UNIVERSITY OF NAIROBI

Science Outputs for Addressing Grand Societal Challenges for Transformational Impacts

RESEARCH WEEK 2021

4th Annual Conference of the Faculty of Science and Technology, University of Nairobi

24 – 26 November 2021

Book of Abstracts and Program

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(2)   Joseph Mutemi, Department of Earth & Climate Science (Co-Chair)
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(10) Francis Mulaa, Dean, Faculty of Science and Technology (Host)
(11) Jacqueline Aput (FST Committee Secretary)

Foreword

Science Outputs for Addressing Grand Societal Challenges for Transformational Impacts

The global, regional and national agenda and programmes for sustainably improved welfare is threatened by many natural and non-natural challenges. The novel Coronavirus has suppressed global economic activities for nearly a year and a half since its outbreak in late 2019 and disrupted conventional work, research and learning environments. The global 2030 agenda, regional and national development visions and action plans did not achieve much during the year ending 2020. We need to appraise how our utilization science and research outputs may guide in the application of knowledge, what we could we have done better and lessons learned that we can use to mitigate such global challenges. Are we upholding good scientific disciplines, for example scientific leadership, championing innovativeness in research, applicability and working towards legacy to the benefit of present and future generations? Addressing these issues will be the core focus on conference papers, online posters and exhibitions during the CBPS research week 2021 **e-conference**. The Conference will run for three days **24 – 26 November, 2021** with an overall theme "Rethinking research, innovation & technology for sustainable development" under the following sub-themes:

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I. Science, Technology and Innovation in Industry for Sustainable Socio-Economic Transformation
    - Start-Ups, SMEs; MSMEs and Spin-offs
    - Science, technology and innovation for value addition and job creation
    - Natural and artificial raw materials in industry
    - Biotechnology and nanotechnology
    - Statistical Quality control and acceptance sampling in industry
    - Automation for improved industry
    - Alternative sources of energy for development
    - Science- Investment Partnerships for Training and Technology Transfer
    - Climate Change Mitigation and Environmental Conservation

II. Accelerating Sustainable Universal Health Care through Advances in Scientific Research, Technology and Innovation
    - Water, Sanitation and Hygiene (WASH) technologies.
    - Emerging viral, bacterial and societal diseases
    - Improved diagnostic techniques
    - Actuarial models for health insurance
    - Models for disease prediction
    - Geo-environment and health
    - Advances in management and disposal of hazardous wastes

III. Promoting Collaborative Scientific Research, Technology and Innovation for Sustainable Utilization of Natural Products
    - Advances in bio-materials for construction, fuel and biochemical production
    - Green-housing technologies
    - Indigenous knowledge, Traditional Health systems and natural products
    - Pharmacology and bio-prospecting

- Sustainable environmental resource utilization
- Biofuels and alternative energy sources versus food security
- Renewable energy sources
- Natural products in drug discovery
- Natural product chemistry -biology
- Patenting
- Climate change and natural product

IV. Scientific Research, Technology and Innovations for Sustainable Food Production
- Insects for food and feed
- Microorganisms in food production enhancement
- Advances in crop protection
- Monitoring, Early Warning Systems for Agriculture and Livestock
- Genetically Modified Foods and Crops
- Water for Food Security
- Rocks for Crops
- Smart farming
- Alternative food sources for enhanced food security
- Climate Change and Smart Agriculture

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V. Management of Emerging Calamities: Climate Change, Diseases and Pests
- Pest control -Locust, army worm, maize virus etc.
- Predicting and managing emerging and chronic calamities such as flooding and drought.
- Models for prediction of agricultural pest invasions.
- Control /management of emerging human diseases such as Ebola, COVID-2019.

VI. Research Outputs and Applications from the Basic Sciences and Practices
- Mathematics (Biostatistics, Algebraic Geometry, Actuarial Sciences, among others)
- Meteorology
- Geology
- Climate Change
- Chemistry
- Biology
- Computer Science
- Physics

Keynote speakers

Dr. Joseph R. Mukabana
Senior Scientific Officer, Capacity
Development and Research
World Meteorological Organization
(WMO)
Regional Office for Africa
Addis Ababa, Ethiopia

The Senior Scientific Officer (SSO) is responsible for collaboration with technical departments at the WMO Secretariat to build the capacity in Numerical Prediction (NWP) in Africa and enhance the access and use of NWP outputs and climate products from Global Producing Centres (GPCs) and Regional NWP Centres by National Meteorological and Hydrological Services (NMHSs) in Developing and Least Developed Countries (LDCs) to improve forecast skills at the National level - and also facilitate enhanced delivery of real time weather observations from NMHSs in Developing and LDCs to GPCs to improve the quality of global forecasts. The SSO is further responsible for outreach to Research Communities in Developing Countries and LDCs in Africa to ensure their full participation in the work of WMO and the Inter-governmental Panel on Climate Change (IPCC). In order to fulfill this task, the SSO will represent the interests of research communities and programmes in LDCs within WMO and IPCC and with relevant governmental and non-governmental international organizations, academic and research agencies, including Climate Research for Development (CR4D) in Africa initiative, foundations in all fields of geosciences, as well as meteorology, climatology and atmospheric sciences, plus hydrology, oceanography, social and economic sciences.

Prof. George Karani
Cardiff Metropolitan University

His group is working on a number of environment and community health topics including Poverty related diseases, Emergency preparedness and response, Traffic accidents, Environmental radiation, Waste management, Pollution in ports and harbours, PM10 & PM2.5 particulate matter and Climate change. He is actively engaged in research, consultancy and knowledge transfer projects in the UK, Europe, East & West Africa, United Arab Emirates, Oman and Qatar

Vegetation Ecologist at the University of Bonn with a background on Agronomy, a Bachelor on Plant Production and a PhD on Geobotany. His current research focus includes Plant Invasions and Wetland Ecology. Most of his field activities are done in Eastern Africa but some projects are located in South America as well. He is also maintaining vegetation plot databases for Africa and South America and developing packages for the statistical assessment of such data in R.

Dr. Miguel Alvarez
University of Bonn, Germany

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Programme for the 4th Annual Conference of the Faculty of Science and Technology, University of Nairobi, Kenya

Wednesday 24th November 2021

Opening Session
Official Opening Ceremony
Master of Ceremony: Prof. D. Kariuki

Time	Speaker
09:30 – 10:10	FST OC Chair makes remarks (5 Minutes)
	FST ASSOC. DEAN- makes remarks (5 minutes) & invites Dean
	FST AG DEAN makes remarks (5 Minutes) & Invites DVC-RIE
	AVC-RIE makes remarks (5 Minute video) & Invites VC
	VC Gives Opening address to the physical and online audience, Opens the Conference (10 minutes Video)
	Dr. Solomon Derese: Programme Overview (5 Minutes)
	Vote of thanks: Prof. Ivivi Mwaniki

Session 1: Science, Technology and Innovation in Industry for Sustainable Socio-Economic Transformation
Session chair: Dr. Franklin Opijah

10:10 – 10:40	**Keynote I**
	Prof. George Karani
	Experiences and lessons for Africa and Kenya for healthier people to steer sustainable development
10:40 – 11:10	**Keynote II**
	Dr. Joseph R. Mukabana
	The State of Science Research and Climate Science Research in Africa
11:10 - 11:40	**Q and A**
11:40 – 12:00	Obunga, P.O., Nyangeri, E.N., Osano S
	Assessing deployment of science, technology & innovation in catalysing sustainable water services provision in Nairobi City County, Kenya: Case of Soweto Kayole Jisomee Mita
12:00 - 12: 20	Omolo Kevin Onyango
	Multi-factor mutual authentication protocol with cancellable fingerprint template for wireless medical sensor network systems
12:20 - 12:40	Mwanthi Anthony, Mutemi Joseph, Opijah Franklin, Mutua Francis, Dyer Ellen and James Rachel
	Multi-scale characteristics of land -atmosphere interactions over East Africa
12:40 - 13:00	Q and A

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Session 2: Management of Emerging Calamities: Climate Change, Diseases and Pests
Session chair: Dr. Evans Mwangi

14:00 – 14:20   John I. Githaiga, Hudson. K. Angeyo, Kenneth A. Kaduki, Wallace D. Bulimo, Silvanos M. Opanda and Samwel L. Symekher
Analyzing potential of independent principal component analysis and extended canonical variates analysis for spectral discrimination in raman spectroscopy

14:20 – 14:40   Kirui Karen Cherono, J.N Mutemi, F.J Opijah, A.M Mwanthi
The validity of observational datasets and mathematical approaches in supporting operational weather researcher and forecasting in East Africa

14:40 – 15:00   Lino Oscar, Mutemi J. Nzau, Dyer Ellen, Opijah Franklin, James Rachel, Washington Richard, Webb Tom
How an irregular Turkana low-level jet stream in climate models impacts on East African rainfall

15:10 – 15:30   Martina Mutheu
Food security amidst COVID 19 challenges. The integrated agri-value chain model in Kenya

15:30 – 15:50   Martina Mulwa
Leveraging on mobile money for sustainability of informal savings and credit associations in the advent of COVID 19: ASCAS and ROSCAS in Kenya

15:50 – 16:10   John I. Githaiga, Hudson. K. Angeyo, Kenneth A. Kaduki, Wallace D. Bulimo, Daniel K. Ojuka
Quantitative raman spectroscopy of breast cancer malignancy utilizing higher-order principal components: A preliminary study

16:10 – 16:30   Joseph N. Mutemi
The physical science basis of worsening climate change with policy implications and actions points for each one of us

16:30 – 16:50   John K. Gitau, Rosaline W. Macharia, Edwin K. Murungi, Kennedy W. Mwangi, Nehemiah M. Ongeso
Inference of Rift Valley Fever pathogenesis in *Bos taurus* using a gene co-expression network

16:50 – 17:10   Brian Juma Mwolobi, Zephania Birech, Kenneth Amiga Kaduki
Opto-magnetic detection of malaria: A potential low-cost, rapid and sensitive malaria screening method

17:10 – 17:30   Q and A

Thursday 25th November 2021

Session 3: Promoting Collaborative Scientific Research, Technology and Innovation for Sustainable Utilization of Natural Products
Session chair: Prof. Abiy Yenesew

09:00 – 09:20   Vaderament-A Nchiozem-Ngnitedem, Leonidah Kerubo Omosa, Solomon Derese, Pierre Tane, Matthias Heydenreich, Michael Spiteller, Ean-Jeong Seo, Thomas Efferth
Homoisoflavonoid and retrodihydrochalcone from *Dracaena usambarensis* Engl.

