NIGERIAN SOCIETY OF PHYSICAL SCIENCES (NSPS)

IN COLLABORATION WITH

AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA

4TH INTERNATIONAL SCIENTIFIC CONFERENCE (HYBRID) ZAZZAU 2026

Theme:

FROM LABS TO LIVES: HARNESSING THE PROSPECTS OF PHYSICAL SCIENCES IN TACKLING NIGERIA'S ECONOMIC, SECURITY, AND ENERGY CRISES

Dated: Monday, 9th February - Saturday, 14th February, 2026

BOOK OF ABSTRACTS

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Day 1: Monday, 9th February 2026

Arrival/Collection of Conference materials

Venue: Deanery, Faculty of Physical Sciences, Ahmadu Bello University, Zaria

Time: 2:00pm – 4:00pm

Day 2: Tuesday, 10th February, 2026

Conference Opening Ceremony, Investiture of Fellows and Recognition of Ph.D. Prize Winners

Venue: Yusufu Bala Usman Hall, Main Campus, Ahmadu Bello University, Zaria.

8:00 – 9:00 am	Collection of Conference items - continued
9:00 – 9:30 am	Arrival of Guests and Online participants
9:30 – 9:35 am	Arrival of Provosts/Deans/Directors/Professors and other University staff
9:35 – 9:35 am	Arrival of the Vice Chancellor & other Principal Officers of the University
9:35 – 9:40 am	Arrival of the Royal Father of the Day, His Royal Highness Mallam Ahmad Nuhu Bamalli, CFR, Emir of Zazzau
9:40 – 9:50 am	Arrival of the Guest of Honour and other Distinguished Guests
9:50 – 10:00 am	Arrival of the Special Guest of Honours
	(i) His Excellency (Senator) Uba Sani, CON, Executive Governor of Kaduna State
	(ii) His Excellency Engr. Abba Kabir Yusuf, Executive Governor of Kano State
10:00 – 10:05 am	Opening Prayers
10:05 – 10:10 am	National Anthem/ABU Anthem
10:10 – 10:20 am	Introduction of Dignitaries and Invited Guests
10:20 – 10:30 am	Welcome Address by the Host, Professor Ibrahim Abdulkadir, Dean, Faculty of Physical Sciences, Ahmadu Bello University, Zaria
10:30 – 10:40 am	Welcome Address by the Chairman, Local Organizing Committee (LOC), Professor Abubakar Yahaya, Department of Statistics, Ahmadu Bello University, Zaria
10:40 – 10:55 am	Goodwill Messages by the Co-Hosts (HODs in the Faculty of Physical Sciences)

10:55 – 11:05 am	Address by the National President, Nigerian Society of Physical Sciences (NSPS), Professor Oladiran Abimbola
11:05 – 11:15 am	Address by the Chief Host, Professor Adamu Ahmed, Vice Chancellor, Ahmadu Bello University, Zaria.
11:15 – 11:25 am	Remarks by the Chairman of the Occasion/Declaration of the Conference open. Professor Ibrahim Garba, Former Vice Chancellor, Ahmadu Bello University, Zaria
11:25 – 11:55 am	Citation and Presentation of the Keynote Address by Professor Abubakar Sani Sambo, Honourable Commissioner for Education, Kaduna State
	Topic: Enhanced Energy Security as the Basis for Sustainable Economic Growth in Nigeria
11:55 – 12:45 pm	Citations & Presentation of Prestigious Awards of Excellence to Recipients
	(i) His Excellency, Senator Uba Sani, Executive Governor of Kaduna State
	(ii) His Excellency, Engr. Abba Kabir Yusuf, Executive Governor of Kano State
	(iii) Rt. Hon. Garba Datti Muhammad Babawo, APC National Vice Chairman (North West)
	(iv) Professor Adamu Ahmed, Vice Chancellor, Ahmadu Bello University, Zaria
12:45 – 12:55 pm	Remarks of Appreciation on behalf of other distinguished recipients of Awards by His Excellency, Executive Governor of Kaduna State
12:55 – 1:15 pm	Citation Presentation & Investiture of Distinguished Fellows of NSPS
	(i) Professor Olabode Matthias Bamigbola – *Mathematics & Statistics*
1:15 – 1:30 pm	Recognition of PhD Prize Winners and Conferral of Life Membership
	(i) Dr. Paul Oyeyiola Adesina – *Physics and Astonomy*
	(ii) Dr. Timilehin Gideon Shaba – *Mathematics & Statistics*
	(iii) Dr. Temitayo Olamide Ale – *Earth Sciences*
	(iv) Dr. Bello Alhaji Buhari – *Computer Science*
	(v) Dr. Temitope Ogunnupebi - *Chemistry*
1:30 – 1:35 pm	Investiture of New Life Members of NSPS
	(i) Professor John Abidemi Laoye
	(ii) Dr. Emmanuel Agboeze
	(iii) Dr. Ibrahim Isah

1:35 – 1:40 pm	Vote of Thanks by the LOC Secretary, Professor Abdelghaffar Amoka Abdelmalik
1:40 – 1:45 pm	Closing Remarks by the Chairman of the Occasion
1:45 – 1:50 pm	Second Stanza of the National Anthem Closing Prayers
1:50 – 2:00 pm	Refreshment
2:00 – 3:00 pm	Tour of ABU Campus

Day 3: Wednesday, 11th February, 2026

Venue: Yusufu Bala Usman Hall, Main Campus, Ahmadu Bello University, Zaria.

8:00 – 9:00 am	Arrival of Participants
9:00 – 9:30 am	Citation and Presentation of Lead Paper by **Dr. Abdulhakeem Bello**, Department of Theoretical and Applied Physics, African University of Science and Technology, Galadimawa, Abuja TOPIC: Physics and Chemistry of Advanced Energy Materials and Storage
9.30 – 10.00 am	Tea Break
10:00 – 1:00 pm	Workshop on Machine Learning in Physical Sciences
1:00 – 2:00 pm	Prayer/Lunch Break
2:00 – 4:00 pm	Parallel technical sessions

Day 4: Thursday, 12th February, 2026

Venue: Yusufu Bala Usman Hall, Main Campus, Ahmadu Bello University, Zaria.

8:00 – 9:00 am	Arrival of Participants
9:00 – 11:00 am	Visit to Centre for Energy Research and Training (CERT), Multiuser Science Research Laboratory (MUSRL), and High Voltage Materials Research Laboratories
11:00 – 11:30 am	Tea Break
11:30 – 1:00 pm	Parallel technical sessions
1:00 – 2:00 pm	Prayer/Lunch Break
2:00 – 4:00 pm	Parallel technical sessions

Day 5: Friday, 13th February, 2026

8:00 – 9:00 am	Arrival of Participants
9:00 – 10:30 am	Parallel technical sessions
10:30 – 11:00 am	Tea Break
11:00 – 1:00 pm	Parallel technical sessions
1:00 – 3:00 pm	Prayer/Lunch Break

Closing Ceremony

3:00 – 3:10 pm	Remark by Professor Ibrahim Abdulkadir, Dean, Faculty of Physical Sciences, Ahmadu Bello University, Zaria.
3:10 – 3:20 pm	Remark by Professor Adamu Ahmed, Vice Chancellor, Ahmadu Bello University, Zaria.
3:20 – 3:30 pm	Vote of thanks by Remark by the Chairman, Local Organizing Committee (LOC), Professor Abubakar Yahaya.
3.30 – 3.40 pm	Closing Prayer/Certificate collection
5:00 – 7:00 pm	AGM

Day 6: Saturday, 14th February, 2026

==========Departure ==========

HISTORY OF THE NIGERIAN SOCIETY OF PHYSICAL SCIENCES

The Nigerian Society of Physical Sciences (NSPS), a non-profit and non-political organization of physical scientists incorporated by the Corporate Affairs Commission of Nigeria on January 9, 2019 (CAC/IT/NO 123135), has a rich and illustrious history that reflects its commitment to advancing knowledge in the field of physical sciences. Established as a professional organization, NSPS has played a pivotal role in fostering collaboration, promoting academic excellence, and contributing to the scientific community in Nigeria.

Inception:

NSPS was founded with a visionary purpose, aiming to create a platform for scholars, researchers, and professionals in the physical sciences to come together, exchange ideas, and collectively contribute to the growth of scientific knowledge. Its inception marked a significant step toward creating a community that would address the unique challenges and opportunities within the realm of the physical sciences.

Early Years and Formation:

The process of establishing NSPS commenced in January 2018 through extensive discussions between Dr. Babatunde James Falaye and Professor Oladiran Johnson Abimbola. These discussions centred around the imperative of advancing research and studies in the physical sciences within Nigeria. The envisioned initiatives included the organization of conferences, workshops, and scholarship programs; the establishment of scientific prizes and awards; and the publication of scholarly journals.

In February 2018, the duo sought counsel from senior colleagues, and by March 2018, they encountered additional like-minded colleagues, namely Dr. Oluwatimilehin Joshua Oluwadare, Dr. Wasiu Yahya, and Dr. Tolulope Latunde, who not only shared the same vision but also made significant contributions toward the realization of society. The public announcement of the society, initially named "Nigerian Physical Society," appeared in several prominent daily newspapers, including The Nation, Daily Trust, and New Telegraph, on May 7, 2018.

In September 2018, a formal notification prompted a reconsideration of the society's name, necessitating a revision before obtaining the consent of the Registrar General of the Corporate Affairs Commission of Nigeria. Following careful deliberation among prospective Trustees, the decision was made to change the name to "Nigerian Society of Physical Sciences." Consent and approval for this name change were successfully obtained in November 2018 and widely publicized in leading newspapers, including Leadership, Pilot, and Blue Print, on November 6, 2018.

Ultimately, the Nigerian Society of Physical Sciences was officially incorporated on January 9, 2019, with the overarching goal of promoting research and study in the physical sciences within Nigeria and providing effective programs and support.

In its early years, NSPS focused on building a strong foundation, establishing its organizational structure, and defining its mission and objectives. The society attracted members from various branches of physical sciences, including physics, mathematics, chemistry, earth sciences, and computer science.

Promoting Research and Collaboration:

The NSPS quickly emerged as a catalyst for academic research and collaboration. The society organized conferences, seminars, and workshops that provided a platform for scientists and researchers to present their findings, share knowledge, and engage in fruitful discussions. These initiatives aimed to foster a spirit of interdisciplinary collaboration and contribute to the advancement of scientific understanding.

Journal Publication:

Recognizing the importance of disseminating high-quality research, NSPS launched the Journal of the Nigerian Society of Physical Sciences. This scholarly publication became a reputable outlet for researchers to publish their work, contributing to the body of knowledge in the physical sciences. Over the years, the journal has gained recognition both nationally and internationally. It is currently indexed in Scopus (Q1), Scimago (Q3), DOAJ, etc. NSPS also published and co-published other journals such as African Scientific Reports, Recent Advances in Natural Sciences, and Proceedings of the Nigerian Society of Physical Sciences.

Ph.D. Prize Awards:

As part of its commitment to recognizing and celebrating academic excellence, NSPS instituted the Ph.D. Prize Awards. This initiative acknowledges outstanding doctoral theses in various branches of physical sciences, encouraging researchers to strive for excellence and innovation in their academic pursuits.

Global Recognition:

NSPS has actively sought to enhance its global standing. The inclusion of its journal in renowned indexing databases such as Scopus and the Directory of Open Access Journals (DOAJ) reflects the society's dedication to reaching a broader international audience and contributing to the global scientific discourse. NSPS forged affiliations with various international communities, including the American Metrological Society, the Israeli Physical Society, and the Geophysical Society of America, among others. This positioned NSPS as a global hub for collaboration and furthered its mission on an international scale.

Educational Outreach and Community Impact:

Beyond academic pursuits, NSPS has engaged in educational outreach initiatives and community impact programs. Workshops, seminars, and outreach activities have aimed at promoting scientific literacy, raising awareness, and inspiring the next generation of scientists.

Continued Growth and Future Outlook:

As NSPS celebrates its journey, society remains committed to its mission of promoting excellence in the physical sciences. The future outlook includes further collaborations, research initiatives, and educational programs that will continue to shape the landscape of physical sciences in Nigeria.

The Nigerian Society of Physical Sciences stands as a beacon of academic excellence, collaboration, and innovation, contributing significantly to the scientific community in Nigeria and beyond.

SUBTHEME 1: SUSTAINABLE ENERGY AND ADVANCED ENERGY SYSTEMS

ASSESSMENT OF SOLAR RADIATION VARIABILITY AND ITS IMPACT ON ENERGY GENERATION OVER KANO

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Abstract

This study investigates the variability of solar radiation and its impact on photovoltaic (PV) energy generation in Kano, Nigeria, using a 31-year dataset (1990–2020) of global solar radiation, sunshine duration, and temperature obtained from the Nigerian Meteorological Agency (NIMET). Empirical sunshine and temperature based models were applied and validated with statistical indicators of Mean Bias Error (MBE), Root Mean Square Error (RMSE), Mean Percentage Error (MPE) and coefficient of determination (R^2). Results showed that annual mean global solar radiation was 17.86 $MJm^{-2}day^{-1}$, higher values were observed in the rainy season (April to October) with 23.06 $MJm^{-2}day^{-1}$, than in the dry season (November to March) with 22.82 $MJm^{-2}day^{-1}$, due to the influence of dust and aerosols. The monthly average PV energy output was 2721.44 kWh, peaking in May (3078.29 kWh) and reaching its minimum in January (2402.58 kWh). Correlation analysis revealed strong positive relationships between solar radiation, sunshine duration, and PV output, with the Garcia temperature-based model (H3) achieving the best performance (R^2 = 92.2%). The findings confirm Kano's high solar potential and underscore the suitability of temperature-based models for reliable solar energy estimation in the Sahelian region. This study provides valuable insights for planning, optimizing, and deploying solar energy systems in northern Nigeria.

Keywords: Empirical models, Kano, PV energy, solar radiation, variability.

