorination has proven effective against a range of water-borne pathogens, however, occurrence and re-growth of chlorine resistant pathogens in drinking water poses the latest health crisis around the world. Photodynamic antimicrobial therapy (PACT) combines the action of sunlight, non-toxic photosensitizer(PS) and molecular oxygen to generate toxic substances that kills these pathogens completely. In this study, novel meso substituted porphyrins were synthesized. To enhance the porphyrin properties for PACT, different metals were inserted to enhance intersystem crossing and further red shift the PS into therapeutic window. The porphyrins were characterized by TLC, UV/VIS spectrometry and CHN elemental analyzer. Characterization data from UV-Vis spectrum was consistent with assigned data for free base porphyrins and metalloporphyrins.

The Chemical Kinetics of the Permanganate Oxalate Reaction

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Abstract
The reaction between permanganate ion and oxalic acid has been studied extensively for over a century. It involves the reduction of Mn(VII) to Mn(II) and the oxidation of the oxalate ion to CO2 in acidic medium as shown in the overall equation below.

\[ 2\text{MnO}_4^{2-} + 5\text{C}_2\text{O}_4^{2-} + 16\text{H}^+ \rightarrow 2\text{Mn}^{2+} + 10\text{CO}_2 + 8\text{H}_2\text{O} \]

When permanganate Mn(VII) undergoes reduction by another compound to the manganous ion, Mn(II), the reaction takes place through different steps that involves the formation of intermediates bearing the manganese ion at different oxidation states. The different oxidation states are easily identifiable due to their distinct colors. Different researchers have proposed different reaction kinetics and mechanisms for the permanganate oxalate reaction and to date a common route has not been agreed upon. The reaction is believed to be auto catalyzed by the Mn²⁺ ions formed, while at the same time forming intermediates in either the +3 or +4 oxidation states. The study aimed at establishing the rate law, activation energy of the reaction and characterizing intermediates that can in principle act as an autocatalyst. Progress of the reaction was monitored using spectrophotometry at different wavelengths and intermediates positively identified. The oxidation states of the intermediates are used to propose a possible mechanism to describe the sequence of elementary reactions that occur.

Removal of Heavy Metals from Water using Water Hyacinth (Einchornia Crassipes)

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Abstract

Water hyacinth (Eichhornia Crassipes) is one of the most invasive aquatic species which commonly covers the surface of rivers, lakes, canals and cause a series of environmental problems such as choking waterways, providing a habitat for mosquitoes and diseases, hindering fishing and transport. On the other hand water hyacinth is believed to have a huge potential in the removal of heavy metals such as Cadmium, Zinc, Lead and Copper from waste water by adsorbent method. This study considers the efficiency of using dry stems of the water hyacinth plant which is inexpensive as an adsorbent for the removal of heavy metals from an aqueous solution. Water hyacinth was obtained from Lake Victoria, dried, grounded and then sieved to different particles size. Parameters that are used in this study were contact time, dosage of the bio-adsorbent and particle sizes. All the experiments were carried out at room temperature 25°C and a constant pH of 9.64. The effect of contact time on the percentage adsorption range for cadmium, copper, zinc and copper were 82-57, 74-85, 51-75 and 56-84% respectively. The percentage of ion adsorbed increased with the time of exposure. The effect of particle size on the percentage adsorption range for cadmium, copper, zinc and copper were 69-82, 24-84, 28-75 and 42-70 % respectively. The percentage of ion adsorbed increased with the decreased particle size. The effect of amount of adsorbent on the percentage adsorption range for cadmium, copper, zinc and copper were 69-82, 24-84, 28-75 and 42-70 % respectively. The percentage of ion adsorbed increased with the amount of adsorbent used. The study showed that the DPWHB is an efficient adsorbent for the removal of heavy metals and thus as an inexpensive adsorbent which is easily available it’s preferable for the removal of heavy metals from waste water.