09:20 – 09:40   Mary Simiyu, Francis Nyongesa, Bernard Aduda, Zephania Birech, Nikolina Ilin, Dickson Andala, Victor Odar
Strength-porosity relationship in diatomaceous-based membranes and the role of the aspect ratio in filtration efficiency

09:40 – 10:00   Dickson L. Omucheni, Kenneth A. Kaduki, Wolfgang R. Mukabana
Rapid identification of medically important mosquitoes using raman spectroscopy and discriminant analysis

10:00 – 10:20   Vicent Kamya, Abiy Yenesew, Albert Ndakala
Phytochemical investigation of five *Pentas* species for Leishmanicidal principles

10:20 – 10:40   Ombui H. N, Okoko B. A, Khan N, Ogonda L. A, Mulaa F. J, Onyari J. M and Omosa L. K
Isolation and characterization of extremophiles for potential application in silk degumming

10:40 – 11:00   Q and A

Session 4: Science, Technology and Innovation in Industry for Sustainable Socio-Economic Transformation
Session chair: Dr. Samuel Kiboi

11:10 – 11:40   **Keynote III**
Dr. Miguel Alvarez
Vegetation-plot databases and GIS as tools for research on vegetation ecology

11:40 – 12:00   Olan'g Alfred Philip Bill Okaka, Florence Ondieki–Mwaura, Maurice Sakwa
Effect of community health support systems and technology obsolescence on utilization of mhealth Information by teenagers living with HIV/AIDS in island communities of Lake Victoria, Kenya

12:00 – 12:20   Mavyline K. Motari, Geoffrey O. Okeng'o & Rana Liaqat Ali, Robinson N. Gathoni Designing, thermal modelling and parametric analysis of an improved automatic sun tracking and self-cleaning solar panel for sustainable green energy generation

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12:20 – 12:40	Joyce G. N. Kithure, James Mungai, Ajuliu P. Kinyua Efficacy of various methods of pesticides reduction and degradation processes
12:40 – 13:00	Q and A and Discussions

Session 5: Scientific Research, Technology and Innovations for Sustainable Food Production
Session chair: Dr. Solomon Derese

14:00 – 14:20	Jane Wangui Mugo, Franklin Opijah, Joshua Ngaina, Faith Karanja, Mary Mburu Suitability of green gram production in Kenya under present and future climate scenarios using bias-corrected Cordex RCA4 models
14:20 – 14:40	Evaristus M. Irandu, Parita Shah Biofuel production versus food security in Kenya
14:40 – 15:00	Dorothy M. Mwanzia, Geoffrey O. Okeng'o & Collins O. Mito A study on the influences of the sun's variability on earth's climate change
15:00 – 15:20	Gitau Anthony Kiragu, Florence Awino Oyieke, Wolfgang Richard Mukabana Assessment of the role played by poor housing in aggravating tungiasis in Kandara sub-county, Kenya
15:20 – 16:00	Q and A

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Friday 26ᵗʰ November 2021

Session 6: Research Outputs and Applications from the Basic Sciences and Practices
Session chair: Prof D. K. Kariuki

09:00 – 09:20   Douglas O. Manasi, Geoffrey O. Okeng'o & John B. Awuor
                   Is cosmology in a crisis? Exploring the evidence of a closed universe

09:20 – 09:40   Oriama Shadrack Odikara, Benard W. Kulohoma, Evans Nyaboga, Reuben
                   Otsyula
                   Identification of genetic variants and genes associated with scab resistance
                   using diverse set of common bean accessions by GWAS analysis approach

09:40 – 10:00   Lynet Allan
                   Computational Methods in Materials Science Studies

10:00 – 10:20   Joab O. Odhiambo, Patrick G. O. Weke and Philip Ngare
                   Stochastic Modeling of Systematic Mortality Risk Under Collateral Data and
                   its Applications

10:20 – 10:40   Elly K. Kirwa, Gabriel O. Aboge, Timothy Maitho, Alfred O. Mainga, Johnson
                   Nduhiu
                   Genotypic Characterization of Antimicrobial Resistant *Staphylococcus*
                   Species in Raw Camel Milk from Garissa County, Kenya

10:40 – 11:00   Q and A

Session 6: Research Outputs and Applications from the Basic Sciences and Practices
**   (Continued)**
Session chair: Dr. Catherine Lukhoba

11:10 – 11:30   Musiga L. A.
                   Continuous-time markov chain modelling of a hierarchical system

11:30 – 11:50   Minori Kono, Edward Kariuki, David Odongo
                   Prevalence and diversity of haemoparasites and gastrointestinal parasites in
                   donkeys co-grazing with zebras at Amboseli National Park and adjacent
                   areas

11:50 – 12:10   Kiilu, J. M., Kaniu, M. I., Patel, J. P. and Wanjohi, J. M.
                   Novel   chemometrics-assisted   energy   dispersive   X-ray   fluorescence
                   spectroscopy approach for investigation of mercury in skin lighteners

12:10 – 12:30   Samuel Njoroge, Benard Kulohoma, Timothy Kamanu, Astrid von Mentzer,
                   Laura Falzon, Eric Fèvre and Samuel Kariuki
                   Molecular epidemiology and characterization of enterotoxigenic *Escherichia
                   coli* in three Western Kenya counties: A one health concept

12:30 – 12:40   Q and A

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Session 6: **Research Outputs and Applications from the Basic Sciences and Practices (Continued)**

Session chair: Dr. Evans Mwangi

12:40 – 13:00	Hellen M. Mwaura, Timothy K. Kamanu, Benard W. Kulohoma Variation in socio-demographic determinants of maternal mortality in Kenya
13:00 – 13:20	Nyambariga F.K., Opere A. O. , Kituyi E. and Amwata, D. A. Towards climate resilient food systems: Assessment of food crises and coping strategies in Taita Taveta county, Kenya
13:20 – 13:40	Harrison Weda Research output dissemination – scholarly & science communication capacity building
13:40 – 14:00	J.J. Okonda, H. K. Angeyo, A. Dehayem-Massop and A. E. Rogena Chemometrics-enabled X-ray fluorescence analysis of trace biometals in human fluids as cancer biomarkers
14:00 – 14:10	Q and A

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Official Closing Ceremony

Session chair: Dr. Catherine Lukhoba

14:10 – 14:30	Dr. Catherine Lukhoba, Introduce members of the organizing committee Closing remarks, Prof. Francis Mulaaa, Dean, FST Vote of thanks and closing prayer: Dr. Joseph Mutemi

Session 1: Science, Technology and Innovation in Industry for Sustainable Socio-Economic Transformation

ASSESSING DEPLOYMENT OF SCIENCE, TECHNOLOGY & INNOVATION IN CATALYSING SUSTAINABLE WATER SERVICES PROVISION IN NAIROBI CITY COUNTY, KENYA: CASE OF SOWETO KAYOLE JISOMEE MITA

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More than 40% of Kenya's population depend on unimproved water sources and water and sanitation challenges are prominent in the informal settlements characterised by poor infrastructure of piped water. Deploying STI interventions can help residents of Nairobi City County and NCWSC with more efficient, innovative, and profitable water services provision. The purpose of the study was to assess the successes and challenges of deployment of STI in catalysing sustainable water services provision, water services infrastructure development, utilization and management in Soweto Kayole and appropriate recommendations for possible adoption and uptake of the emerging innovations and technologies for improved and efficient management of water services provision. The overall objective of the research proposal was to assess the level of deployment of STI in catalysing sustainable water services provision in Nairobi City County, Kenya: Case of JM in Soweto Kayole. There were five specific objectives under this study: to assess the status of water services provision; to identify the on-going and potential STI applicable in the urban water services provision; to investigate STI infrastructure for water services development, utilization and management; to identify the current challenges hindering adoption and uptake of STI in improving sustainable management of water services and access; and to assess the strategies in place for mainstreaming best practices in STI interventions into national water sector development policies and frameworks. The researcher used a descriptive survey design and analysis, where questionnaires were used to collect data. It relied on a qualitative approach capturing detailed information about the perceptions and dominant narratives on the role and impact of deployment of STI for instance impacts of IoT, AI & ML in accelerating progress toward meeting SDG 6. 320 residents including 10 landlords from Soweto Kayole were interviewed in addition to 7 staff from NCWSC and 2 WB staff. Also interviewed were local water vendors, operators and community representatives aided by research assistants. The researcher obtained qualitative and quantitative data on water supply, distribution and installation of JM gadgets. Primary data was gathered with the aid of a closed and open-ended structured questionnaire. Secondary data collected from various empirical study reports, government documents, journals, books, manuals and other online sources. Descriptive statistics and correlational analysis was used to analyse the data and descriptive statistics used to interpret the findings. Inferential statistics used to establish the level of deployment of STI in catalysing sustainable water services provision while addressing issues on water services development, utilization and management in Nairobi City County.

Main finding is that factual evidence in which STI infrastructure plans and deployments aligned to organizational and institutional visions do not always sometimes conform to situations and realities on the ground especially by the final beneficiaries. This has been confirmed by the JM as it represents a reality in which projects diverge beyond their "institutional set-up and technical infrastructure", adjusting to "new circumstances". Water service provision and sanitation demand by the unserved and underserved slum dwellers require a combination of political commitment, engagement of the planning authorities, substantial increase in investments, innovative solutions

and business models. The initiative has proved feasible for the informal settlement and it can be enhanced more by deployment of STI enabled digital tools for existing public structures and institutions; institutional strengthening, financial and STI pro poor innovations and community engagement and subsequently enhance transparency and accountability.

JM and similar innovations with functionalities such as of billing and customer care system would need to clear the following detected hurdles in order to stand on its own, regardless of the applicability of a wider social connections policy: It has to deliver the lowest price-performance ratio of the alternatives considered; It has to be fit for purpose; It should be delivered within reasonable time frames; and it should fit in with the overall strategy of the utility that is implementing the social connection policy, and it should have a relatively short time to go to market. Measured against these metrics, then, a business case for expansion of JM to other informal settlements in Nairobi City County can be laid out as already envisioned by NCWSC.

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MULTI-FACTOR MUTUAL AUTHENTICATION PROTOCOL WITH CANCELLABLE FINGERPRINT TEMPLATE FOR WIRELESS MEDICAL SENSOR NETWORK SYSTEMS

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Multi-factor mutual authentication protocols have traditionally been based on biometrics as one of the authenticating factors, specifically finger print biometric. However, the challenge on limitation of fingerprint templates that are limited to nine templates apart from the registered one continues to trouble computer scientists. This has been made worse by the development and growth of Internet of Things (IoT) that has enabled all objects to connect to the internet and exchange data through wireless sensor networks, whose major application has been manifested in the smart health with the goal of spurring growth in the access to medical services whenever the medical professionals are available. This research explores the application of Delaunay triangulation on minutiae points of fingerprint templates and secure sketch, to break this limitation of 10 fingerprint templates by enabling cancellable fingerprint templates to an unlimited number similar to resetting passwords.

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MULTI-SCALE CHARACTERISTICS OF LAND -ATMOSPHERE INTERACTIONS OVER EAST AFRICA

Mwanthi Anthony[1*], Mutemi Joseph[1], Opijah Franklin[1], Mutua Francis[1], Dyer Ellen[2] and James Rachel[2]

[1]University of Nairobi, Kenya

[2]University of Oxford, UK

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Land-atmosphere interactions are key processes of the climate system. In this study, focus is given to unravel the nature of the coupling processes between the land surface and the atmosphere over East Africa in selected models participating in the sixth phase of the Coupled Model Intercomparison Project (CMIP6). Due to lack of soil moisture and latent heat flux ground observations, both ERA5 and MERRA2 reanalysis datasets are used as reference datasets. Seasonal characteristics based on both atmospheric and terrestrial coupling indices indicates that parts of East Africa have strong atmospheric response to land surface characteristics. Soil moisture memory lasts for several weeks during the March-May season over some regions. The diurnal cycle indicates that over the arid and semi-arid regions of Kenya, Somalia and Ethiopia, maximum temperature is significantly correlated with early morning, 0800 local time, latent heat flux. These correlations show remarkable spatial variability between March to May based on rainfall patterns. This study brings to light several aspects on climate research; implementation of processed-based model evaluation to support model development, spatial characteristics of the land surface forcing to the atmosphere at seasonal and sub-seasonal timescales and the need for in situ records on surface fluxes such as latent heat flux and soil moisture. Communities and policy makers should note that regions of strong land-atmosphere interactions are susceptible to extreme weather, specifically, heat waves and droughts, especially in seasons of soil moisture deficits.