DETERMINATION OF SPIN-INDUCED MECHANICAL, MAGNETIC AND THERMODYNAMIC PROPERTIES OF QUATERNARY HALF-HEUSLERS ZRPBFEX (X=SI,AS AND GE) USING FIRST-PRINCIPLE CALCULATIONS

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ABSTRACT

The First-principle Density Functional Theory method was used to investigate the half-metallic character, magnetic and thermodynamic properties of ZrPbFeX (X=Si,As and Ge). Properties such as Band structures, magnetic moments and spin – polarization indices of each alloy are also determined to confirm half-metallicity and ferromagnetism. Thermodynamic properties such as Free Energy, Entropy and Heat Capacity are also computed using Quantum Espresso-based Thermo_pw code. The half-metallic band gaps of ZrPbFeAs, ZrPbFeSi and ZrPbFeGe are 0.306eV, 0.304eV and 0.302eV respectively. The spin-up channels in the electronic band structures of ZrPbFeX (X=Si,As and Ge) have indirect energy band gap, indicating that they exhibit half-metallic character.The quaternary Heuslers ZrCoFeX (X=Si,As and Ge) are ferromagnetic as they all obey Slater Paulin's rule having magnetic moments of 4.0515μB,4.1973μB and 4.5611μB respectively and are 100% spin-polarized. The Curie Temperatures T_c of ZrPbFeX (X=Si,As and Ge) are 625K ,3631K and 747K respectively. However, only ZrPbFeAs, and ZrPbFeGe preserved their ferromagnetism after undergoing strain field. This makes them preferable candidates in semiconductor physics. The heat capacities of ZrPbFeX (X=Si,As and Ge) obey Dulong-petit law showing that they have good thermal applications in optoelectronic devices.

Keywords: Quaternary Ha Heuslers, first principle computations, Physical properties

RENEWABLE ENERGY AND THE GREEN TRANSITION: IMPLICATIONS FOR RURAL ELECTRICITY ACCESS IN NIGERIA

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Abstract

The transition to green energy has become central to sustainable development debates, yet its implications for rural electricity access in developing economies remain insufficiently explored. This study investigates how Nigeria's shift toward renewable energy affects rural access to electricity within the broader framework of the green energy transition. Using annual time series data spanning 1990 - 2024, sourced from the World Bank, the International Renewable Energy Agency (IRENA), and the International Energy Agency (IEA), the study employs the autoregressive distributed lag (ARDL) model to examine both short-run and long-run dynamics. Key variables include rural electricity access, renewable energy consumption, carbon intensity, and economic growth, with trade openness and financial development serving as control variables. The results are expected to reveal whether increased renewable energy adoption enhances electricity availability in rural areas, thereby promoting inclusive energy access. In addition, the study seeks to identify the extent to which renewable energy consumption mediates the relationship between Nigeria's green transition efforts and rural electrification outcomes. The findings will provide new insights into how energy transition strategies can be harnessed to close the rural energy access gap while supporting environmental sustainability goals. Policy recommendations will focus on strengthening renewable energy investments, rural electrification initiatives, and regulatory frameworks that support a just and inclusive green transition in Nigeria.

Keywords: Green energy transition, renewable energy consumption, rural electricity access, energy inclusion, Nigeria.

MEASUREMENT OF DIELECTRIC PROPERTIES OF PREPARED STABLE NANOFLUIDS USING COATED TiO_2 NANOPARTICLE BASED PALM KERNEL OIL

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ABSTRACT

The increasing demand for environmentally friendly and high – performance insulating fluids has driven research in to bio – based nanofluids with enhanced dielectric characteristics. This study focuses on the measurement and analysis of dielectric properties of prepared nanofluids formulated by dispersing coated Titanium dioxide (TiO_2) nanoparticles in to methyl ester obtained from palm kernel oil. Subsequently, the TiO_2 nanoparticles were coated with oleic acid (as surfactant) to improve dispersion stability and reduce agglomeration. And the particles were characterised by Fourier Transform Infrared (FT-IR) Spectroscopy. The Nanofluids were prepared at controlled nanoparticle concentrations using appropriate mixing and stabilization techniques. Then, the prepared samples were used to study the physicochemical (viscosity, pour point and flash point) and dielectric properties (relative permittivity, loss factor, leakage current, DC and AC breakdown test) for power equipment use. However, the dielectric properties were measured over a selected range of frequency range of 20 to 200 kHz using the Rohde & Schwarz HM8118 Programmable inductive capacitive reactance (LCR) Bridge. The results indicate that the incorporation of coated TiO_2 nanoparticles significantly modifies the stability of Nanofluids and addition of particle's concentration improved dielectric properties. These findings suggest that TiO_2 - based palm kernel oil nanoparticles have strong potentials as sustainable insulating materials for electrical and power equipment applications.

Keywords: insulating fluids, dielectric properties, nanoparticles, surfactant, stability,

DESIGN AND EXPERIMENTAL PERFORMANCE EVALUATION OF A HYBRID SOLAR THERMAL PARABOLIC TROUGH SYSTEM FOR RURAL ELECTRIFICATION IN NIGERIA

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Abstract

This study presents the design and experimental performance evaluation of a hybrid solar thermal parabolic trough system, developed for rural electrification in Nigeria. The system includes a parabolic trough collector, an evacuated receiver tube, a supplementary gas heater, and a compact impulse steam turbine connected to a DC electric generator. The experiments were performed over three successive days, from 9 AM to 5 PM in October 2019 at the University of Ilorin, with a focus on solar irradiance, receiver's inlet and outlet temperatures, superheated steam temperature, power production, and system efficiency. During the experimental testing, the system generated a maximum thermal-to-electric efficiency of 15.1 % and yielded a peak electrical output of 34.06 W. The results showed effective energy conversion, indicating the system's capability to meet Nigeria's energy deficiency particularly in off-grid or rural settings and its applicability in regions with sporadic solar obtainability.

Keywords: Hybrid solar thermal, parabolic trough, supplementary gas heater, rural electrification, Nigeria

MODIFICATION OF SARA SEPARATION METHOD FOR ENHANCED RESIN RECOVERY AND ANALYSIS IN CRUDE OIL FROM NIGER REPUBLIC

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Abstract

The analysis of crude oil via fractionation of Saturates, Aromatics, Resins, and Asphaltenes (SARA) is critical for understanding petroleum properties for processing and utilization. The resin fraction is important for crude oil flow and stability and its recovery using the traditional SARA method is limited. Thus, the need to modify the separation protocol to enhance resin recovery in crude oil from Niger Republic. A mixture-design methodology was employed using Design-Expert® (Software v13) to screen acetone (ACT), dichloromethane (DCM), ethyl acetate (EtOAc) and toluene (TOL) into 6 binary pairs which generated 65 experimental runs. Laboratory fractionations were carried out to evaluate resin yields, and the generated ANOVA model (resin yield) was used to predict the optimum binary solvent pair. This was optimized using the lattice design to obtain efficient solvent ratio. The mixture-design screening identified a DCM/ACT as superior for targeted resin elution, offering an optimal balance between solvent strength and polarity. Optimization of the DCM/ACT ratio has resulted to 10:90 (v/v) with significant resin recovery (98.5%) compared to the traditional method (48.13%). Fourier-Transform Infrared (FT-IR) analysis revealed distinct functional group signatures at 3450 cm^{-1} (O-H/N-H stretch of phenols or pyrroles), 1700 cm^{-1} for a C=O and 2850-2960 cm^{-1} characteristics of C-H stretches of aliphatic chains. The FT-IR provided evidence of functional groups consistent with the polar resin class. The modified SARA separation method proved to be highly effective for resin recovery in crude oil from Niger Republic. This may offer valuable tool for better understanding the resin fraction in crude oil processing and utilization.

Keywords: crude oil, SARA, resin, mixture design, FT-IR

BIOCONVERSION OF RAW OIL PALM LEAVES VIA NOVEL FUNGAL STRAINS TRICHODERMA ASPERELLUM UC1 AND RHIZOPUS ORYZAE UC2 FOR SUSTAINABLE ENZYME PRODUCTION

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Abstract

The growing demand for cellulases and xylanases in lignocellulosic degradation and reutilization has spurred the need for their improved production at reduced cost. The aim of this study is to use the abundantly available oil palm leaves (OPL) as an alternative and sustainable substrate for producing enzymes in the degradation and biotransformation of unwanted lignocellulosic biomass. Both enzymes are key players in the biotransformation of biomass into other value-added commodities. This study statistically optimized the solid-state fermentation (SSF) of raw OPL by novel fungal strains *Trichoderma asperellum* UC1 and *Rhiopus oryzae* UC2, to produce cellulase and xylanase, where raw OPL was pretreated using ultrasonication before the dual enzymes-assisted saccharification process. This experiment aimed to identify the best parameters for the highest activity of CMCase (EC 3.2.1.1.4), FPase (EC 3.2.1.91) and xylanase (EC 3.2.1.1.8) of *T. asperellum* UC1 and of β-glucosidase (EC 3.2.1.21) of *R. oryzae* UC2 for improved saccharification. Activities of CMCase (126.78 Ug^{-1}), FPase (85.53 Ug^{-1}) and xylanase (215.42 Ug^{-1}) achieved the maximum under optimized SSF conditions (30 ^{o}C, 2.0 x 10^{7} spores g^{-1}, 75% moisture content, pH 6). The best β-glucosidase activity (131.76 U g^{-1}) was obtained at 32 ^{o}C, 2.0 x 10^{7} spores g^{-1}, 50% moisture content, pH 12. OPL saccharification yielded 1240 ± 32 mgg^{-1} total reducing sugar. Individual enzymes cocktails improved juice clarification (84-88%) and dough rising (1.7-2.0-fold). The optimized SSF of raw OPL successfully afforded the production of effective cellulases and xylanases for saccharification-related reactions.

Keywords: Palm leaves, Cellulase, Xylanase, Fungi, Saccharification

IMPACT OF CTAB ON THE MORPHOLOGICAL AND ELECTROCHEMICAL PERFORMANCE OF MoO_3 NANOPARTICLES WITH IMPROVED ENERGY STORAGE PROPERTIES

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ABSTRACT

The search for high specific capacitance, low-cost electrode material for supercapacitor material is a challenge in energy storage devices. Among the numerous potential candidates, layered compounds such as MoO_3 have attracted increasing attention. A hydrothermal synthesis process using hexadecyltrimethyl ammonium bromide [CTAB] as a surfactant was developed for the synthesis of supercapacitor MoO_3 anode material. The impact of CTAB on the morphology and the electrochemical properties of the material were investigated. With the variance of hydrothermal reaction time(s) on the nanoparticles, high specific surface area and more active sites were observed from the SEM images. The electrochemical measurement demonstrated that CTAB@MoO_3-12h nanoparticles had the best performance as compared to CTAB@MoO_3-4h and CTAB@MoO_3-8h, with specific capacitance of 480 F/g at a current density of 1.0 mA/g over 5000 cycles.

Keywords: SEM, electrochemical, morphology, material, hydrothermal synthesis

CONVERTING TROPICAL AGRICULTURAL WASTE INTO FUNCTIONAL BIOPOLYMERS: A COMPARATIVE FRAMEWORK FOR DECENTRALIZED PRODUCTION IN EMERGING ECONOMIES

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ABSTRACT

Tropical agricultural food waste presents significant untapped potential for biopolymer production. However, comparative evaluations across different feedstock types have remained fragmented in the literature. This narrative review offers a comprehensive comparative framework examining biopolymer development from four abundant waste streams: orange peels, banana skins, cassava peels, and potato waste. The focus is specifically on decentralized production approaches suitable for resource-constrained environments. We examine extraction methodologies, processing innovations, and material performance across these feedstocks, identifying key trade-offs and synergies that influence feedstock selection. Emerging techniques, including enzyme-assisted extraction, show promise for reducing energy requirements, while waste-derived crosslinking agents such as tannins have been reported to increase tensile strength in pectin films by 40-43%, eliminating the need for synthetic additives. Literature from decentralized processing contexts suggests that local waste valorization can reduce disposal costs while creating revenue opportunities from materials currently discarded. We identify optimal feedstock-application pairings based on reported material properties and propose hybrid-processing strategies that could maximize resource utilization and economic viability in developing regions. The comparative framework reveals how local processing might simultaneously address agricultural waste management challenges and create economic opportunities in resource-constrained settings. Our analysis provides conceptual guidance and identifies research priorities for scientists, entrepreneurs, and policymakers seeking sustainable waste valorization solutions in emerging economies.

Keywords: valorization, circular bioeconomy, enzyme-assisted extraction, tensile strength, decentralized processing

DRUG REPURPOSING POTENTIAL OF SYNTHESIZED DINITROPHENYL HYDRAZONE LIGAND AND NI(II)/V(II) COMPLEXES: AN INTEGRATED COMPUTATIONAL STUDIES

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Abstract

The urgency for effective SARS-CoV-2 therapeutics has revived the interest in metal-based drud re-purposing, particulary Schiff base-derived hydrazones with established bio-activity. This study employs an integrated computational approach to evaluate a dinitrophenyl hydarzone ligand (DHZ) and its Ni(II) and V(II) complexes against SARS-CoV-2 main protease (Mpro), RNA dependent RNA ploymerase (RdRp), and spike RDB-ACE2 interface. Molecular docking (autodock Vina) was coupled with ADMET prediction, Lipinski's compliance and bioavailability radar profiling using SwissADME and pkCSM. Density Functional Theory (DFT) calculations at the B3LYP/6-31G(d,p)//LANL2DZ level assessed HOMO-LUMO gaps and reactivity parameters. Metal complexation enhanced binding affinity, pharmacokinetics indices, and electronic reactivity, with the V(II) complex showing the strongest predicted inhibition. The findings indicate that transition metal-hydrazone frameworks are promising candidates for antiviral drug re-purposing and merit experimental validation.