Water Quality Assessment of River Tana (Nunguni), Makueni County, Kenya

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Abstract

Drinking water with high concentrations of fluoride is of great concern in many parts of Kenya. Nonetheless, fluoride in small amounts is essential for bones and formation of dental enamel in both animals and humans. The aim of this research was to assess the content of some anions, cations, total suspended solids (TSS), total dissolved solids (TDS), pH and some heavy metals. Spectrophotometric method was used to measure chloride, sulphate, ammonium and nitrate. Ion selective electrode was used to measure fluoride, total dissolved solids and pH. Gravimetric method was used to measure total suspended solids. Atomic Absorption Spectrometer (AAS) was used to measure the content of cadmium and zinc. The results were as follows: Cd 0.009 mg/L; Zn 1.6 mg/L; F- 1.6 mg/L; pH 8.6; Cl- 41 mg/L; SO4$$^{2-}$$ 145 mg/L; NH4+ 0.4; TDS 508 µS/cm; TSS 25mg/L; and NO3$$^-$$ 11 mg/L. All these were lower than the NEMA guideline values except the levels of zinc, fluoride and nitrate and pH which were all above the NEMA guideline values. The values of zinc, fluoride and nitrate were marginally higher than the guideline values.

Doctoral Training in Inorganic Chemistry for Technological Innovations and Socio-Economic Development

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Abstract

In the current knowledge based world, doctoral training needs to be responsive to not only the advancement of knowledge through original research, but also meeting societal needs that are wider than academia. The knowledge society requires a creativity and flexibility of the researchers’ mindset for a number of different functions and careers that go beyond those directly related to research. Doctoral studying is at the epitome of academic practices and has increasingly achieved recognition as a key part of this process worldwide. There are select few doctorate holders and even fewer doctorate scientists leave alone inorganic chemistry doctorates holders. Previous studies, on the doctoral studying experience in Europe suggest that students face a variety of difficulties during their studies. Attrition rates among doctoral candidates have been reported to range from 30% to 50%, depending on the discipline and country. In Africa the statistics are more depressed as they are coupled with very low enrolment, lack of funding and very high average age of candidates. In addition, there is a high migration rate out of mother country. Doctoral training in inorganic chemistry across the globe is relatively low while its knowledge and skill is in high demand for cutting edge innovations and technologies. Inorganic chemists address issues in medicine and biology, energy storage and consumption, synthesis of materials, photo- and electrochemical homogeneous and heterogeneous catalysis, transition metal and main group organometallic chemistry, solid state and surface chemistry.

Assessment of Pesticide Contamination in Sugar Factory Effluent
**Abstract**

The main purpose for conducting this research was to determine the amount of pesticides drained into R. Sare from Sony Sugar factory effluent. Water pollution being a state at which water is unfit for human, animals and plant within the eco-system. This has caused a serious concern globally due to the deterioration of both the quality and quantity of water. This has been linked in one way or another to the heavy metals and nutrients from various industries. The water samples were collected in triplicate from twenty sites along the effluent drainage system during the wet season of April (2017) and dry season of July (2017), analyzed for physico-chemical parameters and pesticides. Pesticide analysis was done using GCMS. The OCPs from the 20 water samples were detected with a concentration that ranged from BDL to 0.74±0.34 µg/L. The results showed that the banned organochlorine pesticides such as aldrin, dieldrin, endrin, heptachlor, DDT and its metabolites are still present. From the analysis it was evident that the concentration of most of Pesticides was below the permissible level recommended by WHO.

**Determination of Heavy Metal Concentrations in Effluents Emanating from Vegetable Oils and Chemical Industries in Nairobi County**