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ANALYZING POTENTIAL OF INDEPENDENT PRINCIPAL COMPONENT ANALYSIS AND EXTENDED CANONICAL VARIATES ANALYSIS FOR SPECTRAL DISCRIMINATION IN RAMAN SPECTROSCOPY

John I. Githaiga[1*], Hudson. K. Angeyo[1], Kenneth A. Kaduki[1], Wallace D. Bulimo[2], Silvanos M. Opanda[3] and Samwel L. Symekher[3]

[1]Department of Physics, University of Nairobi, 30197 – 0100, Nairobi, Kenya.
[2]Department of Biochemistry, University of Nairobi, 30197 – 0100, Nairobi, Kenya.
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Visualization tools are useful for better understanding of the underlying structure of the chemical data - particularly in an unsupervised way. Principal Component Analysis (PCA) and Independent Component Analysis (ICA) are shown to be powerful pattern recognition algorithms tools for analyzing data sets where there are complicated linear and nonlinear interactions between the input data and the information to be predicted. A challenge lies in PCA and ICA respectively yielding meaningless principal components and independent components; leading to inability in reflecting biologically interpretable information relevant for disease diagnostics. In this paper, we study the feasibility and effectiveness of Independent Principal Component Analysis (IPCA) and extended canonical variates analysis (ECVA) as alternative algorithms in revealing insightful biological information in cells spectra-in *vitro*. The experimental results on cells Raman spectra measured from human cells (Hep 2, Lewis lung carcinorma (LL),Rhabdomyosarcoma (RD)) and animal cells (Vero, Madin-Darby canine kidney (MDCK)) showed ECVA outperformed IPCA. The ECVA result yielded better clustering of the biological samples on graphical representations, when compared to results of IPCA, or principal component analysis followed by linear discriminant analysis (PCA-LDA) and even quadratic discriminant analysis (PCAQDA).For human cells, ECVA method yielded sensitivity values > 80% in 500-1800 cm-1, 600-700cm-1, and 977-1065 cm-1 spectral regions, whereas sensitivity values > 80% in animal cells spectra were observed in 1490-1568 cm-1 spectral region. Adopting ECVA as analysis tool of choice promises to be a new alternative to avoiding curse of dimensionality problem in Raman spectroscopy.

THE VALIDITY OF OBSERVATIONAL DATASETS AND MATHEMATICAL APPROACHES IN SUPPORTING OPERATIONAL WEATHER RESEACHER AND FORECASTING IN EAST AFRICA

Kirui Karen Cherono, J.N Mutemi[1], F.J Opijah, A.M Mwanthi

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Weather research and operational forecasting in East Africa is fast improving. Although the region is subject to dynamic weather changes, seasonal rainfall variability and extremes in seasonal rainfall, the accuracy of weather forecasting has advanced thanks to modern global scale datasets and analysis methodologies. This paper seeks to highlight drivers of seasonal weather in East Africa, in light of enhancing operational forecasting.

This paper will rely on the rainfall anomalies, sea level pressure, wind and specific humidity datasets from NOAA, NCEP/NCAR and TAMSAT. The rainfall datasets will be fundamental in mapping out the spatial distribution and intensity of rainfall in East Africa focusing on hotspot areas. The approach used in this study includes determination of circulation dynamics driven by surface pressure differences, the decomposition of velocity field into divergent and rotational components and the establishment of moisture transport with implications on extreme weather conditions.

The main focus and results presented in this study are drawn from the MAM rainfall of 2018, which we will contrast with the 2019 MAM rainfall. The analysis will identify features that lead to association of isolated drivers contributing to rainfall in East Africa. This will give the researcher and forecaster perspective on the important features to recognise in forecasting for rainfall and seasonal rainfall extremes. Subsequently, this can offer a fundamental basis in the building of models essential in research and operational forecasting.

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HOW AN IRREGULAR TURKANA LOW-LEVEL JET STREAM IN CLIMATE MODELS IMPACTS ON EAST AFRICAN RAINFALL

Lino Oscar[1,3*], Mutemi J. Nzau[1], Dyer Ellen[2], Opijah Franklin[1], James Rachel[2], Washington Richard[2], Webb Tom[2]

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[2]School of Geography and the Environment, University of Oxford, Oxford, UK
[3]Kenya Red Cross, Kenya

Critical decision-making in most climate change adaptation strategies require information with known certainty and accuracy verified at the application space and time scales. Currently, the information as provided by climate models, pose practical challenges for their utility, for example observation-model misfits such as in fine scale variations albeit with some agreement in the induced changes by a climate forcing at large scales. The Turkana low-level jet, which flows through the Turkana channel over Northern Kenya has great socio-economic importance due to its influence on wind and rainfall and rainfall modulator, over its passage. Over Kenya, it has great potential to provide low-cost green energy to drive Kenya's development activities. For countries to the north of Kenya, it is a transporter of moisture-laden air and therefore influences a rainfall mechanism. The jet is considered a moisture transport channel, influencing the region's climate by bringing aridity to most of the region and redistributing rainy regimes to other places further North. This work presents diagnostic that will improve our understanding of the Turkana Jet structure and variability in the models, because simulations of rainfall and winds by some climate models over parts of East Africa and Northern Kenya are poor due to inadequate representation of this feature. Some models exhibit a weaker jet, some no jet at all, depending on the representation of topography in the Turkana channel. Some models can have shallow, and unrealistic channels which can affect wind speed. In such models the Turkana and Somali jets can appear conflated when the Somali LLJ is active, underestimating or overestimating moisture transport and hence exhibit biases in timing of rainfall onsets and cessations, and locating regions of enhanced rainfall (over Northern Kenya and Ethiopia).

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Session 2: Management of Emerging Calamities, Diseases and Pests

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RESEARCH
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FOOD SECURITY AMIDST COVID 19 CHALLENGES. THE INTEGRATED AGRI-VALUE CHAIN MODEL IN KENYA

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Food security in Kenya and other parts of the world has come under great threat as a result of the COVID 19 pandemic. In addition, various measures instituted to combat the spread of the disease make it difficult for farmers to attend to their farming activities as usual. Among these are restrictions on movement, curfews or working from home among others. While these measures are necessary, food security remains critical in the sustainability of livelihoods. There is therefore need for innovative solutions to support farmers in their food production journey.

Key words: Advisory, E-shop, E-market, Financing, AgriValueChain Model

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Integrated Agri Value Chain Model

Integrated AgriValue chain model is an ICT based model that integrates key services in a farmer's journey into a single application. These include advisory, e-shops, savings and credit, e-markets and a chat system. Farmers are able to access pre, during and post-harvest advisory services from agricultural officers without an officer necessarily having to visit their farms. They also order farm equipment and inputs via the app and these are delivered to their farms. In addition, market for their produce is sourced online and early enough to mitigate post-harvest losses. The financing module allows them to save, borrow and repay loans within the app. The general communication provision facilitates feedback and an avenue for enquiries as well as general communication to farmers. This becomes a one stop shop for farmers.

Objectives

The objective of this paper is to demonstrate the functionalities of the integrated AgriValueChain model for sustainability of food production in Kenya

Specific objectives

(1) Highlight the various services and activities farmers engage in during the farming process

(2) Demonstrate the functionality of IAVC model in addressing the farming needs of farmers

Conclusion

For sustainability of food supply even for those financially able, farmers across the country will need to be supported to produce food. With the current situation where instructions on limited movement have been instituted, it will be difficult for extension officers to offer farmers' physical support as it has always been. With many people working from home, it will also be difficult for farmers to get their farm inputs from their regular shops consequently marketing of their produce will be hampered due to the curfews instituted. Therefore, ICT can come in handy to coordinate all these services to ensure that the food chain is sustained in the Kenya

The Model

INTEGRATED AGRI-VALUE CHAIN MODEL (IACM)
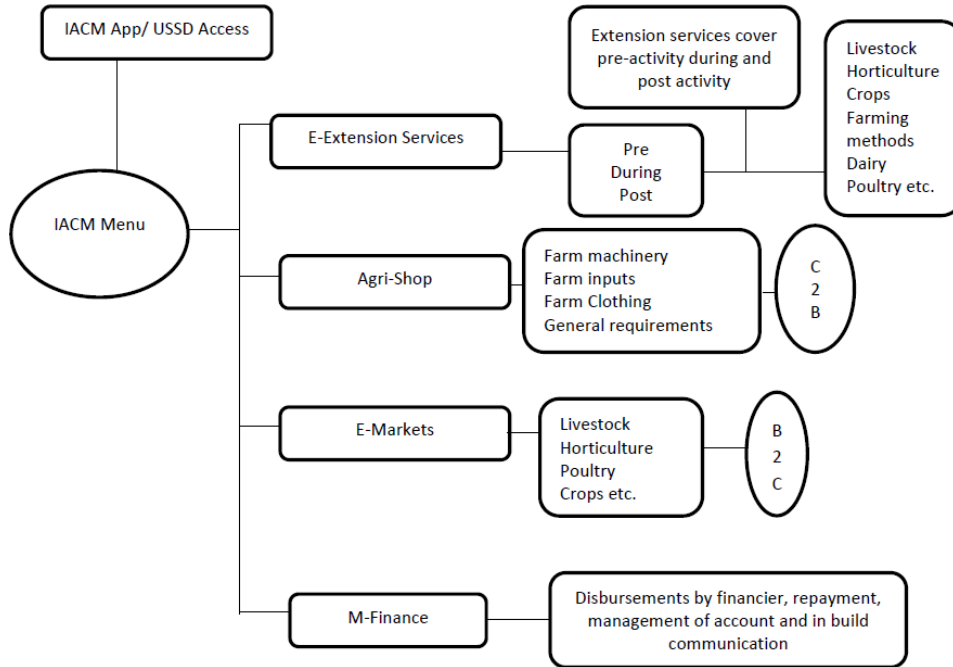
11

LEVERAGING ON MOBILE MONEY FOR SUSTAINABILITY OF INFORMAL SAVINGS AND CREDIT ASSOCIATIONS IN THE ADVENT OF COVID 19: ASCAS AND ROSCAS IN KENYA

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Informal savings and credit models in known as Chamas in Kenya have and continue to play a great role in the management of finances for the financially excluded particularly women. Traditionally the mode of operation requires members to converge at a place, contribute money, give loans or hand it to one person. However, in the Advent of COVID 19, this mode of operation has come under great threat following the ban on gatherings, handling of paper money as well as restriction on movement. This paper discusses the practicality of M-ASCA, a virtual Chama model that automates all functions of both ASCAs and ROSCAS as a means of ensuring that members of these groups continue to participate constructively albeit virtually.

Key words: Chamas, virtual, ASCAs, ROSCAs, COVID 19

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Introduction

The lesser off segments in society are excluded from formal financial services as they are termed unviable and risky. This exclusion has forced this segment to turn to informal non-discriminative financial models among them, Accumulating savings and credit associations (ASCAs) as well as Rotating savings and credit associations (ROSCAs). Despite their informal structure and nature, a total volume of some Kshs 65 billion is intermediated through these two informal groups in Kenya on an annual basis (FSD Kenya (2009). However, with COVID 19 ravaging every known traditional way of operation, these welfare activities have not been spared. It is for this reason that this paper seeks to demonstrate that mobile money as well as ICT has the potential to ensure members of these groups continue to participate actively albeit this time virtually.