Keywords: Hydrazone Complexes, Drug Re-purposing, Molecular Docking, SARS-CoV-2 Inhibition, Transition Metal Therapeutics

DEPENDENCE OF MAGNETIC ENERGY OF METALS ON ELECTRON DENSITY PARAMETERS AND LINEAR STRAIN

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Abstract

The study investigates the relationship between magnetic energy properties of transition metals and their electron density parameters under varying conditions of linear strain. Using first-principles density functional theory calculations, how magnetic moment, exchange coupling and magneto crystalline anisotropy respond to systematic modifications in electron density distribution and applied strain was analyzed. The results reveal a nonlinear correlation between the Fermi-level electron density and magnetic energy, with distinct behaviour observed across different metallic systems. The application of linear strain along crystallographic axes produces substantial changes in magnetic properties with strain-induced modifications to the electronic band structure directly impacting magnetic ordering. Particularly notable is the observation of critical strain thresholds at which sudden transitions in magnetic behaviour occur, accompanied by characteristic changes in electron density profiles. An analytical model that effectively predicts these magnetic energy variations based on key electron density parameters and strain conditions was used. These findings provide valuable insights for materials engineering applications where controlled tuning of magnetic properties is desired. The established relationships between electron density, strain and magnetic behaviour offer a theoretical framework for designing metals with modified magnetic functionalities.

***Keywords**: Electron Density Parameters, Linear Strain, Magnetic Energy, Metals*

JATROPHA CURCAS AS A FEEDSTOCK IN BIOFUEL PRODUCTION

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Abstract

The depletion of fossil fuels and the urgent need for decarbonization drive the global never-ending search for renewable energy sources. Biofuels are central to this strategy. *Jatropha curcas* oilseed is a non-edible source of vegetable oil with many traits that make it fit as a feedstock for biofuel. This review consolidates the current state of *Jatropha* as a viable biofuel source. Developments in lipid content optimization, and the efficiency of transesterification processes for biodiesel production were analyzed, with deeper emphasis on the molecular structure of Jatropha triglycerides, fatty-acid chain distribution, reaction kinetics, activation energy requirements, mass-transfer limitations, and the physicochemical behavior of heterogeneous and homogeneous catalysts. Thermal stability, viscosity profiles, calorific value, and combustion characteristics were also highlighted as essential determinants of fuel quality and engine compatibility. The paper emphasizes the alignment of the biofuel with international or global standards. Also, critical and persistent challenges, including yield instability and processing hurdles, which hinder its widespread adoption, have been discussed. In conclusion, emerging biotechnological innovations, supported by advances in molecular chemistry, catalytic reactor physics, thermodynamic optimization, and integrated agroforestry systems, as essential pathways to overcome these limitations and realize the full commercial viability of Jatropha as a sustainable biofuel were highlighted.

Keywords: Biodiesel, Jatropha curcas, Transesterification, Renewable Energy, physicochemical properties

LOW-COST WEATHER STATION ASSESSMENT OF URBAN HEAT ISLAND COMPARED WITH ERA5 REANALYSIS DATA

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Abstract

Rapidly urbanizing regions usually experience urban heat islands with the attendant environmental and public health challenges. This study has used a low-cost LILYGO T-SIM7000G board with BME280 as a sensor to assess the UHI Index and compare such results with that obtained from the Copernicus ERA5-Land reanalysis data. The result shows a bias of about 1.36 in the UHI Index against the ERA5-Land data; this bias can be mitigated by applying a corrective offset. It was also observed that the ambient temperature in Lafia city has been consistently increasing between the years 1980 and 2024 by about 0.017 ^{o}C per year, with the highest increase recorded in the year 2024. The highest diurnal value of the UHI Index was observed around 1500 *hours*, while the lowest nighttime value was observed at around 0600 *hours*; this finding agrees with results as observed in other studies. This study has shown the importance of adopting low-cost components in monitoring environmental variables such as the UHI Index in low-income areas of the world where funding may pose problems.

Keywords: Urban Heat Island, Climate, Temperature, LILYGO T-SIM7000G, ERA5-Land

EXPOSURE TO HEAVY METALS AND NATURAL RADIOACTIVITY FROM LOCALLY PRODUCED SOAPS USED IN BENUE STATE AND THEIR HEALTH RISK ASSESSMENT

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Abstract

In recent years, humans' exposure to radiation and toxic metals from both natural and artificial sources is one of the major issues of great concern to physicists, chemists, environmentalists, and the general public; due to their health risks. In this study, heavy metals (HMs) (Ni, Pb, Co, Cr, and Cd) and natural radionuclides (NRs) (U-238, Th-232 and K-40) in thirty (30) locally produced soaps used in Benue State were analysed; employing an Atomic Absorption Spectrophotometer (AAS) and NaI(Tl) detector, respectively. The range of concentrations of Ni, Pb, Co, Cr, and Cd observed were 0.100 – 0.400, 0.124 – 1.235, 0.003 – 0.034, 0.001 – 0.010, and 0.0037 – 0.115 ppm, respectively. These values were below the recommended safe limit set by the World Health Organization (WHO) and the United State Food and Drug Administration (U.S. FDA). This indicates no health risk except in prolonged exposure, due to accumulation of HMs. Furthermore, results revealed that among the thirty surveyed soaps, only three posed a severe health risk due to high concentrations of NRs. This implies improvement in the quality of locally made soap. The Margin of Safety, Systematic Exposure Dosage, and Carcinogenic risk at 50 % and 100 % bio-accessibility indicate a higher health risk in children than in adults. This study, therefore, promotes the production and patronage of locally produced soaps, which will contribute significantly to the growth of Nigeria's economy.

Keywords: Exposure, Health Risk, Heavy Metals, Locally Made Soap, Natural Radioactivity

A DFT STUDY ON THE EFFECT OF HYDROSTATIC PRESSURE ON OPTO-ELECTRONIC, ELASTIC AND THERMOELECTRIC PROPERTIES OF THE DOUBLE PEROVSKITES RB2SEX6(X CL,BR)

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Abstract

In this study, Quantum ESPRESSO code with a plane wave basis set was used to study the opto-electronic, elastic, and thermoelectric properties of Rb2SeX6 (X=Cl, Br) double perovskites under hydrostatic pressure (0 - 8 GPa). The exchange-correlation functional employed is the Perdew-Burke-Ernzerhof for Solids (PBESol) with generalized gradient approximation (GGA). Under hydrostatic pressure, the band gap values of the materials are found to decrease. Rb2SeCl6 has a band gap value of 2.44 eV at 0 GPa, 2.21 eV at 2 GPa. Above 2 GPa, the material has a metallic nature. Rb2SeBr6 has a band gap value of 1.56 eV at 0 Gpa, but has a metallic nature under hydrostatic pressure (2 GPa to 8 GPa). The optical properties results indicate that the materials exhibit maximum absorption, high reflectivity, low optical loss in the visible and ultraviolet regions, good optical conductivity, and a refractive index suitable for use in opto-electronic applications. The materials are confirmed to be mechanically stable under all the hydrostatic pressure values studied. Electrical conductivity, thermal conductivity, and Seebeck coefficient (S) values of the studied materials increase with an increase in hydrostatic pressure and temperature. The maximum value of S for Rb2SeBr6 is 0.248 ×103 (m V/k), while for Rb2SeCl6, maximum S = 0.175 ×103 (m V/k). The positive values of S suggest that the predominant charge carriers of Rb2SeCl6/Br6 are holes. Also, Rb2SeBr6 has a figure of merit (ZT) value of 3.44, while for Rb2SeCl6, ZT = 1.07. Since the values of ZT are greater than unity, the two double perovskite materials have good ZT values for thermoelectric device engineering. The results also suggest that Rb2SeBr6 is a better thermoelectric material than Rb2SeCl6.

Keywords: *Hydrostatic pressure, Density functional theory, Double perovskite, Opto-electronic property, Thermoelectric property*.

ANALYZING THE GLOBAL SHIFT IN ENERGY PRODUCTION: TRENDS AND FUTURE OUTLOOK OF COAL, NUCLEAR, PETROLEUM, AND NATURAL GAS

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Abstract

The worldwide energy industry is changing in big ways. For a long time, fuels like coal, oil, and gas determines how cities were built, how economies grew, and industrialized. Yet, using these fuels has hurt the environment and caused issues between countries. The carbon dioxide (CO_2) released when energy is made, is the main reason for climate change, which leads to warmer temperatures, rising sea levels, and extreme weather. Even with these environmental problems, fossil fuels still make up most of the energy used worldwide. Renewable energy sources like solar and wind, at the same time, have become popular and are challenging traditional energy sources. This study provides a comprehensive analysis of the global shift in energy production, focusing on the evolving roles of coal, nuclear energy, petroleum, and natural gas. Driven by climate imperatives, technological innovation, and policy changes, the global energy landscape is transitioning away from carbon-intensive sources. The research examines historical consumption patterns, assesses key economic and environmental drivers, and projects future trajectories under different scenarios. Findings indicate a structural decline for coal, a peak in oil demand, a transitional yet constrained role for natural gas, and regional growth for nuclear power. The analysis underscores the critical interplay between policy frameworks, market forces, and technological advancements in shaping a sustainable and secure energy future, emphasizing the need for strategic planning to manage economic and social impacts.

Keywords: Fossil fuels, renewable energy, energy transition, decarbonization, carbon policy

ENERGETIC COMPOUND'S MODELING: MOLECULAR DESIGN, CALCULATIONS OF DETONATION'S DENSITY, AND ENERGETIC PERFORMANCES

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Abstract

Energetic compounds (ECs) offer high performance for specific applications like propulsion, demolition, and defense, but they come with significant challenges. These challenges involve performance reliability, manufacturing, and complexity. Addressing these challenges requires the use of method that can ultimately improve performance reliability and reduce the manufacturing complexity ahead of synthesis and large productions. The use of quantitative structure-density relationship (QSDR) to model and design Nitrated pyrazoles (Compounds with high stored energy) ECs became an important choice. Using this theoretical method, about five (5) novel Nitrated pyrazoles ECs were carefully designed. The compounds are (aminooxy)-3,6-dinitropyrazolo[4,3-c]pyrazol-1(4H)-ol, 4-((hydroxyamino)oxy)-3,6-dinitropyrazolo[4,3-c]pyrazol-1(4H)-ol, O,O'-(3,6-dinitropyrazolo[4,3-c]pyrazole-1,4-diyl)bis(hydroxylamine), O-(4-(aminooxy)-3,6-dinitropyrazolo[4,3-c]pyrazol-1(4H)-yl)-N-hydroxyhydroxylamine, and N-hydroxy-O-(4-((hydroxyamino)oxy)-3,6-dinitropyrazolo[4,3-c]pyrazol-1(4H)-yl)hydroxylamine. All the designed ECs shows an excellent property of detonation densities of 0.30, 0.32, 0.30, 0.33, 0.35 g/cm^3 respectively as compared to the standard/commercially sold TNT (Detonation density).

Keywords: *QSDR, Energetic compounds, ECs; Detonation Densities, QSPR.*

HARNESSING SOLAR ENERGY FOR SUSTAINABLE DEVELOPMENT IN OFF-GRID RURAL COMMUNITIES.

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Abstract

The study is based on harnessing solar energy to end Nigerian energy poverty by providing a model for universal access to affordable, reliable, sustainable, and modern energy for all. The study leverages the technical and economic feasibility of photovoltaic (PV) solar systems as a sustainable alternative for providing energy to rural communities. The method applied is the design and analysis of a mini-grid for the off-grid rural electrification using a community with a population of 1000 as a yardstick. The designed system consists of solar PV modules of 500 capacities connected in an array field, solar inverters for conversion of direct current to alternating current, energy storage (battery bank) housing, and plant control systems. The solar mini-grid load capacity was evaluated and analyzed to be 100 kW, with an average per-home consumption of 300W. The PV system design (PVsyst) software was used for the design and simulation to predict energy production and consumption over time.The evaluated result shows that off-grid communities can have access to electricity with the application of a renewable energy system harnessed from sunlight.

Keywords: Solar energy, off-grid, rural communities, photovoltaic (PV), PV system design (PVsyst) software.

RENEWABLE ENERGY AND SUSTAINABLE DEVELOPMENT: EVALUATING THE ROLE OF ALTERNATIVE ENERGY TECHNOLOGIES IN REDUCING ENERGY POVERTY IN NIGERIA

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Abstract

This study evaluates the contribution of renewable and alternative energy technologies to reducing energy poverty and advancing sustainable development in Nigeria between 2010 and 2023. The analysis focuses on the impact of renewable energy generation and consumption on economic growth, environmental quality, and human development outcomes. Secondary data were obtained from the World Bank Global Electrification Database, the International Renewable Energy Agency (IRENA), and the National Bureau of Statistics (NBS). A panel regression model was employed, using key variables such as renewable energy capacity, CO_2 emissions, electricity access rate, and GDP per capita to estimate the relationship between renewable energy expansion and energy poverty reduction. The findings reveal that renewable energy utilisation significantly improves electricity access and income levels while reducing environmental degradation. However, institutional weaknesses and limited investment hinder broader impact. The study concludes that renewable and alternative energy technologies are pivotal for achieving Sustainable Development Goals 7 and 13 in Nigeria. It recommends strengthening policy coherence, increasing public–private investment in off-grid renewable projects, and enhancing local capacity for technology maintenance and deployment. Overall, the study underscores that sustainable energy transition is essential for inclusive economic growth, environmental protection, and long-term national resilience.

Keywords: Renewable energy, energy poverty, sustainable development, alternative technologies, Nigeria

INFLUENCE OF TOPOLOGICAL DEFECT ON RO-VIBRATIONAL ENERGY AND RO-VIBRATIONAL PARTITION FUNCTION FOR A YUKAWA POTENTIAL

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Abstract

This study examines the solutions of the Schrödinger equation for a Yukawa potential in the presence of a topological defect (cosmic string). The topological defect modifies the centrifugal term through the introduction of a conical parameter η. Using the traditional parametric Nikiforov–Uvarov method, the energy spectrum and the radial wave functions are obtained. The results are then employed to study the ro-vibrational partition function via the Poisson summation formula in the presence of the topological defect. The ro-vibrational partition function is derived by first evaluating the summation over the rotational quantum number ℓ which has not previously been considered in many literatures and then applying the Poisson summation formula to simplify the summation over the vibrational quantum number n. The investigation reveals that the presence of the topological defect increases the energy of the system; however, as the conical parameter increases, the energy decreases. The topological defect also reduces the ro-vibrational partition function. Similarly, although the defect lowers the value of the partition function, its influence on the partition function differs from that of the rotational quantum number, which the defect modifies.