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**Abstract**

The rate at which Kenya is urbanizing is alarming. Millions of Kenyans are relocating to urban centers every year to search for employment opportunities in industries. As a result of this rapid population growth and urbanization, there is a high demand for goods such as vegetable oils and detergents. These oils and detergents are contaminated with heavy metals through endogenous and exogenous sources. Most of these industries discharge their effluents in sewers, rivers and other water bodies without following the NEMA, KEBS and WHO guidelines. This project was therefore aimed at determining the concentration of Pb, Cd, Cr, Mn, Cu and Zn from effluents emanating from chemical and vegetable oil industries and determines their level of compliance. Samples from the two industries were collected on the same day at two sampling points; (i) Entry to the treatment plant for untreated effluents, (ii) Discharge from the treatment plant for treated effluents. Digestion of the samples was carried out using aqua-regia. Analysis of heavy metals was carried out using atomic absorption spectrophotometer. Physicochemical parameters were also determined using the standard method for the examination of waste and waste water. The concentration of Cd, Zn, Mn and Cu were within the set standards of discharge with mean value ± standard deviation (sd) in the treated effluent of chemical industry as 0.02 ± 0.01, 0.44 ± 0.07, 0.64 ± 0.37 and 0.04 ± 0.01 respectively. Similar results were obtained from a vegetable oil industry where the mean concentration ± sd for Cd, Zn, Mn and Cu in the treated effluents were 0.02 ± 0.01, 0.39 ± 0.13, 0.56 ± 0.04 and 0.05 ± 0.01 respectively. Chromium was not detected in both untreated and treated effluents from the two industries. Lead concentration in chemical industry exceeded the KEBS limits. For the physicochemical parameters, Total dissolved substances (TDS) values in the chemical industry were within the limits however in the vegetable oil industry, the values exceeded the limits set by NEMA and KEBS. Electrical conductivity values in the treated effluents from the chemical industry were within the NEMA and KEBS limits while the conductivity values in treated effluents exceeded both limits. All the pH and temperature values were within the NEMA and KEBS limits. Due to the presence of heavy metals and total dissolved substances in the effluents, regular monitoring of the effluent from these companies is important. NEMA should enforce the existing regulations for compliance.

**C–H activation and functionalisation using late transition metals**

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Direct one step conversion of unreactive carbon-hydrogen bonds into bonds with a desired functional group is a highly effective and rational way of producing bulk and fine chemicals, but it still remains a fundamental challenge in synthetic chemistry. Here we report on some different approaches towards understanding and application of C–H activation. Pincer complexes serve as model systems for understanding and developing C–H activation reactions and some examples involving multiple, reversible and low temperature C–H activations will be presented.

Problems remain in providing site selective functionalization of a single C–H bond within a complex organic molecule that contains numerous positions suitable for activation. We will show how this problem can be addressed both through the choice of metal but also through the choice of ligand. Furthermore, examples of recyclable catalysts will be discussed.

**Selected references:**
Building Sustainable Capacity in Population and Health Research in Africa: The Experience of the Consortium for Advanced Research Training in Africa (CARTA)

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Renewed interest in the enhanced production and utilization of research knowledge and evidence-based decision-making has led to a corresponding need for building and retaining research capacity in Africa. High-quality research capacity is key to addressing the myriad issues facing Africa and to developing effective programmes to improve socio-economic outcomes and systems in the region. Meeting the development needs of the continent requires research conceptualized, conducted, analyzed, and published by Africans themselves. To address the rising burden of social problems, improve systems, and attain improved livelihoods and better health, the continent needs strong research capacity in various fields including social and health sciences, development, governance and public policy, ICT, education, and agriculture, among others. Countries without strong research expertise have limited capacity to identify and prioritize their needs and, hence, are unable to design and deliver effective programmes to promote well-being.

The urgent research capacity needs of Africa create enormous opportunities for innovative interventions. The Consortium for Advanced Research Training in Africa (CARTA) was established in 2008 with the primary aim of producing research leaders in population and health research. CARTA comprises of 9 African partner universities, 4 leading research institutes and 6 northern partners. The northern partners include the University of Gothenburg and Umea in Sweden, University of Warwick in the United Kingdom and the Swiss Tropical Institute.

Northern partners have played a crucial role in the development of CARTA. They have provided support in selection of CARTA fellows, planning and facilitating residential month-long Joint Advanced Seminars, faculty and administrators’ workshops, and supervisors’ trainings, organizing short courses for capacity building, providing research placement/internships, mentoring of the doctoral students, providing replacement teachers for fellows and postdoctoral fellows, and proposal development and fundraising for the programme. In turn, the European universities have gained by building networks for future collaboration, adapting new models for research training in practice, initiation of collaborative work, and access to material from research institutes.

The mutual relationship between African partner institutions and CARTA partners in Europe have produced twenty 53 high quality PhD graduates who have published over 330 journal articles in peer-reviewed journals, attracted over $9.2 million in research grants and influenced policy in population and health in Africa. The lessons learned in the establishment and running of the Consortium point at the unexploited potential that rests in a collaborative approach of doctoral training that curbs brain-drain in Africa while building a critical mass of researchers and change agents for universities in Africa.
Chemists do not usually stutter. It would be very awkward if they did, seeing that they have at times to get out such words as methylethylamylphenylum.

SIR WILLIAM CROOKES, 1832 - 1919