Objectives

The purpose of this paper is to demonstrate the functionalities of the chama kwa simu model and its suitability in the continuity of ROSCA and ASCA activities in Kenya amidst COVID 19 challenges

Specific objectives:

1. Determine the traditional functionalities of both ASCA and ROSCA models in Kenya
2. Demonstrate the Chama Kwa Simu model and its suitability in filling the gap occasioned by measures put in place to mitigate the covid 19 pandemic

QUANTITATIVE RAMAN SPECTROSCOPY OF BREAST CANCER MALIGNANCY UTILIZING HIGHER-ORDER PRINCIPAL COMPONENTS: A PRELIMINARY STUDY

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A major challenge in analyses of molecular spectra from biological samples has been the detection of trace biomarkers, which are subtle biochemical alterations (in parts per million (ppm)) caused by disease, buried in pronounced background fluorescence. We report a quantitative chemometrics-assisted Raman study of subtle biochemical alterations associated with breast cancer malignancy using whole blood samples, based on a 785 nm laser excitation. To understand biochemical differences between healthy (control) and diseased samples, spectral analysis was undertaken in the 500-1800 cm-1 region using principal components analysis (PCA), linear discriminant analysis (LDA), and partial least squares discriminant analysis (PLS-DA). The subtle spectral markers at 589, 594, 630, 858, 868, 1005, 1160, 1250, 1347, 1358, 1626, 1630, and 1638 cm-1 differentiated controls from diseased patients and were assigned to proteins, lipids, and nucleic acids. Out of the above, six spectral regions were determined: 589 cm-1, 594 cm-1, 630 cm-1, 1626 cm-1, 1630 cm-1 and 1638 cm-1, which can be regarded as new spectral markers for breast cancer. Various pure basic biochemical components were used to develop a partial least squares regression calibration model for quantitative analysis. The relative concentrations of biochemical alterations in healthy and diseased samples were estimated by applying the developed least squares fitting model to the determined trace spectral markers' measured blood spectrum. The fitting model revealed that the relative concentrations of proteins, lipids, and nucleic acids increased with disease status ($p < 0.05$). Both PCA-LDA and PLSDA models yielded sensitivities and specificities > 80%, and overall diagnostic accuracies between 90-100%. Considering the limited number of samples involved in this study, preliminary results from this approach are promising, encouraging further investigations.

THE PHYSICAL SCIENCE BASIS OF WORSENING CLIMATE CHANGE WITH POLICY IMPLICATIONS AND ACTIONS POINTS FOR EACH ONE OF US

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There is no doubt that the worrying climate conditions in the form of adverse changes is a grand challenge to humanity in our times and the choice is ours as individuals, nations and international community to do something about it now or let momentum of change derive humanity to doom in the long term. During August 2021, the Intergovernmental Panel on Climate Change (IPCC) released the Sixth Assessment of the Climate Change, the Physical Science Basis. The key message therein is that due to man's influence, the current level of climate warming is unprecedented in thousands and perhaps hundreds of thousands of years and adverse implications on the welfare of humanity is very serious. Herein, is an articulation of what is it that you yourself have done to bring us where we are in the climate change problem and what is it that you can do to be part of the wide-spread effective climate change mitigation action. We are aware of potential global scale climate action commitments which might come out of COF26 at international level, but the actual solution is cumulatively what each one does towards NOT INCREASING GREEN HOUSE GAS EMISSIONS (NIGHGE). What dose climate action entail and what can a poor pastoralist in Turkana do about it? What about each of us as individuals, households, business leaders and policy makers?

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In this paper, these issues are articulated consistently with the status the inherent science knowledge and most importantly, there is something each person, group, organization and community of nations can do to slow down adverse changes and eventual reversal of sustainable climate conditions, consistent with the aspirations of national and internal long term development goals.

Session 3: Research Outputs and Applications from the Basic Sciences and Practices

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ASSESSMENT OF THE ROLE PLAYED BY POOR HOUSING IN AGGRAVATING TUNGIASIS IN KANDARA SUB-COUNTY, KENYA

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Introduction

Tungiasis (jigger infection) is a zoonotic disease associated with resource deprived communities. It is brought about by penetration of female *Tunga penetrans* (sand flea), into the skin of a predisposed human or animal, and the subsequent hypertrophy of the ectoparasite. The aim of this study was to assess the role that might have been played by poor housing in exacerbating tungiasis in the resident community of Kandara sub-County in Kenya.

Methods

This was un-matched case-control study involving 776 participants. Half of this number was the case group comprising of jigger infected people while the other half was the control, made up of jigger free individuals. Heads of the households to which the participants belonged, were requested to fill structured questionnaires with the help of community health extension workers (CHEWS) to help gather information concerning the housing factor. Univariate logistic regression analysis was applied to all data to determine the variables that had significant differences. Secondly, all the parameters depicting significant differences were subjected to a multivariate analysis in order to establish those that were independent.

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Results

In the univariate analysis, the jigger infected participants were 1.6 times more likely to live in earthen houses in comparison to the control (1.60;95%CI: 1.16-2.20; *P*< .002). The floors of their houses were 4.2 times more likely to be uncemented when compared to the control (4.2;95%CI:2.6-6.8; *P*< .001). 54% of these floors were also cracked and dusty. A good number of these houses had cracked rough walls (49%). There was no single parameter that featured out as an independent variable.

Conclusion

There is a high relationship between poor housing and jigger infection in Kandara sub- County. The findings of this research will be instrumental in facilitating successful interventional measures in future by the government and associated stake holders so as to put jigger infection under control and eventually to its complete eradication.

PREVALENCE AND DIVERSITY OF HAEMOPARASITES AND GASTROINTESTINAL PARASITES IN DONKEYS CO-GRAZING WITH ZEBRAS AT AMBOSELI NATIONAL PARK AND ADJACENT AREAS

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Donkeys (*Equus asinus*) play an important role as a mode of transport in many communities; however, their role is constrained by illness due to parasitic infections which can also affect other wild equid species such as zebra (*Equus* sp.). Lack of a boundary fence at the Amboseli National Park (ANP) allows zebra migration out of the park and their interaction with donkeys and other domestic animals within the adjacent community, with the possibility of transmitting infections between them. This study determined the prevalence and described the diversity of parasites occurring in sympatric zebras and donkeys at the ANP and adjacent areas.

Fifteen blood samples were collected opportunistically from plains zebras (*Equus quagga*) during Kenya Wildlife Service scheduled management activities. Seventy-Nine donkeys were sampled from communities adjacent to ANP. Blood samples were screened for *Theileria*/*Babesia* and *Ehrlichia*/*Anaplsma* species by PCR amplifications and sequencing of the 18s and 16s rRNA gene respectively. Fecal samples were collected from both zebras and donkeys and analyzed for gastrointestinal parasites (GIP) using the sugar flotation technique and the modified sedimentation technique.

Ehlerichia/*Anaplasma* was detected in donkeys (but not in zebras), with *Anaplasma* cf. *platys* detected in 4% of the donkeys. This study is the first report of *Anaplasma* cf. *platys* infections in donkeys in Kenya. *Thileria*/*Babesia* was detected in 92 % donkeys and 93% zebras, with the prevalence of *Theileria equi* at 87% and 84% respectively. Majority of zebras and donkeys were infected with GIP, with *Habronema* spp. and *Dictyocauls* sp. only found in zebras, while *Strongyloides* spp. (A zoonotic soil-transmitted parasites) was only found in donkeys. The potential reservoir role of donkeys should be further investigated to inform preventive and control measures of zoonotic parasitic infections.

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LOCAL COMMUNITY KNOWLEDGE AND PERCEPTIONS ON CONSERVATION OF BATS ALONG THE KENYAN COAST

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Although bats are the second largest group of mammals, they are rarely appreciated, by many people worldwide. However, people's knowledge, attitude and perceptions can contribute hugely to the overall success of conservation efforts implemented for any wild species. We used semi-structured questionnaires to investigate local community knowledge and perceptions about bats and threats faced by bats by interviewing 142 respondents living around several Kaya coastal forests in Kenya. We also documented bat roosting sites along the Kenyan coast. A total of 23 roosting sites which included seven caves, three tree roosts and 13 human structures were documented. Most of these caves were not in protected areas, and were highly threatened by human disturbance and modifications. Many people in the study area referred bat in local name as Nundu with only 2.8% of Giriama sub-tribe referring to it as Ndema. 64.08% of interviewed people used body size (big and small) to distinguish different types of bats. 69.7% of interviewed indicated that they would react positively on seeing a bat: by doing nothing (61.26%) and admiring it (8.45); while 26.63% would react by killing (13.38%) and disturbing (7.75%) them. Bats were poorly understood with majority (41.2%) of respondents indicating that bats had no direct benefits to humans and were destructive to farmers' fruit trees. Cutting down of trees, use of caves by witchdoctors as premises for consultations, shooting bats with catapults to kill or chase them away, negative perceptions of people to bats, and large number of visitors to caves were identified as the main threats to bats and their habitats. This study indicate that human-bats interactions information is crucial and should documented, because it can be used in the design of the most appropriate conservation strategy to implement to help conserve bats populations and their habitats.

Key words: Bats, perceptions, roosting sites, Mijikenda, Kenya.
Running title: Interactions of Mijikenda community with bats in Kenya.

OPTO-MAGNETIC DETECTION OF MALARIA: A POTENTIAL LOW-COST, RAPID AND SENSITIVE MALARIA SCREENING METHOD

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Malaria is a sickness transmitted by a bite of female Anopheles mosquito which carries a *Plasmodium* parasite. Malaria is prevalent in Sub-Saharan Africa, parts of South America, Asia and portions of Central America. In the year 2017, close to 219 million people were infected with malaria with an estimate of 435000 deaths globally according to the WHO report. The malaria deaths are mainly associated with late diagnosis and lack of screening kits as most of these places are remote and less resourced.

The commonly used screening methods include: PCR (polymerase chain reaction), RDT (Rapid Diagnostic Tests) and Giesma microscopy which are expensive and require specialist to operate. This work involved fabrication of a portable and rapid malaria screening device. The device composed of an LED, lenses, a pair of disc magnets, a photo-diode and a screen. This battery powered device was applied in the detection of hemozoin (malaria pigment) first when suspended in de-ionized water and later in rat's blood. The absorption spectra (measured using a spectrophotometer) of hemozoin suspensions were obtained. Prominent absorption bands were observed at around 377, 421 and 449 nm assigned to SoS2 transitions (Soret/B-band) 551, 665, 723 and 866 nm assigned to So-S1 transitions (Q-band) in hemozoin. Transmittance of LED light emitting at 450 nm and 667 nm decreased with concentration of hemozoin. This was due to absorption by hemozoin. These LEDs were used in the malaria screening device. The voltage difference detected by the photodiode indicated nonlinear relationship with concentration. The transmittance was also measured using the malaria device in presence and absence of magnetic field.

When graphs of voltage against concentration were plotted, the fit equation was obtained and the trend was equation of the form $y=kLn(x)+C$ which can be equivalently expressed as $e =y-C k$
In this relation, y and x represented the voltage and hemozoin concentration respectively. The later equation was used as malaria diagnostic algorithm as it (x) in the sample. The R^2 values obtained for the curve in the presence of magnetic field was 0.983 and was higher than that without the magnetic field which was 0.971. This indicated that taking the measurements in the presence of magnetic field was better and makes the device more sensitive. This also supported the idea that the magnetic field influences the orientation of hemozoin nanocrystals such that majority are aligned in a certain way.

RAPID IDENTIFICATION OF MEDICALLY IMPORTANT MOSQUITOES USING RAMAN SPECTROSCOPY AND DISCRIMINANT ANALYSIS

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Identification of insect vectors of disease is an important exercise that allows collection of important epidemiological data. Traditionally, identification of mosquitoes that transmit diseases such as malaria, yellow fever, chikungunya, dengue fever among other diseases is done by observation of external morphological features at different stages of their life cycle. This is a tedious and labour-intensive process that generally fails to distinguish cryptic species.

In this paper, we explore the capability of Raman spectroscopy in combination with Linear and Quadratic Discriminant Analysis to classify three categories of mosquitoes: *Aedesaegypti*, *Anopheles gambiae* and *Culex quinquefasciatus* based on their cuticular biochemical differences. They represent two important subfamilies of medically important mosquitoes i.e. the Anophelinae and the Culicidae while housefly (*Musca domestica*), a Diptera, is included as a "control" group to test the discrimination ability of the classifiers. Raman spectra were obtained from fresh insects anaesthetized with chloroform. The measurements were obtained by scanning the legs. Preprocessed data were used to train and test Linear Discriminant Analysis (LDA) and Quadratic Discriminant Analysis (QDA) classifiers.