Keywords: Bound states; Eigensolution; Partition function; Thermal properties; Potential model

GREEN SYNTHESIS AND ANTIBACTERIAL EFFICACY OF SILVER NANOPARTICLES FROM *PSIDIUM GUAJAVA* LEAF EXTRACT ON *STAPHYLOCOCCUS AUREUS* AND *KLEBSIELLA PNEUMONIAE*

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Abstract

The rise of antibiotic-resistant bacteria presents a major public health concern and highlights the urgency for developing alternative antimicrobial approaches. This study aimed to synthesize silver nanoparticles (AgNPs) using *Psidium guajava* and to evaluate their antibacterial properties against clinical isolates of *Staphylococcus aureus* and *Klebsiella pneumoniae*. The bacterial isolates were identified using standard microbiological techniques. Green synthesis of *P. guajava*-based silver nanoparticles (PG-AgNPs) was achieved using aqueous leaf extract, and the resulting nanoparticles were characterized through UV-Visible spectroscopy, Fourier Transform Infrared (FTIR) spectroscopy, X-ray Diffraction (XRD) analysis, and Scanning Electron Microscopy (SEM). UV-Vis analysis confirmed nanoparticle formation, indicated by a color shift from light yellow to reddish brown. FTIR spectra revealed that biomolecules present in the leaf extract facilitated the reduction of silver ions and served as both reducing and stabilizing agents. XRD analysis showed a distinct peak at approximately 38°, corresponding to the cubic crystalline structure of silver nanoparticles. SEM images further confirmed the nanoscale morphology of the synthesized particles. The PG-AgNPs exhibited notable antibacterial activity against both *S. aureus* and *K. pneumoniae* strains with inhibition zone diameter of 15 mm and 18 mm respectively. Overall, *P. guajava* demonstrated potential as a natural, eco-friendly source for green synthesis of silver nanoparticles with significant antibacterial effectiveness.

Keywords: Antibacterial, *Psidium guajava*, Green synthesis, Silver nanoparticle.

INFLUENCE OF CONCENTRATION ON LEAD SULPHIDE (PBS) THIN FILMS NANOPARTICLES

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Abstract

To the best of our knowledge, little research has been reported on the influence of concentration on PbS thin films via Successive ionic layer and adsorption reaction (SILAR) technique. Thus, this study focuses on SILAR as a cheaper and quick technique to deposit Lead Sulphide (PbS). Lead Sulphide (PbS) thin films were deposited on Soda Lime Glass (SLG) substrate with a variation in the molar concentrations of lead (Pb) ions (0.3, 0.5 and 0.7) M as well on Indium-doped Tin Oxide (ITO) substrate with a variation of SILAR cycles (15, 25 and 35 cycles). The XRD patterns showed that grown PbS thin film was observed to be crystalline in nature and has a cubic structure. The SEM micrographs of PbS thin films revealed that the particles are densely packed, uniform and homogeneous without visible pores probably due to the adhesive elements and glass substrates used during sample preparation. Increase in number of SILAR cycle brought about increase in the absorbance of the films whereas increase in the number of SILAR cycle on SLG and ITO substrates respectively brought about decrease in the energy band gap. Increase in concentration and number of SILAR cycle decrease the transmittance of PbS thin films.

Keywords: PbS thin film, SILAR cycle, ITO, SLG, Nanocrystallinity

FIRST-PRINCIPLES INVESTIGATION OF STRUCTURAL, ELECTRONIC, AND OPTICAL PROPERTIES OF SC8S12 ANDSM8S12 FOR PHOTOCATALYTIC WATER SPLITTING APPLICATIONS

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Abstract

The rare-earth sulfides have emerged as a new class of semiconductors with unique electronic structures and anisotropic optical responses, making them attractive for energy conversion and optoelectronic applications. Their potential with regards to photocatalysis, where light-driven processes enable solar-to-chemical energy conversion, is basically the motivation behind growing interest in their band gap engineering and stability. Using density functional theory implemented through the Vienna Ab initio Simulation Package, a systematic first-principles investigation is made on scandium sulfide (Sc_8S_{12}) and samarium sulfide (Sm_8S_{12}). Both compounds take up an orthorhombic structure derived from the Sc_8S_{12} prototype and are confirmed to be structurally and thermodynamically stable, with no imaginary phonon modes and negative formation energies. Sc_8S_{12} exhibits a wider band gap of 2.7 eV and displays a strong ultraviolet optical response, while Sm_8S_{12} has enhanced absorption in the visible region at 2.4 eV. These features render Sc_8S_{12} promising for UV optoelectronics and Sm_8S_{12} for visible light energy harvesting in photocatalytic and photovoltaic devices.

Keywords: Rare Earth Sulfide, Optical Absorption, Photocatalysis, Water splitting

INTEGRATING ERBIUM IONS INTO MANGANESE OXIDE NANOSTRUCTURES SYNERGISTICALLY IMPROVES PHOTOVOLTAIC EFFICIENCY

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Abstract

The superior optical and electrical characteristics of erbium-doped Mn_2O_4 suggest its suitability for photovoltaic use. High-quality Er-doped Mn_2O_4 for solar energy conversion has been synthesized using a hydrothermal synthesis approach. The data show that incorporating erbium into manganese oxide photovoltaic cells significantly enhances their performance. The trends observed in current, voltage, power, fill factor, and efficiency metrics highlight the potential benefits of material optimization in photovoltaic technology, paving the way for more efficient solar energy solutions. Slight peak position shifts, caused by altered lattice parameters from 0.01 Er, confirm successful doping. Mn_2O_4's phase stability remained consistent, showing no significant secondary phases. XRD patterns at 0.02 Er concentration exhibit sharper peaks, showing enhanced crystallinity and phase purity. Higher intensity peaks suggest a more ordered crystal structure. The XRD pattern at 0.03% Er doping shows changes, including new peaks and increased intensity, suggesting the creation of secondary phases and phase transitions. Er doping enhances the surface roughness of Mn_2O_4, improving its photovoltaic performance. Increased surface roughness leads to more active reaction sites. Introducing Er influences material porosity. Higher porosity makes the surface more accessible to reactants, thus improving photovoltaic efficiency.

Keywords: transition metals, manganese; oxide, photovoltaic; efficiency

INTEGRATING ERBIUM IONS INTO MANGANESE OXIDE NANOSTRUCTURES SYNERGISTICALLY IMPROVES PHOTOVOLTAIC EFFICIENCY.

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Abstract

The superior optical and electrical characteristics of erbium-doped Mn_2O_4 suggest its suitability for photovoltaic use. High-quality Er-doped Mn_2O_4 for solar energy conversion has been synthesized using a hydrothermal synthesis approach. The data show that incorporating erbium into manganese oxide photovoltaic cells significantly enhances their performance. The trends observed in current, voltage, power, fill factor, and efficiency metrics highlight the potential benefits of material optimization in photovoltaic technology, paving the way for more efficient solar energy solutions. Slight peak position shifts, caused by altered lattice parameters from 0.01 Er, confirm successful doping. Mn_2O_4's phase stability remained consistent, showing no significant secondary phases. XRD patterns at 0.02 Er concentration exhibit sharper peaks, showing enhanced crystallinity and phase purity. Higher intensity peaks suggest a more ordered crystal structure. The XRD pattern at 0.03% Er doping shows changes, including new peaks and increased intensity, suggesting the creation of secondary phases and phase transitions. Er doping enhances the surface roughness of Mn2O4, improving its photovoltaic performance. Increased surface roughness leads to more active reaction sites. Introducing Er influences material porosity. Higher porosity makes the surface more accessible to reactants, thus improving photovoltaic efficiency.

Keywords: transition metals; manganese; oxide; photovoltaic; efficiency

POWER POTENTIAL ASSESSMENT OF WIND–HYDRO HYBRID SYSTEMS USING TWO-PARAMETRIC PROBABILITY DISTRIBUTION FUNCTIONS

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Abstract

This study presents a statistical framework for evaluating the power potential of wind–hydro hybrid systems in Nigeria using two-parameter Weibull and Gamma probability distributions functions. Ten years (2014–2024) of wind speed and rainfall data from Katsina, Maiduguri, and Calabar collected at Nigeria Meteorological Agency (NIMET) headquarter, Abuja, were analysed, with parameters estimated through an improved Method of Moments. Model accuracy was assessed using Kolmogorov–Smirnov and Anderson–Darling goodness-of-fit tests. The Anderson–Darling test showed that Weibull and Gamma distributions fit well at the distribution tails, while the Kolmogorov–Smirnov test rejected both for surface water data at an observed significant level $D_n^{\alpha}(0.1534 - 0.1587)$. For wind energy, Weibull was suitable for Katsina and Maiduguri, but both distributions were rejected in Calabar at a critical value of $C_{\propto}(0.7436 - 0.7498)$. Using the validated parameters, hybrid power potential was calculated, reaching up to 1,123 W—higher than wind or hydro alone—and reducing seasonal variability. Overall, the approach provides a data-driven method for optimal site selection and reliable energy planning, offering a strategic pathway for sustainable rural and urban electrification in Nigeria.

Keywords: Wind energy, Hydropower, Hybrid systems, Weibull distribution, Gamma distribution

GREEN SYNTHESIS AND CHARACTERIZATION OF Fe_3O_4 NANOPARTICLES FOR ITS POTENTIAL IN ADSORPTION STUDIES

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Abstract

The synthesis and characterization of Fe_3O_4 nanoparticles offers advancement in nanomaterial research, giving it a unique property with wide ranging applications in different field of sciences. In this study, the synthesis and characterization of Fe_3O_4 nanoparticles was examined. The nanoparticles were synthesized via green method using *ugu* stem plant as reducing and capping agent. The nanoparticles were characterized for mineralogical phase structure, elemental composition, particles size and morphology using X-ray diffraction (XRD), Energy Dispersive X-ray (EDX), Dynamic Light Scattering (DLS) and Transmission Electron Microscopy (TEM). The XRD result showed four distinct peaks at angles of 26.88, 30.758, 35.30 and 44.02 degrees which is related to planes of (130), (101), (211) and (150) with designated phase structure of cubic cantered face and crystal size of 14.01 nm. The elemental compositions also showed a separate peak of iron (Fe, 2.31 keV) and oxygen (O, 0.51 keV). While the surface morphology showed a well dispersed and slightly nanoparticles with average particle size distribution of 18.91 nm. The study demonstrated that Fe_3O_4 nanoparticles can be prepared by green synthesis method with unique properties.

Keywords: Green synthesis, *ugu*, nanoparticles, Fe_3O_4, Characterization

CHEMICAL SYNTHESIS AND CHARACTERIZATION OF COPPER BARIUM IRON SULPHIDE THIN FILM MATERIALS FOR ELECTRONIC DEVICE UTILIZATION

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Abstract

Copper barium iron sulphide (CBFS) thin films were synthesized using a chemical bath deposition (CBD) method on glass substrates. Fourier Transform Infrared (FTIR) Spectroscopy was employed to analyse the chemical characteristics of the aqueous precursor and the deposited films at room temperature. Experimental observations revealed distinctive CBFS absorption bands below 900 cm^{-1} in the FTIR spectrum of the precursor. The optical band gap energy was determined to be 1.26 eV, with the absorbance decreasing from 0.6 to 0.38 as the wavelength increased. Scanning electron microscopy (SEM) micrographs showed that the films were crack-free, rough, and uniformly covered with grains of various shapes. X-ray diffraction (XRD) analysis confirmed the crystalline structure of the deposited films. These findings suggest that the synthesized CBFS thin films have potential for integration in diverse electronic applications.

Keywords: Band gap, Deposition, Optical, Thin film, Wavelength

NON-CONDUCTING NANOCOMPOSITE EFFECTS ON PDVF FOR AN IMPROVED INSULATING PROPERTIES

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Abstract

The work investigated the effect of incorporating non-conducting nanoparticles into polyvinylidene fluoride (PVDF) to enhance its insulating properties. PVDF, a widely used polymer in electrical insulation, has good dielectric properties but can be further improved for advanced applications. By adding a non-conducting nanoparticle, such as calcium carbonate ($CaCO_3$ of 0.5% and 1%) showed significant reduction in its electrical conductivity and enhances the breakdown strength of the PVDF. This makes it a promising material for high-performance insulation material in electrical and electronic devices.

Keywords: Polymer nanocomposite, high-performance insulation, dielectric response, Permittivity,

ENHANCING BROADBAND AND WIDE ANGLE MICROWAVE ABSORPTION VIA DIELECTRIC SEMICONDUCTOR BILAYER COATINGS ON METALLIC SUBSTRATES

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Abstract

The growing demand for broadband and angularly stable microwave absorbers in high frequency electronic systems has exposed fundamental limitations in conventional single layer absorber designs, particularly their narrow bandwidth and sensitivity to oblique incidence. In this work, a thin dielectric semiconductor bilayer microwave absorber is numerically designed and optimized to overcome these constraints using finite-element electromagnetic analysis. Frequency domain simulations were conducted over the 2 – 4 GHz frequency range in COMSOL Multiphysics v6.1 (RF Module), considering Al_2O_3 dielectric layers (0.003 – 0.015 cm) and Si semiconductor layers (0.005 – 0.02 cm) deposited on aluminum, copper and zinc substrates. Material parameters were defined using experimentally reported permittivity and conductivity values, while metallic substrate conductivities were obtained from the COMSOL material library. The results demonstrate that the optimized bilayer configuration achieves a 3.2fold enhancement in >90% absorption bandwidth compared with semiconductor only absorbers. Zinc backed structures exhibited superior performance, reaching 98% peak absorption at highest frequency in GHz with a minimum reflection coefficient. Parametric analysis revealed that an optimal Al_2O_3: Si thickness ratio of 1:1.5 simultaneously maximizes impedance matching and semiconductor power dissipation, accounting for up to 94% electromagnetic energy loss within the structure. Furthermore, the dielectric top layer significantly improves angular stability, maintaining high absorption up to 60° incidence by suppressing Brewster angle reflections. These findings establish robust numerical design rules for thin, broadband and omni directional microwave absorbers, offering strong potential for EMI shielding in 5G enclosures, curved aerospace platforms and stealth oriented electromagnetic systems.

Keywords: Angular stability, Bilayer microwave absorbers, Dielectric semiconductor interfaces, Electromagnetic interference shielding.

DARK CURRENT REDUCTION AND PERFORMANCE ENHANCEMENT IN MOLYBDENUM TRIOXIDE/N-SILICON MSM DIODE BY APPROPRIATE GO DOPING USING SPRAY PYROLYSIS TECHNIQUE

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Abstract

The research into MoO_3 films produced on various substrates for heterojunction diodes has been excellent. However, the electrical characteristics of MoO_3-based material diode have been unfavorably affected by large dark currents resulting from large surface states and a small barrier height at the interface. Hence, the demand for high-performing optoelectronic devices necessitates the improvement of the material. Herein, the graphene oxide (GO) doping technique was used to enhance the electrical performance of the MoO_3 diode. The 0 % to 3 % doping range was used with a 1 % doping increment in the MoO_3 matrix. The influence of GO doping on the structural, morphology and vibrational modes of MoO_3 films was studied. Moreover, based on the Ag/GO-doped MoO_3/n-Si/Al structure, the 2 % GO doping caused the Schottky barrier height to improve from 0.64 to 0.69 eV. As a result, significant dark-current suppression was established more than seven times under zero bias voltage. To clarify the essential mechanisms contributing to this improvement. Raman analysis was used to illustrate the intercalation of C into the MoO_3 matrix through the development of the C–O–Mo bond. According to the literature, the increase in the C is significantly compensated by shifting the E_F downward, which makes the barrier height to increase accordingly. This work provides a novel route to advance the effectiveness of photodiodes as well as the photovoltaic device performance.

Keywords: Heterojunction, Doping, Diodes

ENHANCING LIGHT ABSORPTION IN DYE-SENSITIZED SOLAR CELLS VIA CONJUGATED BENZO[D]THIAZOL-2-AMINE PHOTOSENSITIZERS

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Abstract

This study explores the enhancement of light absorption in dye-sensitized solar cells (DSSCs) using conjugated benzo[d]thiazol-2-amine-based photosensitizers. Two benzothiazole–azo derivatives (Dye A1 and Dye A2) were synthesized via diazo coupling reactions and characterized for their structural, optical, and photovoltaic properties. Physical analysis revealed melting points of 184–202 °C, with Dye A1 as a dark red solid and Dye A2 as a brown solid. UV–Visible spectroscopy indicated absorption maxima at 444 nm (Dye A1) and 540 nm (Dye A2), with molar absorptivity values of 24,809 and 7,009 $L \cdot mol^{-1} \cdot cm^{-1}$, respectively, reflecting differences in conjugation and electronic transition probability. FT-IR spectroscopy confirmed characteristic functional groups, including C=O, N–H, C–H, and azo –N=N– linkages. DSSCs sensitized with these dyes demonstrated conversion efficiencies of 1.45% (Dye A1) and 1.69% (Dye A2), with the higher efficiency of Dye A2 attributed to enhanced photocurrent and fill factor. These results underscore the potential of conjugated benzo[d]thiazol-2-amine chromophores as effective organic sensitizers for improving light absorption in DSSCs.

Keywords: Conversion efficiency, Fill factor, Molar absorptivity, Open-circuit voltage, Short-circuit current density,

Assessment of Solar Radiation Variability and its Impact on Energy Generation over Kano

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Abstract

This study investigates the variability of solar radiation and its impact on photovoltaic (PV) energy generation in Kano, Nigeria, using a 31-year dataset (1990–2020) of global solar radiation, sunshine duration, and temperature obtained from the Nigerian Meteorological Agency (NIMET). Empirical sunshine and temperature based models were applied and validated with statistical indicators of Mean Bias Error (MBE), Root Mean Square Error (RMSE), Mean Percentage Error (MPE) and coefficient of determination (R^2). Results showed that annual mean global solar radiation was 17.86 $MJm^{-2}day^{-1}$, higher values were observed in the rainy season (April to October) with 23.06 $MJm^{-2}day^{-1}$, than in the dry season (November to March) with 22.82 $MJm^{-2}day^{-1}$, due to the influence of dust and aerosols. The monthly average PV energy output was 2721.44 kWh, peaking in May (3078.29 kWh) and reaching its minimum in January (2402.58 kWh). Correlation analysis revealed strong positive relationships between solar radiation, sunshine duration, and PV output, with the Garcia temperature-based model (H3) achieving the best performance (R^2 = 92.2%). The findings confirm Kano's high solar potential and underscore the suitability of temperature-based models for reliable solar energy estimation in the Sahelian region. This study provides valuable insights for planning, optimizing, and deploying solar energy systems in northern Nigeria.

Keywords: Empirical models, Kano, PV energy, solar radiation, variability.

Assessment of Solar Radiation Variability and Its Impact on Estimated photovoltaic electricity output Across Kano, Nigeria

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This study assesses the variability of solar radiation and its impact on photovoltaic (PV) energy generation across one Sahelian city in Nigeria (Kano) using 31 years (1990 to 2020) of meteorological data from the Nigerian Meteorological Agency (NIMET). Monthly, seasonal, and annual variations of global solar radiation (GSR), sunshine duration and mean temperature were analyzed to evaluate their influence on solar energy output. The average annual GSR was 17.86 $MJm^{-2}day^{-1}$ in Kano. Sunshine duration ranged from 7.55 to 7.88 h/day, while mean annual temperature varied between 26.78°C and 28.82°C. Using a 21.9% efficient monocrystalline panel (2.58 m^2), estimated monthly energy outputs was 2721.44 kWh (Kano), with peak generation occured during the rainy season. Correlation analysis showed a strong positive relationship between GSR and energy output (0.98 to 1). Garcia's temperature-based model performed best in Kano (R^2 > 90%). The findings confirm solar variability significantly influences PV generation, with temperature-based models offering superior estimation accuracy in Sahelian climates, supporting large-scale solar deployment in northern Nigeria.

Keywords: Solar, Radiation, Variability, Energy, Kano

DEVELOPMENT OF PROTOCOLS FOR NEUTRON ACTIVATION ANALYSIS (NAA) OF GEOLOGICAL AND BIOLOGICAL SAMPLES AFTER CONVERSION OF NIGERIA RESEARCH REACTOR-1 (NIRR-1) TO LOW ENRICHED URANIUM (LEU) CORE

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Abstract

The major analytical work with NIRR-1 is NAA which required well developed protocols for the new LEU core. In this research, the experimental procedures for determination of over 30 elements of interest of geological and biological samples have been developed using standard reference materials (SRM) In order to validate the experimental procedures the following standard reference materials, (IAEA-359, IAEA-336, IAEA 158, NIST 2690, and NIST1633C) were irradiated and analyzed. The concentrations in part per million (ppm) of the following elements Eu, Fe, Ga, Hf, In, K, La, Lu, Ca, Ce, Cl, Co, Cr, Cs, Cu, Mg, Mn, Na, Rb, Sb, Sc, Sm, Ta, Tb, Th, Ti, Al, As, Au, Ba, Br, Dy, U, V, Yb and Zn are in good agreement with the certified values. The capability of the technique and the facility was also validated with a very minimal detection value. Finally, the results of this research serve as a database for the protocols and procedures for the use in NAA with NIRR-1 LEU core.

Keywords: NIRR-1, LEU, NAA, Irradiation and counting facility

INFLUENCE OF CONCENTRATION ON LEAD SULPHIDE (PBS) THIN FILMS NANOPARTICLES

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Abstract

To the best of our knowledge, few research has been reported on the influence of concentration on PbS thin films via Successive ionic layer and adsorption reaction (SILAR) technique. Thus, this study focuses on SILAR as a cheaper and quick technique to deposit Lead Sulphide (PbS). Lead Sulphide (PbS) thin films were deposited on Soda Lime Glass (SLG) substrate with a variation in the molar concentrations of lead (Pb) ions (0.3, 0.5 and 0.7) M as well on Indium-doped Tin Oxide (ITO) substrate with a variation of SILAR cycles (15, 25 and 35 cycles). The XRD patterns showed that grown PbS thin film was observed to be crystalline in nature and has a cubic structure. The SEM micrographs of PbS thin films revealed that the particles are densely packed, uniform and homogeneous without visible pores probably due to the adhesive elements and glass substrates used during sample preparation. Increase in number of SILAR cycle brought about increase in the absorbance of the films whereas increase in the number of SILAR cycle on SLG and ITO substrates respectively brought about decrease in the energy band gap. Increase in concentration and number of SILAR cycle decrease the transmittance of PbS thin films.

Keywords: PbS thin film, SILAR cycle, ITO, SLG, Nanocrystallinity

SUBTHEME 2: MATHEMATICAL SCIENCES AND INTELLIGENT SYSTEMS

ENHANCING CLOUD DATA SECURITY USING QUANTUM KEY DISTRIBUTION (QKD) AND QUANTUM CRYPTOGRAPHY

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Abstract

The speedy development of quantum computers has posed a significant and massive threat to traditional cryptographic methods used in cloud data security, specifically through the "harvest now, decrypt later" attack model. Public-key methods like RSA and ECC that rely upon computational hardness assumptions are structurally vulnerable to quantum methods such as Shor's. As a countermeasure, we introduce a hybrid quantum-classical security model integrating Quantum Key Distribution (QKD) and Post-Quantum Cryptography (PQC) to protect cloud infrastructures. We utilize QKD's information-theoretic security—offered by the laws of quantum physics—to secure key exchange among cloud tenants and providers, while using PQC algorithms (such as CRYSTALS-Kyber) for initial authentication and metadata protection. We recommend a cloud-native hybrid infrastructure with QKD-enhanced edge nodes, a quantum-intelligent Key Management Service (KMS), and multi-tenancy through quantum VLANs (qVLANs). Early trials on a local cloud testbed conservatively estimate this hybrid QKD-PQC infrastructure achieves outstanding network throughput (over 9.5 Gbps) with small latency overhead (under 5% increase vs. classical TLS) and strong security guarantees. The system reliably detects and aborts suspicious key exchanges when eavesdropping is simulated (Quantum Bit Error Rate >11%), protecting information-theoretic confidentiality. It also includes a transparent fallback to PQC-based key exchange during QKD failures, ensuring uninterrupted service without sacrificing quantum resistance. These findings corroborate the framework's scalability, performance optimality, and two-layer immunity against current classical and future quantum threats. By converting quantum security theory into empirical cloud deployment, this study offers a scalable solution toward quantum-safe cloud computing.

Keywords: Cloud Data Security, Quantum Key Distribution (QKD), Quantum Cryptography, Post-Quantum Cryptography (PQC), Hybrid Cryptosystems.

Some Observations in the Advancement of Quantum Calculus

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Abstract

Quantum calculus has profoundly shaped Geometric Function Theory (GFT) by providing versatile frameworks for redefining classical subclasses of analytic functions and extending foundational results. It has proven instrumental in characterizing various subclasses of univalent functions, exploring their geometric features, and determining coefficient bounds within the family A* of normalized analytic functions.

A thorough review of the literature indicates that while coefficient problems related to A* under q-calculus are generally well developed, studies addressing their geometric properties often suffer from inconsistencies and incomplete reasoning. Motivated by the need to address these challenges, we observe that several q-classical results contain errors in formulation or proof, which have been propagated in later works.

This study seeks to identify and critically reassess such flawed results to correct misconceptions and strengthen the theoretical foundation of q-analogues in Geometric Function Theory.

Keywords: q-calculus, subordination, q-Jack's lemma, Analytic function

First-Principles Analysis of Electric Field, Spin–Orbit Coupling and Lithium Adsorption in Graphene

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Abstract

This study conducts a first-principles examination of the impact of external electric fields (EEF) on ion transport and adsorption processes in. The research utilized the Perdew–Burke–Ernzerhof (PBE) and local modified Becke–Johnson (lmBJ) exchange-correlation functional as implemented in WIEN2k to examine 4×4 monolayer graphene and lithium absorption on graphene subjected to electric fields between 0.5 and 5 V/Å. The results indicate that the external field and spin–orbit coupling alter graphene's electrical structure, with lmBJ observed to enhanced bandgap resolution. Lithium adsorption generated localized states and improved charge transfer, it also tuned the energy gap with variable EEF. The results indicate that regulated electric fields can be used to modify graphene's electrical characteristics, and hence facilitating advancements in nanoelectronics and energy storage applications.

Keywords: Graphene, Density Functional Theory (DFT), Electric Field, Ion Transfer Adsorption, Doping, Band Structure, WIEN2k

VEHICLE SURVEILLANCE SYSTEM USING YOLOv11 AND DEEPSORT ALGORITHMS

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ABSTRACT

The act of parking vehicles in unauthorised locations, especially in tertiary institutions' premises, has resulted in situations such as blocking access paths and parking on green lawns, that has general negative effects on the ecosystem. While there are conventional deterring methods and improved surveillance with gadgets, most of which can be considered ineffective for managing dynamic needs. These acts still require attention, this paper presents an intelligent surveillance system that integrates a state-of-the-art machine learning algorithm, You Only Look Once (YOLOv11), with the DeepSORT algorithm to address the challenges of occlusions and identity switches, for real-time vehicle recognition and monitoring in an environment. While the proposed system relies on YOLO to capture images and video of vehicles as input, it tracks their movements across frames using the DeepSORT algorithm to identify them based on predefined zone mappings of classified areas. The system then sends notification emails to the assigned personnel for prompt action. Testing the system in a controlled environment showed good detection performance with a Mean Average Precision (mAP) of 99% at an Intersection of Union (IoU) threshold of 0.5. It also maintained consistent object identities across frames with reliable tracking and an average processing speed of 28 frames per second, achieving an ID F1 score of 93%, thereby improving the reliability of vehicle tracking in dynamic scenarios. It can be concluded that the combined capabilities of the YOLOv11 algorithm for precise detection and DeepSORT for persistent tracking provide a robust solution for real-time detection of vehicles.