LDA performed moderately achieving an overall accuracy of 68% . QDA performed best achieving overrall accuracy of 97%. The success of the QDA on Raman spectroscopy data gives hope for future discrimination of morphologically indistinguishable mosquito and other insect species.

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HOMOISOFLAVONOID AND RETRODIHYDROCHALCONE FROM *DRACAENA USAMBARENSIS* ENGL.

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Cancer still remains among the harsh human killer diseases causing one out of six deaths globally. In 2018, more than 18.0 million new cases accounting for 9.6 million deaths were recorded making cancer the second leading cause of death globally (Bray et al., 2018). To make the matter worse, more than 25 million new cases with 17 million deaths are expected by 2040. Chemotherapy, which is one of the major means of treatment of malignancies, is greatly hampered by the development of resistance, or even multi-drug resistance (MDR) of cancer cells to cytotoxic drugs. Hence, this study was designed to investigate the roots of *Dracaena usambarensis* Engl for anticancer application. Chromatography, spectroscopic and spectrometric techniques were mainly used for isolation and characterizations of isolates. Resazurin reduction assays were performed to assess the cytotoxicity of the crude extract and isolated compounds. As a result, two hitherto flavonoids derivatives, usambarin (**1**) and 4′,4-dihydroxy-2,3-dimethoxyretrodihydrochalcone (**2**) along with six known congeners identified as 7-*O*-methyl-8-demethoxy-3-hydroxy-3,9-dihydropunctatin (**3**), loureiriol (**4**), 3-(4‴-hydroxyphenyl)-*N*-[2′-(4″-hydroxyphenyl)-2′-methoxyethyl]acrylamide (**5**), 25*S*-spirosta-1,4-dien-3-one (**6**), stigmasterol (**7**) and stigmasterol 3-*O*-β-*D*-glucopyranoside (**8**) were successfully isolated and characterized. In the cytotoxicity assay, using doxorubicin as reference anticancer drug, the crude extract and compounds **2**-**8** were inactive in the preliminary screening against leukemia (CCRF-CEM and CEM/ADR5000) cell lines. Moderate activity was observed for **1** against drug sensitive leukemia cell line (CCRF-CEM) with IC_{50} = 40.4 µM but was inactive against all the other tested drug sensitive, resistance phenotypes and normal cells. Future studies should focus on hemisynthesis of **1**-**3** mainly methylation. Methylation in homoisoflavonoids increases lipophilicity, which facilitates cellular uptake and is considered as one of the important features of homoisoflavonoids for strong antiproliferative activity.

Reference: Bray, F., Ferlay, J., Soerjomataram, I., Siegel, R. L., Torre, L. A., & Jemal, A. (2018). Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA: a cancer journal for clinicians, 68(6), 394-424

STRENGTH-POROSITY RELATIONSHIP IN DIATOMACEOUS-BASED MEMBRANES AND THE ROLE OF THE ASPECT RATIO IN FILTRATION EFFICIENCY

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The use of diatomaceous earth, DE, ceramic membranes in water purification has been in existence for centuries. However, these nano porous membranes have not been modelled with existing theoretical models in porosity-mechanical strength relationship to determine optimal morphological structures needed in producing efficient membranes. In this work the experimental data of porosity and strength from diatomaceous earth membranes are compared with the theoretical models of the minimum solid area also called minimum contact area (MSA) and stress concentration effect (SCE) model. The experimental modulus of rupture was compared with the theoretical models of self-consistency spheroidal inclusion theory and the analytical derived theory. It was observed that the diatomaceous membranes had nano pores whose porosity affected the behavior of the mechanical property. The SCE model fitted more in the data obtained from membranes fabricated with a burnout material (charcoal) which had an average porosity of 0.65. Less porous membranes (membranes without a burnout) on the other hand fitted well in the MSA model. The experimental data from the aspect ratio also fitted well with the analytically derived theory. Membranes with aspect ratio close to one produced most efficient membranes in defluoridation as well as removal of Escherichia coli and Rotavirus. Thus, continuous nano cylindrical pores are essential in producing efficient ceramic filters.

IDENTIFICATION GENETIC VARIANTS AND GENES ASSOCIATED WITH SCAB RESISTANCE USING DIVERSE SET OF COMMON BEAN ACCESSIONS BY GWAS ANALYSIS APPROACH

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Phenotypic variation of scab disease among common bean varieties have been observed under natural infestation and through *in vitro* inoculation of the pathogen *Elsinoë phaseoli* on common bean *Phaseolus vulgaris*. Modern computation biology and bioinformatics tools were deployed to promptly identify scab disease resistance genes in common bean by the identification of genomic regions, including genes associated with resistance to scab disease under natural infestation in the field. A GWAS was performed on 165 diverse accessions of common bean in a case and control approach where significant association was detected on chromosome one SNP position 1 with a P-Value of 1.8E-06 closely followed by position 2 which indicated a locus with the associations. Annotation of the hypothetical protein of the association conducted using machine learning algorithm of support vector machine on prPred with an accuracy of 0.935. Where position 1 had a resistant possibility of 0.547104 and position 2 with a resistant possibility of 0.640101 with the later annotated to ABC transporter protein which is known for detoxification functions of microbe toxins. The loci with significant association with scab resistance was identified to provide insights into the genetic control of the disease. The genes associated with the region conferring resistance will be an important tool for introgression of resistance to susceptible commercial cultivars preferred by farmers using marker-assisted selection in common bean breeding programs.
Key words: prPred, GWAS, farmCPU, scab, common bean.

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PHYTOCHEMICAL INVESTIGATION OF FIVE PENTAS SPECIES FOR LEISHMANICIDAL PRINCIPLES

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Leishmaniasis is a disease complex instigated by the protozoa of the genus *Leishmania;* its transmission is mediated by female sandflies of genera *Lutzomyia* and *Phlebotomus*. Contemporary therapies for leishmaniasis employ pentamidine (**1**), amphotericin B (**2**), and pentavalent antimonials (**3**). The efficacy of these drugs has deteriorated due to drug resistance; furthermore, the drugs pose unbearable side effects owing to their toxicity. Some metabolites from the genus *Pentas* (Rubiaceae) have been reported to show antiprotozoal activity against *Plasmodium* species, but no studies on antileishmanial activity have been done. The current study was focused on investigating phytochemicals from five *Pentas* species for antileishmanial principles. The CH_2Cl_2/CH_3OH (1:1) extracts of the roots and/or stems of *Pentas bussei, P. longiflora, P. micrantha, P. parvifolia* and *P. zanzibarica* were subjected to a combination of chromatographic separations resulting in the isolation of 14 compounds. The pure compounds were characterized by utilizing ^1H NMR, ^{13}C NMR, ^1H-^1H COSY, HMBC, HSQC and MS. The crude extract from the roots of *Pentas parvifolia* yielded Busseihydroquinone B (**60**). The stem bark of *Pentas parvifolia* yielded β-stigmasterol (**59**) and β-amyrin (**93**). The aerial parts of *P. parvifolia* yielded vanillic acid (**94**), parahydroxybenzoic acid (**95**) and protocatechuic acid (**96**). The aerial parts of *P. bussei* yielded β-stigmasterol (**59**), a homoprenylated naphthoquinone (**55**), methyl-8-hydroxy-1,4,6,7-tetramethoxy-2-naphthoate (**53**), busseihydroquinone A (**54**), busseihydroquinone B (**60**) and busseihydroquinone C (**61**). The aerial parts of *P. micrantha* yielded compound **81**. The stem bark of *P. zanzibarica* yielded rubiadin-1-methyl ether (**74**) and rubiadin (**73**). The roots of *Pentas longiflora* yielded Pentalongin (**83**). Pentalongin (**83**) showed antileishmanial activity ($IC_{50} = 11$ µM) against the antimony sensitive strain of *Leishmania donavani* (MHOM/IN/83/AG83). It also generated a substantial amount of nitric oxide in the cell culture ($IC_{50} = 1.08 \pm 1.36$ µM) relative to the positive control, miltefosine (**4**), ($IC_{50} = 1.11 \pm 1.6$ µM). busseihydroquinone A (**53**) was oxidized with silver (I) oxide to yield 1-hydroxy-4,6-dimethoxy-7,8-dioxo-7,8-dihydro-naphthalene-2-carboxylic acid methyl ester (**97**). Through computational modeling, the inhibitory potential of phytochemicals from the genus *Pentas* for *Leishmania infantum* trypanothione reductase was studied using UCSF Chimera 1.15. Among the studied compounds, schimperiquinone A exhibited the highest affinity for the binding site of the receptor; with a binding energy of -10.9 kcal/mol. Anthraquinones generally showed superior inhibitory potency for *Leishmania infantum* trypanothione reductase than naphthoquinones. Overall, the phytochemicals from the genus *Pentas* showed sustained hydrogen bonds with Thr335, Lys60 and Cys52; these amino acid residues assist FAD to achieve a proper orientation towards the catalytic site of the enzyme. Therefore, the quinones from the genus *Pentas* have the potential to guide the development of antileishmanial drug agents. Given the distinctive binding mode of the anthraquinones and naphthoquinones observed here, the compounds should be subjected to *in vitro* and *in vivo* studies.
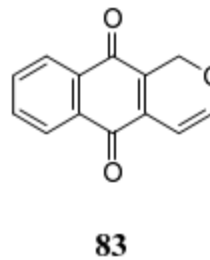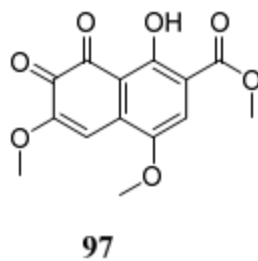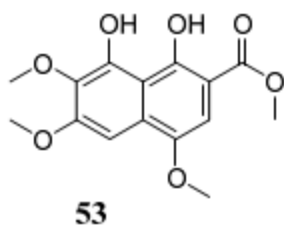
53

97

83

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ISOLATION AND CHARACTERIZATION OF EXTREMOPHILES FOR POTENTIAL APPLICATION IN SILK DEGUMMING

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Introduction

Textile industry is one of the major economic boosters in developing countries like Kenya due to high demand of textile products, thus promoting domestic manufacturing and creating job opportunities (Omolo, 2006).Silk a natural fiber, has been extensively used in the textile industry in making of fabrics with desirable characteristics of luster, brightness and soft to touch thus termed the 'queen of all fabrics (Teli and Rane, 2011). This natural fiber is made up of fibroin filaments stacked together by silk gum known as sericin to form cocoon during the larvae stage of *Bombyx mori* (Kishan Sharma*et al*., 2017). Sericin is very important during fabric production since it protects the filaments from breaking during threading, however, this gum is disadvantageous during dyeing, printing and finishing of the fabric thus it has to be removed through the process called degumming. Since time immemorial different degumming methods have been used including boiling of the silk cocoons using soaps, alkali, acids and use of organic amides(Chopra and Gulrajani, 1994). These conventional processes lead to high consumption of natural resources like water, energy, loss of fibers strength, irregular degumming along with production of effluents with adverse environmental effect (Nakpathom, Somboon, and Narumol, 2009). There has been an increasing interest in the use of microbial enzymes in degumming process in the recent years aimed at improving the efficiency of degumming process (Nakpathom *et al*., 2009). Extremozymes have previously been used in various industrial processes and have been shown to tolerate the harsh environments in industrial processes like high temperatures, high or low pH, and extreme salinity among others leading to high yield of products within a short period of time compared to traditional conventional methods of using chemicals(Sarmiento, Peralta, and Blamey, 2015). Since extremozymes are optimally active and stable under harsh surroundings, they can be used as an alternative in various industrial processes(Sarmiento *et al*., 2015).This research therefore focuses on isolation and identification of potential protease producers from Kenyan soda lakes (L. Bogoria) with silk degumming activity.