Keywords: Vehicle, Surveillance, YOLOv11, DeepSORT

MATHEMATICAL MODELLING FOR THE CONTROL OF UNEMPLOYMENT IN NIGERIA INCORPORATING INDUSTRIES

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Abstract

Unemployment is of great concern in Nigeria; it has resulted in insecurity and an increase in criminal activities. The increase in the unemployment rate is a result of the lack of adequate industries. In this paper, we present a mathematical model for the control of unemployment incorporating industries. The equilibrium states of the model are obtained, and the stability analysis of the Unemployment-Free Equilibrium (UFE) was carried out. Sensitivity analysis was conducted to identify the most sensitive parameters responsible for the increase and decrease in unemployment in Nigeria. Graphical simulations were presented to show the effect of the sensitive parameters on the reproduction number.

Keywords: unemployment, incorporating, industrialization, stability analysis, sensitivity analysis

EXPLORING ENTANGLEMENT EVOLUTION OF QUANTUM SYSTEMS NEAR SCHWARZSCHILD BLACK HOLES

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Abstract

Quantum entanglement, which is a very useful quantum resource, is the backbone of many quantum technologies, such as quantum teleportation and quantum cryptography. However, interactions of the quantum systems with their surroundings have been a major challenge, as they lead to a loss of entanglement, which is referred to as decoherence. In this study, we analyze the entanglement properties of a tripartite fermionic quantum system in which one qubit interacts with a Schwarzschild black hole. The reduced density matrix of the three qubits is obtained by tracing out the inaccessible mode corresponding to the qubit falling into the black hole. Entanglement between subsystems is quantified using log-negativity. The results show an initial spike in log negativity till a Hawking temperature of about 0.05 is reached; during this spike, all three entanglement subsystems show the same entanglement properties. They peak at a log negativity of 1, after which they start to decrease with an increase in the Hawking temperature T. It is observed, however, that the decoherence of the qubit in contact with the black hole with the other subsystems is higher than that for the other qubits.

Keywords: Quantum Entanglement, Schwarzschilds Black Hole, Decoherence, log-negativity, Hawking Temperature.

MODELING NIGERIA'S LABOR MARKET SHIFT USING TIME SERIES ANALYSIS: A CASE STUDY INTEGRATING STATISTICAL AND COMPUTATIONAL METHODS

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Abstract

This paper addresses the building and validation of a balanced hybrid time-series model for forecasting real Gross Domestic Product. The model utilizes the Prophet framework as its primary evaluation tool, which is insightfully enhanced by 1,009 external attributes derived from the computational analysis of job market demand and labor supply data. This hybrid methodology achieved a remarkable Mean Absolute Percentage Error of 0.14% through the rough 2020-2022 test period by combining traditional macroeconomic identifiers with complex computational signs. The potency of the computational factors and traditional variables are both verified by the feature importance. The final model is set for interactive development, presenting high forecasting verification, scenario-based economic predictions.

Keywords: Labour, Modeling, Prophet Framework, Time Series

PREDICTION OF CLIMATE-SENSITIVE SICKLE CELL ANEMIA CRISIS IN NIGERIA USING MACHINE LEARNING MODELS

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Abstract

Sickle cell anemia anaemia (SCA) remains a major public health concern in Nigeria, where climate variability increasingly contributes to fluctuations in crisis episodes. This study proposes a machine learning (ML) driven framework for predicting climate-sensitive SCA crises by integrating environmental indicators such as temperature, humidity, rainfall, and air quality with clinical and contextual data. The approach explores supervised learning models and seasonal time series transformations to capture cyclical climate patterns associated with crisis risk. Decision Tree (DT), Linear Regression, Random Forest, K-Nearest Neighbors (KNN) and Support Vector Machine (SVM) were deployed to predict the performance and Accuracy, Precision and F1-score metrics to evaluate the accuracy of the models. Through enhanced data availability and regional assessments, the work aims to identify areas in Nigeria with the highest climate-related SCA burden and provide insights to guide targeted, sustainable interventions. By combining climate analytics with computational modelling, this work seeks to support community preparedness, and strengthen climate-aware health planning for vulnerable populations.

Keywords: Sickle Cell Anemia Anaemia Disease (SCA), Climate Resilience, Data, Machine Learning, Crises.

A HYBRID AI AND LIGHTWEIGHT CRYPTOGRAPHY FRAMEWORK FOR PROACTIVE THREAT INTELLIGENCE AND SECURE CRITICAL INFRASTRUCTURE IN NIGERIA

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Abstract

Due to the increasing complexity of cyberattacks and the susceptibility of systems with limited resources, safeguarding Nigeria's vital infrastructure has become an urgent concern. Current defenses mostly rely on reactive tactics, and key industries like energy, transportation, healthcare, and financial services face constantly changing threats. One major obstacle to resilience is still the absence of sophisticated, real-time detection systems. The aim of this research is to develop a hybrid framework that combines lightweight cryptography techniques with artificial intelligence (AI) for proactive cyber threat identification and mitigation against Nigeria's vital infrastructure. Four objectives will guide the development of the framework: (1) designing a threat detection model based on artificial intelligence; (2) implementing a lightweight cryptographic algorithm; (3) integrating the AI threat intelligence engine with the cryptographic module; and (4) evaluating the model's performance. To foresee breaches, AI components will use behavioral analysis, anomaly detection, and predictive modeling. Simultaneously, lightweight cryptography would provide data integrity, confidentiality, and authenticity with minimal energy and computational demands, which makes it appropriate for Nigeria's infrastructure with limited resources. It is anticipated that the research would result in a layered, context-sensitive, cost-effective, and adaptive architecture. In addition to offering technical innovation, the study emphasizes how crucial it is to match cutting-edge cybersecurity solutions with institutional procedures and national regulations. As a gain towards strengthening cyber resilience in Nigeria, the proposed research offers a transferable theoretical foundation that can be applied in other developing nations tackling similar infrastructure and cybersecurity challenges.

Keywords: Artificial intelligence, cryptography, cybersecurity, infrastructure, intelligence.

MULTIVARIATE STATISTICAL MODELLING OF NON-COMMUNICABLE DISEASE RISK FACTORS IN NIGERIA: INSIGHTS FROM NATIONAL HEALTH DATA

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ABSTRACT

The increasing prevalence of non-communicable diseases (NCDs) in Nigeria necessitates a multidimensional analytical approach. Using data from the 2018 Nigeria Demographic and Health Survey (NDHS) and WHO STEPS survey, this study employed multivariate regression and factor analysis to explore relationships among hypertension, obesity, diabetes, and socioeconomic variables. Three latent factors lifestyle, income, and urbanization, explained most of the variance in NCD clustering. Strong positive correlations were observed between obesity and hypertension among urban adults. The findings highlight the interconnected nature of NCD risk factors and support the adoption of integrated prevention strategies tailored to Nigeria's socio-epidemiological context.

Keywords: Non-communicable diseases, multivariate analysis, Nigeria Demographic and Health Survey, WHO STEPS, risk factors

DEVELOPMENT OF ECO-FRIENDLY ADSORBENTS FOR REMOVING DYES FROM INDUSTRIAL EFFLUENTS

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Abstract:

The discharge of dye-laden effluents from textile and allied sectors poses a serious risk to human health and aquatic ecosystems because of their toxicity, durability, and aesthetic impact. This research focuses on the creation of environmentally acceptable adsorbents made from inexpensive, renewable natural resources for the efficient removal of dyes from industrial effluent. Simple chemical activation techniques were used to improve the adsorption capabilities of agricultural by-products such banana peels, sawdust, and coconut husk. Batch experiments were conducted to determine the effects of contact time, pH, adsorbent dosage, and initial dye concentration on dye removal efficiency. The results revealed that, the bio-based adsorbents had a great potential for dye removal, reaching up to 90% efficiency under optimized conditions. FTIR and SEM characterization verified the existence of functional groups and porous features that facilitate adsorption, thus, indicated that statistically significant differences ($p<0.05$) were found. This study shows that sustainable, biodegradable, and renewable materials can be effective substitutes for traditional synthetic adsorbents. In alignment with the goals of global environmental sustainability, the advancement of green technologies fosters cleaner industrial practices and strengthens pollution control initiatives.

Keywords: Sustainability, industrial effluents, dye removal, treatment of industrial effluents, and environmentally friendly adsorbents.

AN EVALUATION OF FINANCIAL MODELS FOR OPTIMIZING PORTFOLIO MANAGEMENT IN NIGERIA'S NON-INTEREST REAL ESTATE SECTOR

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ABSTRACT

The study examines the performance and suitability of modern financial models for optimizing investment portfolios within Nigeria's non-interest real estate sector. Using data from the Central Bank of Nigeria (CBN), Nigerian Exchange Group (NGX), and Real Estate Investment Trusts (REITs) between 2018 and 2024, the study applies Mean-Variance Optimization (MVO), Capital Asset Pricing Model (CAPM), and Value-at-Risk (VaR) frameworks to evaluate portfolio performance under Islamic (non-interest) financial constraints. Findings indicate that optimized non-interest portfolios achieved an average return improvement of 17.6% with a risk reduction of 12.9%, compared to conventional benchmarks. Additionally, asset diversification through Sukuk-backed instruments improved portfolio stability by 22.4% during periods of economic volatility. Regression and sensitivity analyses yielded $R^2 = 0.88$, $p < 0.05$, confirming the models' predictive robustness. The results highlight the viability of advanced financial models in supporting ethical investment growth and sustainable wealth creation in Nigeria's real estate sector. This research contributes to the development of Islamic finance and real estate sectors in Nigeria, providing insights for investors, policymakers, and practitioners seeking to optimize portfolio management in the non-interest real estate sector. The study recommends enhanced adoption of data-driven modeling, greater integration of machine learning algorithms, and the harmonization of CBN–SEC–NAICOM regulatory frameworks to improve transparency and portfolio efficiency in the non-interest banking ecosystem.

Keywords: Financial Modeling; Portfolio management; Real Estate Investment; Sukuk Instruments; Risk Analysis

MATHEMATICAL MODELLING AND GAME THEORY: DATA DRIVEN ANALYTICAL APPROACHES TO POLITICAL STRATEGIES AND DECISION-MAKING

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Abstract

A political game model of All Progressive Congress (APC) Party Contestants for the Presidential Primaries towards 2023 General Election in Nigeria was formulated in order to determine the best possible Candidate who would be presented by the Party for winning election. The method of solution involved 3-player and 3-strategy Nash equilibrium which yielded a pure Nash result of Propaganda, Consultation and Youth mobilization Strategies for Yahaya Adoza Bello, Chief Bola Ahmed Asiwaju Tinubu and Oluyemi Oluleke Osinbajo respectively. The study concluded that, the outcome of the Party's primaries which produced Ahmed Tinubu as its flag bearer was consistent with the model's result: Ahmed Tinubu did a lot of deep Consultation with stakeholders while Yahaya Bello's best response was Propaganda as Osibanjo was preferred by the Youth of the Party.

Keywords: Game Theory, Nash Equilibrium, 3-Player, 3-Strategy, Election

DIGITAL MONEY AND YOUTH SPENDING BEHAVIOR IN EBONYI STATE-NIGERIA

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Abstract

This study investigates the adoption and use of digital money among youth in Ebonyi State, Nigeria, and its influence on their spending behavior. Using a convergent mixed-methods design, data were collected from 400 respondents via structured questionnaires and 20 in-depth interviews. Quantitative data were analyzed using descriptive statistics, correlations, and multiple regression, while qualitative data were analyzed through thematic analysis. Findings reveal a high adoption rate (72%) among youth, driven by income, education, financial literacy, trust, and social influence. Digital money usage significantly increases spending, particularly on airtime, internet data, and peer transfers. Trust and perceived risk influence adoption, with youth employing strategies to mitigate risks. The study recommends targeted financial education, infrastructure improvements, and regulatory interventions to enhance trust and responsible usage. These findings contribute to the understanding of digital money adoption and its behavioral implications in subnational Nigerian contexts.

Keywords: Digital money, youth, spending behavior, Ebonyi State

DEVELOPMENT OF AI-POWERED RESUME SCREENING SYSTEM

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Abstract

The growing volume of job applications has made manual resume screening increasingly slow, subjective, and error-prone. To address these challenges, this study develops an AI-powered automated resume screening system designed to streamline recruitment and improve decision quality. The system was implemented as a web-based application using Python, Flask, and SQLAlchemy, and integrated with advanced natural language processing models from Cohere and Hugging Face. These AI services extract key features like skills, education, work experience, and certifications from uploaded resumes and match them against specific job descriptions. Using machine learning-driven scoring, the system ranks candidates based on their alignment with each role and generates personalised job recommendations. The platform incorporates role-based access, enabling candidates to upload and review screening results, while administrators can create job postings, track candidate rankings, and monitor screening outcomes. In pilot tests, the system reduced manual screening time by an estimated 60–70%, improved consistency of candidate evaluation, and minimized human bias in first-stage screening. Overall, this study demonstrates that combining NLP, machine learning, and intuitive interface design can significantly enhance recruitment efficiency. The resulting system offers a fairer, faster, and more scalable alternative to traditional resume screening, with strong potential for adoption in modern data-driven hiring environments.