Results and Discussion

About 94 microorganisms including 84 bacteria and 10 fungi were isolated among which 18 bacterial isolates were screened for protease activity. From the preliminary screening results, 5 among the tested isolates showed high protease activity with Halo: Colony ratios of 2.4, 2.4, 2.7 for isolates BOH 5,BOH14, BOH17, respectively.
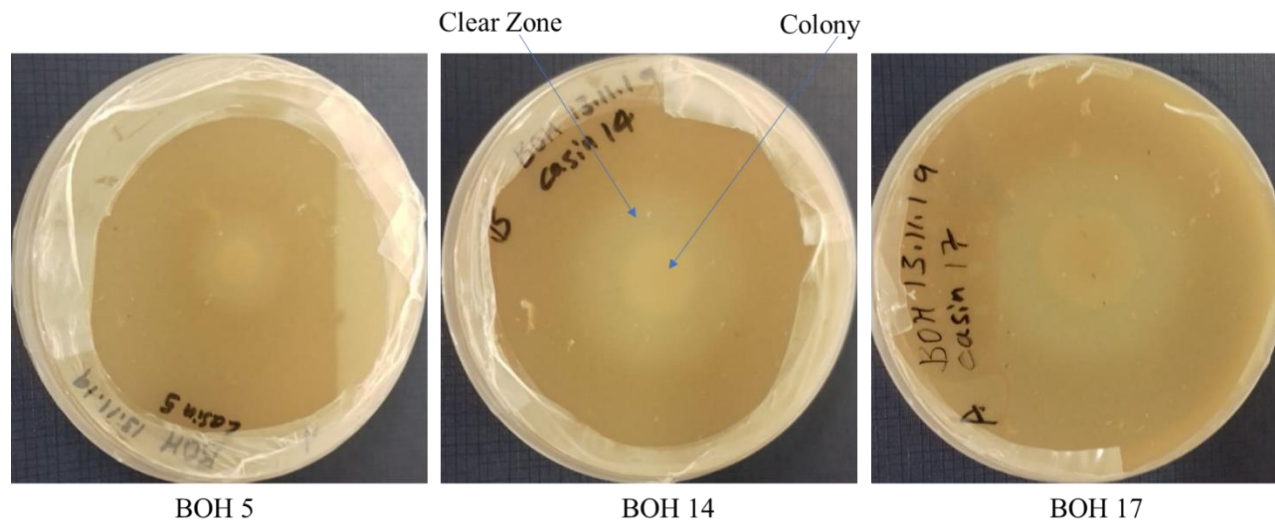
Figure 1: *Photographs of agar plates containing 2% casein spotted with select bacterial isolates. Zones of clearance indicate protease activity.*

Methods

We employed a combination of enrichment culture and spread plate methods to isolate the microorganisms using casein as a model substrate. Zones of clearance (Halo) around bacterial colonies on agar plates were then used to identify efficient proteolytic candidates for identification and further studies.

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Session 4: Science, Technology and Innovation in Industry for Sustainable Socio-Economic Transformation

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RESEARCH WEEK 2021

EFFECT OF COMMUNITY HEALTH SUPPORT SYSTEMS AND TECHNOLOGY OBSOLESCENCE ON UTILIZATION OF MHEALTH INFORMATION BY TEENAGERS LIVING WITH HIV/AIDS IN ISLAND COMMUNITIES OF LAKE VICTORIA, KENYA

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The emergence of mHealth as an alternative access point for care and treatment is lauded by development agencies as ingenious innovation for bridging health care access for teenagers living with HIV/AIDS among detached communities like the islands of Lake Victoria. It is also presumed that mHealth transcends beyond teenagers" concerns with location and unfriendly hours of operation of health facilities. mHealth is alleged to increase privacy and confidentiality, reduce the cost-of-service delivery, and loops over retrogressive cultural beliefs and attitudes exhibited by health care providers and caregivers, consequently increasing access to health information, care, and treatment. Specifically, the study sought to determine the technology obsolescence and explore community-based health support systems that facilitate suitable utilization of mHealth by teenagers living with HIV from the island communities of Lake Victoria and its effect on treatment access. To support this study, two philosophies: The theory of Reasoned Action and the Technology Adoption Lifecycle Model were applied. Anchored on cross-sectional study design, stratified sampling identified the psychosocial support groups of teenagers living with HIV. The probit model was applied to the study. With a study population of approximately 409 in Ringiti, Remba, Rusinga, Mfangano, and Mageta Islands, questionnaires were administered to 173 sampled teenagers living with HIV as a unit of analysis, and a control group made up of 30 percent of the sample ascertained effect of mHealth on treatment access. Five focus group discussions and key informant interviews of 10 and 3 were held on each Island. Multiple linear regression analysis was used to estimate the effect of the independent variables on the dependent variable. Further, the results showed that *technology obsolescence and community-based health support systems* had a significant effect on access to treatment by teenagers living with HIV/AIDS in the Island communities of Lake Victoria. Consequently, this study provides organizations promoting access to access to treatment by teenagers living with HIV/AIDS through mHealth. The study recommended that government and organizations involved in HIV/AIDS related activities should adopt a culture of enhancing mHealth by focusing on technology obsolescence and community-based health support systems. This could go a long way in ensuring there is improved access to treatment by teenagers living with HIV/AIDS in Island communities of Lake Victoria.

Keywords: M-health; Community support systems; Technology obsolescence; Teenagers; HIV/AIDS.

DESIGNING, THERMAL MODELLING AND PARAMETRIC ANALYSIS OF AN IMPROVED AUTOMATIC SUN TRACKING AND SELF-CLEANING SOLAR PANEL FOR SUSTAINABLE GREEN ENERGY GENERATION

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Increased global warming, highly fluctuating fossil fuel prices and the need for clean, low-pollution energy sources have spurred research towards promoting innovative smart technologies for a sustainable planet. The sun remains an alternative free source of cheap, clean, and sustainable energy for household and industrial use, especially in low- and middle-income countries. The mainly used technology for harvesting sunlight is the solar photovoltaic (PV) cell which converts sunlight into electricity. However, use of PV solar panels is faced with three major problems: (i) Low conversion efficiencies of tapped sunlight into usable energy (ii) Overheating of the PV modules by the solar radiation leading to degradation in cell life, reduced energy conversion efficiency and even PV cell damage. (iii) Accumulation of dust at the surface of solar PV panels which reduces its efficiency. In this study, we propose to (i) Design and implement an improved automatic sun tracking and self-cleaning solar panel system (ii) simulate and model the performance of the automatic sun tracking and self-cleaning solar panel subject to thermal modelling and parametric analysis. (iii) conduct performance measurement to compare the efficiency of our smart solar panel with the commonly used fixed-axis solar panels and suggest changes to maximize the power output. (iv) Build and test a prototype of an improved automatic sun tracking, self-cleaning and thermally cooled solar panel and characterize the improved efficiencies for application. The Simulation and characterization of the expected energy output in the ASTS will be done using a model of a photovoltaic cell panel, a servo motor, a light dependent resistor sensor, a battery, a charger, and a microcontroller. The planned experiment shall involve actual measurements of the energy outputs comparing ASTS with the normal fixed-tilt solar panel. Evidence from this study will determine the utility of ASTS for large-scale production and commercial use.

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RESEARCH
WEEK 2021

EFFICACY OF VARIOUS METHODS OF PESTICIDES REDUCTION AND DEGRADATION PROCESSES

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Pesticides are substances that are meant to control pests. In this research, the investigation of the photo-degradation of pentachlorophenol (PCP) and Dimethoate (DM) pesticides, using incandescent bulbs and fluorescence light on spinach leaf surface was done, as well as determining the effectiveness of washing methods in the removal of Chlorothalonil and lambda-cyhalothrin pesticides residues in washing solution. The half-lives of both molecules ranged between 0.007306 to 0.076 days for PCP in incandescent bulb and 0.078 to 0.093 days in fluorescence light, while the range of half-life was 0.037 to 0.00446 and 0.0023 to 0.013 days for DM in incandescent bulb and fluorescence light respectively. On the other hand, 0.001% $KMnO_4$ washing solution was discovered to be the most effective washing solution at 65.67 ±3.73% to 70.23 ±3.82% removal of chlorothalonil and 81.68 ±3.03% to 85.98 ±4.19% for lambda cyhalothrin. Tap water was the least effective pesticides remover, ranging from 10.23 ±2.00% to 11.43 ±0.21% for chlorothalonil and 42.34 ±2.47% to 48.43 ±1.91% removal of lambda cyhalothrin. 0.001% $KMnO_4$ gave the highest degradation rate of 86.63 ±0.02% to 89.01 ±1.03% for lambda cyhalothrin and 81.52 ±1.02 % to 84.08 ±1.78% chlorothalonil.

Key Words: Pesticides, Pentachlorophenol, Dimethoate, Chlorothalonil, Lambda-cyhalothrin, Incandescent bulbs, Fluorescence light, Spinach and washing solutions.

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Session 5: Scientific Research, Technology and Innovations for Sustainable Food Production

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SUITABILITY OF GREEN GRAM PRODUCTION IN KENYA UNDER PRESENT AND FUTURE CLIMATE SCENARIOS USING BIAS-CORRECTED CORDEX RCA4 MODELS

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Green gram is considered as one of the legumes suitable for cultivation in the Arid and Semi-Arid Lands (ASALs) of Kenya. However, climate change may alter the areas suitable for green gram production. This study sought to model green gram suitability in Kenya under present and future conditions using bias-corrected RCA4 models data. The datasets used were: maps of soil parameters extracted from Kenya Soil Survey map; present and future rainfall and temperature data from an ensemble of nine models from the Fourth Edition of the Rossby Centre (RCA4) Regional Climate Model (RCM); and altitude from the Digital elevation model (DEM) of the USGS. The maps were first reclassified into four classes of suitability as Highly Suitable (S1), Moderately Suitable (S2), Marginally Suitable (S3), and Not Suitable (N). The classes represent the different levels of influence of a factor on the growth and yield of green grams. The reclassified maps were then assigned a weight generated using the Analytical Hierarchy Process (AHP). A weighted overlay of climate characteristics (past and future rainfall and temperature), soil properties (depth, pH, texture, CEC, and drainage) and altitude found most of Kenya as moderately suitable for green gram production during the March to May (MAM) and October to December (OND) seasons under the baseline, RCP 4.5 and RCP 8.5 scenarios with highly suitable areas being found in Counties like Kitui, Makueni, and West Pokot among others. During the MAM season, the area currently highly suitable for green gram production (67,842.62 km2) will increase slightly to 68,600.4 km2 (1.1%) during the RCP 4.5 and reduce to 61,307.8 km2 (−9.6%) under the RCP 8.5 scenario. During the OND season, the area currently highly suitable (49,633.4 km2) will increase under both RCP 4.5 (22.2%) and RCP 8.5 (58.5%) scenarios. This increase is as a result of favourable rainfall and temperature conditions in the future.

Keywords: Climate change; Green gram; Kenya; Rainfall; Soil; Suitability; Temperature; Topography

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BIOFUEL PRODUCTION VERSUS FOOD SECURITY IN KENYA

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The United Nations' 2030 Sustainable Development Goals put a lot of priority on food and energy security, with biofuels playing crucial role in achieving both goals. Therefore, there is need to understand the complex interactions among food security, biofuel production and natural resource management. While available literature seems to suggest that biofuel production may compromise food security, this is still not well understood. Although biofuel production may have some negative ecological and other impacts, it also contributes to food security.

The paper aims to contribute to the ongoing ''biofuel or food security debate in reference to Kenya.'' This is because over 80% of the people depend on agriculture and many on subsistence farming thus the need of innovation. Its main objectives are to: a) discuss how integration of biofuel and food production can lead to more sustainable natural resource management b) examine the type of crops to be grown to provide food and energy c) discuss the type of incentives needed to promote investment in biofuel energy technology.

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The paper adopts a qualitative research design by relying heavily on literature review and key informant interviews. The key informants were selected from about 10 companies producing biofuels in Kenya. The major finding is that both biofuel production and food security are not alternatives, but complementary. It is recommended that policy makers provide suitable incentives to enhance investment in biofuel energy production in Kenya.

Keywords: Biofuels, Food security, Natural resource management, Renewable energy, Sustainable development goals.

A STUDY ON THE INFLUENCES OF THE SUN'S VARIABILITY ON EARTH'S CLIMATE CHANGE

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The Sun is the main originator of energy that sustains life on Earth. It has been observed to vary on all timescales and there is increasing evidence that this variation may have an effect on the Earth's climate. Understanding the effects of solar variability on the Earth's climatic change remains a puzzling question that has continued to attract the attention of scientists. Scientists are on the move to establish the quantity of solar energy that illuminates the Earth and what occurs to the energy once it gets through the atmosphere. Climate change is becoming a great concern to humanity and any climatic drift may influence weather patterns. Solar activities are the main cause of climatic change on Earth, hence, any fluctuations in the solar output are likely to influence the climate on Earth. This study is of significance as it may be used to predict the past and future solar variability and climatic response so that the human and natural signals may be untwined in the observational record and hence more dependable estimates can be made. The research made use of solar data from Solar Radiation and Climate Experiments (SORCE) and climate data from Climate Research Unit (CRU). In order to observe how these changes have occurred, analysis of the data was done using GNU-plot and python and explored for the possible correlation linking the solar variability and the Earth's climate change over the last 17 years. Our research findings indicate that the climate responds to solar variability as observed from the graph of global average anomalies which changes in phase with solar activity, although, it is not possible to fully assign the trend of global warming to solar variability since other factors may be contributing to the climate change.

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INFERENCE OF RIFT VALLEY FEVER PATHOGENESIS IN *BOS TAURUS* USING A GENE CO-EXPRESSION NETWORK

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Background

Rift Valley Fever (RVF) is a viral disease caused by the Rift Valley Fever virus and spread mainly by the *Aedes* and *Culex* mosquito species. The disease primarily infects domestic animals such as sheep, goats, and cattle, resulting in a spectrum of clinical outcomes including morbidity, massive storm abortions, and neonatal fatalities. RVF outbreaks are closely linked to above-average rainfall and flooding, which create an ideal environment for mosquitos to breed, multiply, and transmit the virus to animals. The outcomes of human RVF infection range from self-limiting febrile illness to potentially fatal hemorrhagic diatheses and miscarriage in pregnant women. Collectively, the economic losses due to the zoonotic RVF disease is immense.

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Methods

Using the Weighted Gene Co-expression Network Analysis (WGCNA) package, RNA-Seq data generated from five healthy *Bos taurus* steer calves aged 4-6 months was obtained from the Gene Expression Omnibus (GEO) database (Accession number GSE71417). The data was utilized to construct a gene co-expression network. Enriched modules containing genes potentially involved in RVF infection progression were identified. Moreover, using the Multiple Expectation Maximizations for Motif Elicitation (MEME) suite, consensus regulatory motifs of enriched gene clusters were deciphered and the most abundant putative regulatory motif in each enriched module unveiled by comparative analysis with publicly available motifs using the TOMTOM motif comparison tool. The potential roles of the identified regulatory motifs were inferred by literature mining.

Results

The constructed gene co-expression network revealed thirty-three (33) modules, nine of which were enriched for Gene Ontology terms linked to RVF pathogenesis. Enrichment in two (red and turquoise) of the nine modules was significant. The red module contained terms like calcineurin-NFAT signaling cascade, protein ubiquitination, ubiquitin-protein transferase activity, ubiquitin-protein ligase activity, and ubiquitin-dependent protein catabolic process, whereas the turquoise module contained terms like dendrite, G protein-coupled receptor activity, G protein-coupled receptor signaling pathway, response to stimuli, and adenylate cyclase-inhibiting. Additionally, consensus regulatory motif located on the 3' end of genes in each enriched module was identified.

Conclusions

In this study, we have developed a gene co-expression network that has aided in the unveiling of functionally related genes, intramodular hub genes, and immunity genes potentially involved in

RVF pathogenesis. The discovery of functional genes with putative critical roles in the establishment of RVF infection establishment will contribute to the understanding of the molecular mechanism of RVF pathogenesis. Importantly, the putative regulatory motifs identified are plausible targets for RVF drug and vaccine development.

Keywords: Rift Valley Fever, *Bos taurus,* Gene co-expression network, modules, hub genes, Regulatory motifs.

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Session 6: Research Outputs and Applications from the Basic Sciences and Practices

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IS COSMOLOGY IN A CRISIS? EXPLORING THE EVIDENCE OF A CLOSED UNIVERSE

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The geometry and shape of our universe remains one of the most exciting subjects in theoretical physics and cosmology. Particularly, the nature and type of spacetime curvature helps in determining our understanding the very early universe- its behavior and future fate. Recent research published in *Nature*, making use of the *Planck Satellite Legacy* 2018 (PL18) (see Di Valentine *et al.,* 2019) provide results suggesting that we live in a closed universe, with the amplitude of the Cosmic Microwave Background (CMB) radiation much larger when compared to the well-studied standard ΛCDM cosmological model. This research project was aimed at exploring the validity of the suggested evidence of a closed universe with an aim of carrying out an assessment of the possible implications of such results. Equations governing dynamics of a closed Universe are derived and the relevant theory behind the suggested crisis discussed.

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STOCHASTIC MODELING OF SYSTEMATIC MORTALITY RISK UNDER COLLATERAL DATA AND ITS APPLICATIONS

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Many actuaries worldwide use Systematic Mortality Risk (SMR) to value actuarial products such as annuities and assurances sold to policyholders. Data availability plays an essential role in ascertaining the SMR models' accuracy, and it varies from one country to another. Incorrect stochastic modeling of SMR models due to paucity of data has been a problem for many developing countries such as Kenya, thus prompting modifications of the classical SMR models used in those countries with limited data availability. This study aims to model SMR models stochastically under the collateral data environment such as Kenya and then apply it in the current actuarial valuations. In this thesis, we formulate novel stochastic mortality risk models under the collateral data setup. Kenya population data is preferably integrated into the commonly applied stochastic mortality risk models under a framework of a unitary age-period cohort. After testing SMR models on the Kenyan data to assess their behaviours, we incorporate the Bühlmann Credibility Approach with random coefficients in modeling. The randomness of the classical SMR models is modeled as NIG distribution instead of Normal distribution due to data paucity in Kenya (use of collateral data environment) for novelty purposes. The deep Neural Network (DNN) technique solves data paucity during the SMR model fitting. The forecasting performances of the SMR models are done under DNN and, compared with those from conventional models, show powerful empirical illustrations in their precision levels. Numerical results show that SMR models become more accurate under collateral data after incorporation of the BCA. The Actuarial valuation of annuities and assurances using the new SMR offers much more accurate valuations when compared to those under classical models. The study's findings should help regulators like IRA and RBA make policy documents that protect all stakeholders in Kenya's insurance, social protection firms, and pension sectors.

Keywords: Stochastic Mortality Models; Normality; Bühlmann Credibility; Systematic Mortality Risk

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GENOTYPIC CHARACTERIZATION OF ANTIMICROBIAL RESISTANT *STAPHYLOCOCCUS* SPECIES IN RAW CAMEL MILK FROM GARISSA COUNTY, KENYA

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Background: The continuous emergence of various multidrug resistant bacteria with narrow spectrum effective antibiotics to clinically challenging situations is a global concern including in Kenya. Little attention has been paid to bacteria contaminating camel milk yet they pose a feasible threat to public health. *S. aureus* Coagulase negative *Staphylococci* (CoNS) have been reported to be reservoirs of antimicrobial resistance genes and resistance-associated mobile genetic elements which can transfer between the species. *Staphylococcal* isolates with antimicrobial resistant (AMR) phenotypes can contaminate milk meant for human consumption. There is risk of human infection by the resistant pathogenic isolates when contaminated milk is consumed. This cross sectional study investigated the antimicrobial resistant genotypes of Staphylococci strains in 122 raw camel milk samples from Garissa County, Kenya.

Materials &Methods: A total of 231 raw camel milk from apparently healthy camels were collected in the selected Sub-Counties of Garissa. Disk diffusion was used to determine antimicrobial susceptibility of the isolates to the eight selected commonly used antimicrobials in the pastoralist community. This was done by placing antibiotic disks on Mueller Hinton Agar (MHA) streaked with *Staphylococcus* isolates and incubated at 37°C for 24 hours after which zones of growth inhibition were measured and interpreted as per the CLSI guidelines. Genetic determinants responsible for the resistance phenotypes of *Staphylococcus* species were determined by Polymerase Chain Reaction (PCR), sequencing, and Blast analysis. Genes encoding aminoglycoside (streptomycin) resistance (*aph*(6)-Id (*str*B) and beta-lactams (*mec*A, *mec*C, *bla*Z, *bla*TEM) were analyzed.

Results: Highest resistance among the isolates was observed against Cephalexin (81.9%) and Streptomycin (72.1%) while lowest resistance was seen against Chloramphenicol (1.6%) and Tetracycline (3.3%). MRSA and MRCoNS were reported at 9.8% and 15% of the isolates respectively. 43.4% of the isolates showed Multidrug resistance (MDR) while 39.3% were resistant to 1 or 2 antimicrobial tested. Overall, 68 (75.6%) *Staphylococci* isolates harboured at least one of the antimicrobial resistant genes. The *aph*(6)- Id (*str*B) gene was detected in 28.3% of the isolates. Majority of the isolates carried *bla*Z gene (88.6%) and *bla*TEM gene (46.6%) while one isolate harboured *mec*A gene. Both *S. aureus* (4) and CoNS(2) harboured *aph*(6)-Id (*str*B) and *bla*TEM genes. The *mec*A containing isolate also harboured *bla*TEM gene. The *mec*C gene was not detected in all the isolates.

Conclusion: The results of this study showed that CoNS and *S. aureus* isolates from raw camel milk carry similar resistant genes that horizontally transfer between the *Staphylococcus* species. Therefore, continuous monitoring is recommended in order to prevent the spread of AMR.

Keywords: Coagulase negative *Staphylococcus*, *S. aureus*, Multidrug resistance, antimicrobial resistance.

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COMPUTATIONAL METHODS IN MATERIALS SCIENCE STUDIES

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In recent years, the field of density functional Theory (DFT) calculations of electronic structure and properties of materials has progressed significantly. The super speed of computers, software improvements and theory advancement have contributed to the current successful application of DFT to materials science problems. In the field of computational materials science, high-throughput techniques for the search of novel crystal structures and the determination of band structure traits have become very popular. Despite this, there are still many challenges to overcome. Common to all computational materials scientists is the unquenchable thirst for higher speed and better accuracy in DFT calculations. This study presents recent advances in the theory and computational methods in DFT calculation of materials as well as to highlight computational results on structural properties of Tetragonal anatase and rutile TiO_2 in comparison to experimental and other theoretical studies. We employed DFT as implemented in the Quantum ESPRESSO computer code. The obtained lattice parameters of between 3.96Å to 4.06Å were in agreement with the experimental lattice parameter of 4.03Å.