Keywords: Resume, Screening, Machine Learning, Tracking, Artificial Intelligence

CLOSEDNESS AND COMPACTNESS OF GREEN'S EQUIVALENCE CLASSES IN COMPACT METRIC SEMIGROUPS

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Abstract

This paper establishes the closure and compactness of Green's equivalence classes in compact metric semigroup S. Using sequential compactness and continuity of multiplication, we prove that the limit of any convergent sequence of regular elements in S remains regular, and that each Green's relation $L, R, H,$ and D yields closed and hence compact equivalence classes. As a structural corollary, we established that the set of regular elements itself forms a closed, compact subsemigroup. These results establish a topological-algebraic framework that extends classical semigroup theory to compact metric settings thereby providing a foundation for analyzing ideal structure in metric semigroup setting.

Keywords: Compact metric semigroup, Green's relations, regularity, closed subsemigroup

COMPUTATIONAL INVESTIGATION OF THERMODYNAMIC PROPERTIES OF GAS PHASE VANADIUM NITRIDE USING PYTHON

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Abstract

This study examines the thermodynamic properties of Vanadium Nitride (VN) using the Kratzer potential models, with Python employed as the computational tool. We obtained the energy spectra and calculated the partition function, which serves as the foundation for evaluating key thermodynamic properties such as heat capacity, entropy, and enthalpy. In order to assess the accuracy of the potential model, we compute and compared our theoretical thermodynamic properties with that of the experimental data obtained from the National Institute of Standards and Technology (NIST) database over a wide temperature range. Our results show that these potential model offer a reliable approximations for thermodynamic properties, particularly in predicting the specific heat capacity, entropy and enthalpy across a broad temperature range. The theoretical thermodynamic properties exhibit strong agreement with experimental data at lower temperatures ($T \leq 1000$), but deviation emerge at higher temperature ($T > 3000K$) which is likely due to anharmonic effects and electronic contributions not accounted for in the model. Despite these limitations, the overall agreement between theoretical predictions and experimental observations validates the applicability of the potential model in thermodynamic analysis. This work underscores the utility of quantum potential models in evaluating thermodynamic parameters and provides valuable insights into the thermal behavior of diatomic molecules. The methods presented herein can be extended to other transition metal nitrides and molecular systems, thereby contributing to future progress in computational materials science. Incorporating anharmonicity and electronic state contributions in future studies will further enhance the predictive accuracy of theoretical thermodynamic models.

Keywords: Vanadium nitride, Thermodynamic properties, Kratzer potential model, Vibrational partition function

THEORETICAL INVESTIGATION OF THE VIBRATIONAL ENERGY LEVELS OF THE CESIUM DIMER

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Abstract

This study investigates the quantum behavior of the cesium dimer (Cs_2) using a hybrid potential model that integrates the Möbius square and screened Kratzer potentials (MSSKP). The Schrödinger equation was analytically solved through the parametric Nikiforov–Uvarov (pNU) method to obtain the vibrational energy levels of Cs_2. The calculated results exhibit excellent agreement with experimental Rydberg–Klein–Rees (RKR) data. Comparative analyses show that the MSSKP model outperforms the conventional Morse and Manning–Rosen potentials, yielding a minimum mean absolute error (MAE) of 0.0234 cm^{-1}, compared with 0.2364 cm^{-1} and 0.0517 cm^{-1}, respectively. These results demonstrate that the MSSKP model provides an accurate and reliable framework for describing the vibrational spectra of Cs_2. The proposed approach enhances understanding of molecular structure, bonding, and quantum behavior, and offers valuable insights for future studies in quantum chemistry, molecular spectroscopy, and nanophysical modeling of diatomic systems.

Keywords: Cesium dimer (Cs_2); Schrödinger Equation; Vibrational energy levels; Möbius square potential, Screened Kratzer potential, parametric Nikiforov–Uvarov method

DYNAMIC THRESHOLD ACTIVATION: ENHANCING CODEBERT'S PERFORMANCE FOR SOLIDITY SMART CONTRACT VULNERABILITY DETECTION

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Abstract

Deep learning models struggle with the accurate and robust detection of vulnerabilities in Solidity smart contracts primarily due to the limitations of conventional activation functions like ReLU, which result in computational overhead and the notorious 'dying ReLU' problem. These shortcomings severely restrict the model's ability to extract critical context-dependent features. This paper addresses this gap by proposing a novel deep learning architecture that leverages a pre-trained CodeBERT model for generating advanced contextualized vector embeddings, where the classification layers are enhanced by a Modified Activation Function (MAF). This MAF features a dynamic, input-dependent threshold, $\theta(x)$ which modulates feature maps based on local input statistics, adapting its activation behavior to the context of the code embeddings. The MAF equipped CodeBERT model, which will be trained and evaluated on 42,000 unique Solidity contracts, is expected to achieve superior performance across vulnerability classes, surpassing current state of the art benchmarks Furthermore, the dynamic threshold will effectively mitigate the 'dying ReLU' problem and is projected to deliver a significant False Positive Rate reduction compared to ReLU-based baselines. In conclusion, the successful integration of the MAF within the CodeBERT-based classification path will substantially enhance the performance of vulnerability detection, leading us to recommend that future work adopt similar dynamic, input-dependent activation functions to fully leverage the semantic power of models like CodeBERT.

Keywords: Smart Contracts, Vulnerability Detection, Solidity, Deep Learning, CodeBERT, Activation Functions,

SYSTEMATIC FEATURE FUSION AND MULTIPLE CLASSIFIER SYSTEMS FOR ACCELEROMETER-BASED HUMAN ACTIVITY RECOGNITION

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Abstract

Implementation of human activity recognition using mobile and Internet of Things sensors has emerged as a rapidly growing field in machine learning. This growth is driven by a wide range of applications in health monitoring, security, elderly fall detection, medical diagnosis, and physical therapy and rehabilitation. An important step in machine learning based human activity recognition is feature engineering. Feature engineering aims to provide relevant and discriminative feature vectors capable of differentiating various activity details. However, it is challenging to extract accurate features that automatically identify the needed activity details. Conventional feature extraction methods generate large volumes of irrelevant features that are time-consuming to model and require extensive feature selection algorithms. The use of automatic feature selection algorithms inadvertently discards important features, minimizes interpretability, and difficult to understand the contributions of statistical features for human activity recognition. This paper proposes systematic feature fusion that introduces feature-wise integration of features extracted from the accelerometer sensors. The features were analyzed using multiple classifier systems and achieved average performance results of 97.23%, 0.9687, 0.9712, and 0.9699 accuracy, sensitivity, precision, and F-measure, respectively. The systematic integration of feature vectors provides a mechanism to understand the impact of statistical features and multiple classifier systems for sensor-based human activity recognition.

Keywords: Machine learning, Multiple classifier systems, Data fusion, Human activity recognition, Digital health

MULTIVARIATE KOTZ-TYPE AND MULTIVARIATE NORMAL DISTRIBUTIONS FROM FRECHET-BASED VARIANCE-MEAN MIXTURES: PROPERTIES, SIMULATION, AND MODEL EVALUATION

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Abstract

This study develops new classes of multivariate skewed and heavy-tailed distributions by embedding the one-parameter Fréchet distribution into a normal variance-mean mixture framework. In particular, we develop Fréchet-based mixture extensions of the multivariate Kotz-Type and multivariate normal distributions to enhance their capability for modeling asymmetric dependence structures and extreme-value phenomena. The proposed models employ Fréchet-based scale mixing an inherently heavy-tailed mechanism that induces substantial dispersion, positive skewness, and strengthened tail behavior in multivariate contexts. The methodological contributions of the work are threefold. First, we establish the probability density and characteristic function representations for the Fréchet-mixed multivariate Kotz-Type and multivariate normal families, and derive their associated moment structures, marginal distributions, and dependence characteristics. Secondly, we rigorously investigate the induced skewness, kurtosis, and tail heaviness, illustrating how the Fréchet mixing parameter regulates transitions from light-tailed symmetric models to markedly skewed and heavy-tailed multivariate forms. Thirdly, we develop a comprehensive simulation framework designed to assess estimation accuracy, parameter distinguishability, and robustness across diverse data-generating conditions. Model performance is further evaluated through likelihood-based criteria, information-theoretic measures, and goodness-of-fit diagnostics in comparison with the corresponding non-mixed distributions. Overall, the findings provide methodological insight into the use of Fréchet-based variance-mean mixtures as flexible and powerful alternatives for modeling complex multivariate datasets characterized by asymmetry, heterogeneity, and extreme observations. This work contributes to the on-going development of non-Gaussian multivariate models tailored for contemporary statistical applications.

Keywords: Variance-Mean Mixtures, Fréchet-Based Mixing, Heavy-Tailed Models, Simulation-Based Inference, Model Evaluation

GAUSSIAN AND KOTZ-TYPE DISTRIBUTIONS WITH FRÉCHET-BASED MIXTURES: METHODOLOGICAL ADVANCES IN MULTIVARIATE NORMAL VARIANCE-MEAN MIXTURE REPRESENTATION IN PHARMACOKINETIC STUDIES

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Abstract

Normal variance-mean mixture models provide a unifying framework for constructing multivariate distributions capable of capturing skewness, heavy tails, and departures from Gaussian assumptions. Despite extensive methodological development, existing normal variance-mean mixture formulations largely rely on mixing distributions that induce only moderate tail behaviour, limiting their adequacy for applications characterized by extreme variability, such as pharmacokinetic studies. This study aims to systematically review methodological developments in Gaussian- and Kotz-type normal variance-mean mixture distributions, with emphasis on their stochastic representations, inferential properties, computational strategies, and applied relevance, while critically assessing limitations of conventional mixing mechanisms. A PRISMA-guided systematic review was conducted using a structured qualitative synthesis approach. Searches were performed across PubMed, Web of Science, Google Scholar, Science Direct, and Scopus for peer-reviewed English-language studies published between 2000 and 2025. Explicit inclusion and exclusion criteria were applied, with screening, quality assessment, and data extraction conducted independently and reconciled through consensus. From 2,588 identified records, 17 studies met the eligibility criteria. The literature reveals substantial advances in theoretical formulation, likelihood-based inference, and computational implementation of NVMMs, including extensions to skew-normal, skew-Laplace, and Kotz-type baselines, as well as grouped and high-dimensional mixture structures. The review demonstrates that NVMMs form a coherent and powerful modelling paradigm; however, their performance is strongly driven by the choice of mixing distribution. The findings highlight a methodological gap in extreme-value-based mixing, establishing a rigorous foundation for Fréchet-based NVMM extensions as a natural and theoretically justified progression for modelling extreme heterogeneity, particularly in pharmacokinetic applications.

Keywords: Variance-mean mixture, Gaussian density, Kotz-type density, Fréchet-based mixing, Multivariate heavy-tailed densities, Systematic review

DESIGN AND FORMULATION OF A FOUR-STEP COMPUTATIONAL ALGORITHM FOR THE FISHER–KPP REACTION–DIFFUSION EQUATIONS

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Abstract

The Fisher–KPP reaction–diffusion equation is a cornerstone model in mathematical biology, widely used to characterize population growth, biological invasion fronts, and spatio-temporal diffusion–reaction dynamics. Owing to its nonlinear structure and wave-propagation behavior, obtaining accurate and computationally efficient numerical solutions remains a significant challenge. This study develops and mathematically formulates a new Four-Step Computational Algorithm (FSCA) designed to enhance the stability, accuracy, and efficiency of numerical approximations of the Fisher–KPP equation. Using the method of lines, the governing partial differential equation is semi-discretized in space to obtain a system of ordinary differential equations, upon which the FSCA is applied. The algorithm incorporates multistep approximations and higher-order derivative corrections, producing a method that satisfies consistency, zero-stability, and convergence conditions. Numerical experiments conducted on benchmark Fisher–KPP problems show that the FSCA reduces absolute and root-mean-square errors and decreases CPU execution time significantly compared with classical fourth-order Runge–Kutta and some existing methods. The findings confirm that the FSCA provides a more robust computational framework for capturing travelling-wave fronts and other spatio-temporal features inherent in reaction–diffusion systems. Overall, this work offers a reliable, high-accuracy numerical tool for solving second-order nonlinear partial differential equations of Fisher–KPP type.

Keywords: Fisher–KPP equation, Reaction–diffusion model, Four-step Multistep Algorithm, Convergence analysis

INFERENCE ON A PROPOSED BIVARIATE ODD RAYLEIGH-EXPONENTIAL DISTRIBUTION WITH FARLIE-GUMBEL-MORGENSTERN COPULA-BASED DEPENDENCE MODELLING

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Abstract

This study proposes a novel bivariate odd Rayleigh-exponential distribution (OR-ED), constructed using the Farlie-Gumbel-Morgenstern copula to model dependent lifetime data. The new model combines the flexibility of the OR-ED marginals with the analytical simplicity of the FGM copula, allowing for effective representation of weak to moderate dependence structures. Two estimation techniques: the maximum likelihood estimation (MLE) and the inference functions for margins (IFM) are employed, and their efficiencies are examined through extensive simulation experiments and empirical analyses of real-life survival datasets. Simulation results confirm the efficiency of both estimators, with biases and RMSEs diminishing as sample size increases. Findings, however, reveal that the superiority of an estimation method is data-dependent: MLE performs reliably in highly variable settings, whereas IFM yields greater numerical stability and efficiency in large samples or when marginal complexities are pronounced. The proposed FGM copula-based bivariate OR-ED demonstrates strong practical adaptability and analytical tractability, making it a promising tool for contemporary survival and reliability modelling.