Keywords: Computational physics, modeling and simulation, materials properties

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CONTINUOUS-TIME MARKOV CHAIN MODELLING OF A HIERARCHICAL SYSTEM

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Stochastic models, specifically Continuous-Time Markov Chain (CTMC) models are instrumental in modeling the dependability attributes of critical systems. The availability of a critical system is of great importance for service provision. This paper presents a CTMC model for the steady-state availability of a hierarchical system. CTMCs are used to derive the system modules' steady-state availabilities, hence the overall system steady-state availability. Imperfect coverage and switch-over factors are incorporated into the CTMC models where applicable.

Keywords: Dependability attributes, balance equations, failures, repairs.

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MOLECULAR EPIDEMIOLOGY AND CHARACTERIZATION OF ENTEROTOXIGENIC *ESCHERICHIA COLI* IN THREE WESTERN KENYA COUNTIES: A ONE HEALTH CONCEPT

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Enterotoxigenic *Escherichia coli* (ETEC) is a major cause of cholera-like diarrhea in traveler's to, and children from developing countries. ETEC is responsible for diarrhea and subsequent death of neonatal animals such as suckling piglets, calves, lambs, camels and goat kids. ETEC produce two types of virulence factors; enterotoxins (heat labile and/or heat stable toxins), and adhesins/colonization factors (CFs). There is the human derived LT-I gene (LTh) and LTB/LT-II variant predominantly in swine, also referred to as LTp. Similarly, STa/ST-I or STh are human derived heat stable toxins while STb/ST-II are animal derived with STp classified as part of the STa family.

We investigated the molecular epidemiology of enterotoxigenic *E. coli* with an emphasis on toxin diversity among strains from humans and animals (pigs and ruminants) from Busia, Bungoma and Kakamega. Samples were collected from an integrated surveillance on fifteen zoonotic diseases study conducted in the three Counties from 2017-2019 (Falzon L.C *et al.,* 2019). Samples were collected in Hospitals, Livestock Markets and Slaughter-houses. Toxin PCR validation was performed using previously described primers.

A total of 1508 *E. coli* samples were tested. Pigs sampled and slaughtered were 168 (11%), 605 cows (40%), 110 sheep (7.2%), 244 goats (16%) and 315 humans (20.8%). Mesenteric lymph nodes and fecal samples were tested only in pigs and fecal-only for the rest. Of the 168 pigs, 85(50.5%) had a fecal-only test, 17 (10%) had only their mesenteric lymph tested and 66(39.2%) had both mesenteric lymph node and fecal tested. Twelve (7.1%), 10(3.2%), 30(12.3%), 42(6.9%), 10(10%) ETEC isolates were from pigs, humans, goats, cows and sheep respectively. Human derived LTh toxin was obtained from diarrheic fecal sample from a cow sampled at Lubao market while one STh toxin was from a diarrheic fecal sample from a cow at Amukura market. Additionally, animal derived toxin LTB was found in an adult human sampled at Chwele Sub-County hospital. Two animal derived heat stable toxins were found in two human adults sampled separately at Busia referral Hospital and Mukumu mission hospital. ETEC from Humans were more resistant to antimicrobials than ETEC from Animals.
In conclusion, animal derived ETEC can be found in humans and vice-versa. Tolerance and disease severity should be investigated across species.

VARIATION IN SOCIO-DEMOGRAPHIC DETERMINANTS OF MATERNAL MORTALITY IN KENYA

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Background

Maternal mortality is a global concern referring to the death of mothers elicited from pregnancy and birth related obstetric complications; and is targeted in the world's third Sustainable Development Goals (SDG-3). Given the economical and cultural disparities in Kenya, there is need for targeted interventions guided by credible qualitative research and thematic analysis of the indicators of maternal mortality in the sub-populations. We aim to utilize computational tools for statistical analysis and visualization of secondary data to expose correlation in the patterns of maternal mortality ratio (MMR) and its covariates across the various demographics in Kenya.

Methods

We used the 2014 Kenya demographic and health survey (KDHS) data. The data on indicators of maternal mortality was retrieved. We performed exploratory data analysis using to determine the cumulative contribution by multiple indicators for each county using rankSum, compare the performance of each region to the national average using rate ratios and visualized of patterns and trends if the indicators against MMR. GeoDa application package was used for geo-spatial visualization of the indicators and ranksum valued across counties in Kenya.

Results

Our results show 11 counties that scored less than 100 rankSum points with West-Pokot (27) having the lowest value. 17 counties scored more than 200 rankSum points with Kiambu (294) scoring the highest. FGM and teenage pregnancies were the main cultural practices affecting maternal health. Education and wealth were the social demographics impacting on the uptake of health facility services by mothers.

Discussion

Our results show high MMR in the resource-poor setting coupled with inadequate uptake of maternal health services attributed to inadequate health facility infrastructure, poverty, lack of education and detrimental cultural practices.

Conclusion

These findings give insight to customized intervention dynamics required to improve maternal health in Kenya.

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TOWARDS CLIMATE RESILIENT FOOD SYSTEMS: ASSESSMENT OF FOOD CRISES AND COPING STRATEGIES IN TAITA TAVETA COUNTY, KENYA

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The research examined the effects of climate change on food systems ranging from production processing, aggregation, storage, transportation, distribution and consumption of food as well as handling and disposal of food wastes. The main objective of the study was to examine the impacts of climate change on food system and, assess dynamics of past and current trends of food security. The study explored adaptation options for enhanced sustainability of food security in Taita Taveta County due to recurrent chronic food insecurity prevalent in Kenya's Arid and Semi-Arid Lands (ASALs). The study adopted food systems theory and resilience approach using household surveys, Focused Group Discussion (FGD) with actors and face to face interviews of selected key informants who play special roles such as policy makers, administrators, agricultural and livestock extension officers, meteorological offices aggregators and agro-dealers. A sample size of 400 producers, marketers of agricultural commodities and consumers were selected using stratified random sampling to represent diverse categories of players in the food system. Data was collected using questionnaires for three surveys, interview schedule for key informants and FGDs. The data gathered from the surveys using Open Data Kit (ODK) tool was loaded at the end of each day. Information from FGDs and scheduled interviews was summarized using tables' graphs and charts to enable drawing of conclusions. The results include historical food security trends in Taita Taveta County including past extreme climate events and coping strategies from 1981 to 2020; projected climate change scenarios and how they could relate with the food systems in Taita Taveta County up to 2065; and policy, strategic interventions and resilience building for food security in Kenya and Taita Taveta County in particular. The study finally recommends a hybrid model between traditional indigenous and scientific practices for adoption and scaling up in climate-resilient food systems in Taita Taveta County.

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RESEARCH OUTPUT DISSEMINATION – SCHOLARLY & SCIENCE COMMUNICATION CAPACITYBUILDING

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Effective dissemination and communication of research output is vital to ensure that the conducted research has a social, political, or economical impact. They draw attention of governments and stakeholders to research results and conclusions, enhancing their visibility, comprehension, and implementation.

The Training Centre in Communication Africa(TCC-Africa), noted a gap that ― reveals a bleak picture of the low status of public science engagement in Africa. In the universities, the postgraduate students take too long to graduate than the stipulated period, research output are no visible to the public hence low uptake and an unstable funding. TCC-Africa therefore filled the gap by conducting capacity building sessions through trainings on scholarly communication and provision of research resources through institutional collaborations for research discovery. TCC Africa builds research capacity through training in scholarly and science communication and supporting researchers on how to translate their work to various audiences through interactive workshops, where we bring open access partners ,science media partners, and science communication specialists and guide scientists how they can effectively communicate with different publics.

We have supported over 10,287 researchers from 80 institutions across 40 countries in Africa which involves working closely with early career researchers and higher education stakeholders. There are currently a number of reforms in the administrations of resources available to researchers that can be used to help guide their dissemination planning and activity through the global north-south collaborations .Given the current emphasis on enhancing the uptake of knowledge about the effects of lack of visibility, research institutions could consider encouraging researchers to embrace open access and adopt a technological-informed approach to their research dissemination.

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CHEMOMETRICS-ENABLED X-RAY FLUORESCENCE ANALYSIS OF TRACE BIOMETALS IN HUMAN FLUIDS AS CANCER BIOMARKERS

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Effective treatment of diseases depends on its early detection and correct diagnosis. Trace biometals (Mn, Fe, Cu, Zn and Se) not only play significant roles in normal body biochemical processes but also in disease pathogenesis such as the onset and development of cancer depending on their concentration levels and alterations. The goal of this work was to investigate and exploit the potential of chemometric-aided energy dispersive X-ray fluorescence (EDXRF) spectrometry towards early diagnosis of cancer based on the correlative concentration and multivariate alterations of trace elements in human body fluid (urine). Spectral data were acquired using the XRF spectrometer operated at irradiation time of 200s, at 50 W and 50 kV. The exploratory and quantitative analysis of trace biometals were done using chemometrics techniques (PCA and HCA) and advanced FP (fundamental Parameter) methods respectively. Elevated levels of trace biomarkers; Fe (116.2 ± 2.9), Cu (6.0 ± 0.4) and alterations of Zn, Mn and Se were correlated to the onset and development of cancer. Exploratory analysis by Principal Component analysis enabled characterization of prostate and cervical cancer. The results not only demonstrate the power of chemometrics-enabled EDXRFS in cancer detection and diagnosis but also the potential of Fe, Cu and Zn as urinary bladder cancer biomarkers for cancer characterization. The results underscore the role of trace elements in cancer and indicate that Cu, Fe, Zn, Se and Mn can be used as trace biomarkers for early diagnosis of cancer (prostate and cervical) in human body fluids. The method has the ability to provide necessary diagnostic information about cancer and stage of development.

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NOVEL CHEMOMETRICS-ASSISTED ENERGY DISPERSIVE X-RAY FLUORESCENCE SPECTROSCOPY APPROACH FOR INVESTIGATION OF MERCURY IN SKIN LIGHTENERS

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The use of cosmetic products for skin colour lightening or bleaching is a common practice across the globe. However human health effects associated with mercury in these products such as skin cancer and kidney failure have been reported. Conventional techniques used in the analysis of mercury are destructive, time consuming and expensive. Although the energy dispersive X-ray fluorescence (EDXRF) spectroscopy method is rapid, non-destructive and requires minimal or no sample preparations, it has a high detection limit for mercury and therefore quantification of mercury concentrations below 1ppm is challenging. This is mainly due to spectral overlaps, weak mercury fluorescence signals and extreme matrix effects. In this work, a novel chemometrics-assisted EDXRF spectroscopy method was utilized to realize rapid, direct detection and quantification of both low (< 1ppm) and high mercury levels in skin whitening creams and lotions. 50 simulate samples (mixtures of distilled water and pure glycerol) spiked with mercury concentrations ranging 1 ppb – 500 ppm were prepared and analyzed in triplicates for 900s using a tube-excited EDXRF spectrometer. Two chemometric techniques namely, principal component analysis (PCA) and artificial neural networks (ANNs) were used to perform exploratory analysis of the measured EDXRF spectra and quantification of the mercury levels. From PCA results, it was observed that spectral data formed distinct clusters for both the low and high mercury concentration levels in the 9.6-10.4 keV Hg L_α and 11.2-12.4 keV Hg L_β regions. ANN models for Hg quantification of both ppb and ppm were realized. The ppb model had an R^2 value of 0.7, a root mean square error of prediction (RMSEP) of 21% and a limit of detection (DL) of 527 ppb while the ppm model had R^2 value of 0.9, RMSEP of 4.6%, and DL of 3 ppm. These preliminary findings suggest that the method can be improved to provide rapid, non-destructive, and cost-effective trace quantitative analysis of mercury. The approach is also applicable to quality control and assurance of consumer products by regulatory authorities such as the Kenya Bureau of Standards.

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