Keywords: dependence modelling, FGM copula, inference functions for margins, maximum likelihood estimation, odd Rayleigh-exponential distribution

OPTIMIZATION OF HEMA COMPOSITION IN POLYMER GEL DOSIMETERS FOR COST-EFFECTIVE RADIATION MEASUREMENT

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Abstract

Polymer gel dosimeter (PGD) is a potential tool for radiation measurement in radiotherapy planning system and in nuclear energy monitoring. Optimization of monomer composition is an essential aspect of PGD formulation to achieve optimal performance. In this study, 2-hydroxyethyl methacrylate (HEMA) in combination with N,N'-methylene-bis-acrylamide (Bis) was optimized to improve the efficiency of dose evaluation and cost-effectiveness. The HEMA PGD formulations here are named HEMABIS, a combination of the acronyms of the two co-monomers HEMA and Bis. The results show that when the HEMA weight fraction (WF) is 0% C and Bis makes the total monomer WF of 2 wt%, the sensitivity is lowest, and when the Bis and HEMA were both added, the sensitivity increases linearly with the total co-monomer WF. However, if the WF of Bis is fixed and WF of HEMA increased from 0–60% C, the sensitivity decreases beyond the optimal value, due to exhaustion of vinyl groups in the Bis, which are required for the crosslinking with the HEMA. The mass density of the HEMABIS PGDs (≈ 1.04 gcm^{-3}), their electronic density (ρ_e = 3.42 × 10^{23} - 3.43 × 10^{23} cm^{-3}), their number of electrons per unit mass (n_e = 3.28 × 10^{23} - 3.30 × 10^{23} gr^{-1}) and their effective atomic number (Z_{eff} = 7.3624 - 7.4176) are comparable to those of water, which indicates their water equivalence. These findings do not only produce a more efficient HEMA-based PGD, but also improves the cost effectiveness, thereby improving their affordability for health care applications.

Keywords: HEMA, Polymer Gel Dosimeter, Monomer Optimization, Tissue Equivalence, Radiological Properties

A PURSUIT–EVASION DIFFERENTIAL GAME WITH NTH- AND MTH-ORDER DYNAMICS AND MIXED CONSTRAINTS IN THE PLANE

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Abstract

This paper studies a pursuit–evasion differential game involving multiple pursuers and a single evader whose motions follow n^th and m^th-order differential equations, with n<m. The game is formulated within a closed convex subset of the plane, where each player's control satisfies both coordinate-wise and general integral constraints. The objective is to establish a guaranteed capture condition under these mixed constraints. A non-anticipative strategy for the pursuers is developed, structured in distinct operational phases to ensure finite-time pursuit. Analytical techniques are used to derive a sufficient condition guaranteeing capture, expressed in terms of system parameters and control bounds. Numerical analysis confirms that higher-order dynamics significantly influence pursuit feasibility and capture time. The results generalize existing first-order formulations and demonstrate that coordinated control under mixed constraints improves capture efficiency. This work contributes to the theory of differential games with complex motion dynamics and provides insights applicable to guidance and control systems.

Keywords: Pursuit–evasion game, higher-order dynamics, mixed constraints, guaranteed capture, differential equations.

IMPLEMENTATION OF AN ARTIFICIAL INTELLIGENT CHATBOT SYSTEM FOR CYBER THREATS IN NIGERIA

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Abstract

Cybersecurity threats are rapidly increasing not only in Nigeria but in the whole world as large due to the world growing digital footprint and limited cybersecurity awareness among individuals and organizations. This paper is on the implementation of an artificial intelligence (AI)-powered Chabot designed to address cyber threats in Nigeria. The Chabot serves as an intelligent first-line defense system, capable of identifying, analyzing, and responding to basic cybersecurity incidents in real-time. By leveraging natural language processing (NLP) and machine learning algorithms. An agile methodology was adopted no guide development, emphasizing iterative test and continuous user feedback. The study evaluates existing cybersecurity challenges in Nigeria, including limited access to expert support, low awareness, and delayed incident reporting. The new system was evaluated using confusion matrix, to measure threat detection performance, achieving an overall accuracy of 92%. The results indicate that system generates meaning responses, enhance cyber threat response times and provide scalable support across diverse sectors such as banking, education, government and enhancing user awareness of cyber threats. This research highlights the potential of AI-driven solutions to complement national cybersecurity efforts and bridge the gap in Nigeria's digital defense landscape.

Keywords: Cybersecurity, Cyber thread, Natural language processing (NLP) and machine learning

TOWARDS A FULLY AUTOMATED ONLINE VOTING SYSTEM FOR CREDIBLE ELECTIONS IN NIGERIA

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Abstract

Nigeria's electoral process is currently semi-automated and fraught with challenges such as disenfranchisement of elderly citizens and Nigerians living abroad, violence at polling units, and delays in announcing election results due to manual collation. Human involvement also opens the system to manipulation and exploitation by electoral violators. To address these issues, an Online Voting System (OVS) with facial authentication was developed to enhance voter turnout and enable eligible citizens to vote remotely using smart devices. A hybrid development methodology was employed, combining Structured Systems Analysis and Design Methodology (SSADM) with Object-Oriented Methodology (OOM). The system's front-end interface was built using Adobe Macromedia Dreamweaver, while Python was used for implementing facial biometric authentication. Hypertext Preprocessor (PHP) served as the scripting language, and MySQLi was used for database creation and management to ensure data security and system efficiency. The OVS was integrated with the National Identity Management Commission (NIMC) database to extract eligible voter information. The system automatically notifies registered voters about their eligibility and voting schedule via email and SMS. During voting, the facial features captured during registration are authenticated against real-time input to ensure only eligible voters cast their votes. The application offers a secure and automated platform for online voting, enabling accurate vote tallying, quicker result announcements, and reduced electoral malpractices. It improves transparency, enhances voter confidence, lowers election costs, and promotes convenience by allowing voters to participate from any location.

Keywords: Electoral process, Online voting, Facial Authentication, Reduce Electoral Malpractices.

DATA-DRIVEN INSIGHTS INTO NIGERIA'S 2024 SUBSIDY WINDFALL: COMPUTATIONAL ANALYSIS OF STATE FISCAL BEHAVIOUR USING MULTI-YEAR PUBLIC FINANCE DATA

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Abstract

Nigeria's 2023 fuel subsidy removal produced the largest fiscal redistribution in its history, sharply increasing federally disbursed resources to state governments. This shift created a unique opportunity to assess how states absorbed and utilised exceptional revenue inflows. The purpose of this study is to evaluate the fiscal behaviour, spending priorities, and transparency practices of Nigeria's 36 states following the unprecedented ₦12.1 trillion allocations received in 2024, equivalent to 78.2% of the total disbursements from 2020–2023 combined. Using a computational, data-driven analysis of multi-year financial datasets (2020–2024), this study integrates revenue, expenditure, debt, and Internally Generated Revenue (IGR) indicators to construct a Fiscal Performance Index and transparency-compliance metrics. Findings show a significant surge in capital expenditure, with states collectively spending ₦7.6 trillion in 2024 and many doubling their investment levels. In contrast, personnel spending increased by only 45.4% despite an average inflation rate of 33.24%, resulting in real wage gains of just 12.16%. Debt behaviour diverged markedly, separating states into fiscally disciplined units that reduced borrowing and others that accumulated new debt despite higher revenues. This study reveals 100% non-compliance with programme-objective reporting and bank reconciliation disclosures, highlighting systemic weaknesses in data governance. These results underscore the need for nationwide adoption of Programme and Objective-Based Reporting supported by GIFMIS to enhance transparency, strengthen expenditure traceability, and improve evidence-based fiscal decision-making.

Keywords: Computational, Data-driven, Fiscal Decentralisation, Capital Expenditure. Subsidy removal.

A TRAFFIC-AWARE AND SECURITY-COGNIZANT DYNAMIC RADIO RESOURCE ALLOCATION FRAMEWORK FOR URLLC AND MMTC SERVICES

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Abstract

Radio resource allocation (RA) in next-generation wireless networks must efficiently support heterogeneous services such as ultra-reliable low-latency communications (URLLC) and massive machine-type communications (mMTC). These services exhibit highly dynamic traffic patterns and stringent, yet distinct, requirements for latency, reliability, and security. However, most existing RA schemes are static or semi-dynamic and lack the flexibility to adapt to real-time variations in network load, channel conditions, and emerging security threats, resulting in resource underutilization and weakened service guarantees. This paper proposes a holistic, traffic-aware, and feedback-driven dynamic RA framework that jointly addresses spectral efficiency and security assurance. The proposed framework is designed to adapt radio resource assignments and cryptographic configurations based on instantaneous network state information, including traffic demand, channel quality, and security risk indicators. Lightweight analytical models will be employed to capture cryptographic processing delays, enabling real-time trade-offs between security overhead and quality-of-service (QoS) constraints. In addition, an intelligent resource reclamation mechanism is incorporated to identify underutilized resources and dynamically reassign them while preserving latency, reliability, and security requirements for active traffic. The proposed framework will be evaluated through simulations under realistic URLLC and mMTC traffic and threat models. Performance metrics such as spectral efficiency, resource utilisation, latency, reliability, and resilience to jamming will be analysed and compared with conventional static and semi-dynamic RA schemes. The expected outcome is a scalable and security-aware solution for efficient radio resource management in future wireless networks.

Keywords: Resource allocation, MMTC, URLLC, security-aware, QoS

DEVELOPMENT OF AN ANDROID BASED MOBILE PHONE THEFT TRACKER WITH ALARM SYSTEM

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Abstract-

The high cost of mobile phones and the data each contains have made them attractive for thieves who dispossess them of their owners and sell them, especially for monetary gains. This research work is on the development of an android based mobile phone theft tracker with an alarm system that is capable of triggering alarm when there is SIM removal, using object oriented analysis and design methodology (OOADM) with the aid of unified modeling language (UML) tools such as use case, sequence and flow chart diagrams. The qualitative method of research methodology was adopted in this research. The system sends location which is found using Google Map, fetched through Global Positioning System (GPS) using Short Message Service (SMS) and Email to the predefined recovery contacts and security personnel. The project was implemented using Android studio as integrated development environment (IDE), SQlite as database management, Application Program Interface (API) from www.kudisms.net which used for sending SMS and Email for capturing the location of the missing phone. The results show alarm that triggers alarm between 4 and 9 seconds after SIM removal; and lasts between 1min and 9secs to 1min and 40seconds and then starts vibrating, continuously. SMS and Email containing the name of owner of the mobile phone and location coordinate which was fetched from GPS are sent to predefined recovery contacts and security personnel by the anti-theft application. The results obtained from and experiment have the accuracy (94%) and availability (24hrs), respectively. The figures of merit of the devices enhance the existing system of mobile phone tracking. It is recommended that more research be conducted for better and efficient means of tracking our mobile phones.

Keyword: Mobile Phone, Tracker, Alarm System

DEVELOPMENT OF A FEDERATED LEARNING FRAMEWORK FOR CYBER THREAT DETECTION IN MOBILE HEALTHCARE ENVIRONMENTS

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Abstract

The growing reliance on mobile healthcare (mHealth) systems for real-time patient monitoring and diagnosis has intensified concerns over data privacy and cyber threats. Conventional centralised machine learning models expose sensitive medical data to significant risks of interception, manipulation, and unauthorised access. This paper explores integrating Federated Learning (FL) with privacy-preserving techniques as a transformative approach to safeguarding health data while maintaining robust cyber threat detection capabilities. The framework allows multiple healthcare devices and institutions to collaboratively train intelligent models without sharing raw patient data, thereby reducing exposure to potential breaches. A Federated Averaging (FedAvg) optimisation method is employed to efficiently synchronise global models while mitigating communication overhead and data heterogeneity. The proposed privacy-preserving FL framework demonstrates the potential to detect evolving cyber threats, such as malware infiltration, unauthorised access, and model poisoning attacks, within mHealth environments. Beyond security, this approach aligns with ethical Artificial Intelligence (AI) principles and emerging data protection regulations, providing a pathway toward secure, transparent, and scalable healthcare intelligence. Ultimately, the implication of the study is to bridge the gap between cybersecurity, artificial intelligence, and digital health by ensuring that patient safety and privacy remain central to technological innovation in the mobile healthcare ecosystem.

Keywords: Artificial Intelligence, Federated Learning, Privacy-Preserving Techniques, Cyber Threat Detection, Mobile Healthcare Systems

ENHANCING ADAPTIVE LEARNING MANAGEMENT SYSTEM WITH BERT AND DATA ANALYTICS

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Abstract

The rapid evolution of artificial intelligence (AI) and data analytics has opened new possibilities for personalized education through Adaptive Learning Management Systems (ALMS). This study explores the integration of BERT (Bidirectional Encoder Representations from Transformers) a state-of-the-art natural language processing (NLP) model with data analytics to enhance adaptive learning. By leveraging BERT's deep contextual understanding, the proposed system dynamically analyzes student interactions, feedback, and performance data to deliver personalized learning pathways. The framework employs predictive analytics to identify learning gaps, recommend tailored content, and optimize engagement in real time. A prototype implementation demonstrates BERT's effectiveness. A key innovation of the system is its ability to detect when a learner fails a Computer-Based Test (CBT) question. Experimental results show improved student performance compared to traditional methods, along with enhanced adaptability to individual learning styles. Challenges such as model bias, computational overhead, and data privacy are also discussed. The system achieved effective performance with ROUGE-1 of 0.485, ROUGE-2 of 0.245 and ROUGE-L of 0.445 confirming an effective semantic content retrieval with an overall personalization accuracy of 93%. The findings suggest that BERT-powered ALMS, combined with robust analytics, can significantly improve e-learning outcomes, offering a scalable solution for both academic and corporate training environments.

Keywords: Adaptive Learning Management System (ALMS), Bidirectional Encoder Representations from Transformers (BERT), Data Analytics in Education, Personalized Learning, Natural Language Processing (NLP)

SOME OBSERVATIONS IN THE ADVANCEMENT OF QUANTUM CALCULUS

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Abstract

Quantum calculus has profoundly shaped Geometric Function Theory (GFT) by providing versatile frameworks for redefining classical subclasses of analytic functions and extending foundational results. It has proven instrumental in characterizing various subclasses of univalent functions, exploring their geometric features, and determining coefficient bounds within the family A* of normalized analytic functions.

A thorough review of the literature indicates that while coefficient problems related to A* under q-calculus are generally well developed, studies addressing their geometric properties often suffer from inconsistencies and incomplete reasoning. Motivated by the need to address these challenges, we observe that several q-classical results contain errors in formulation or proof, which have been propagated in later works. This study seeks to identify and critically reassess such flawed results to correct misconceptions and strengthen the theoretical foundation of q-analogues in Geometric Function Theory.

Keywords: q-calculus, subordination, q-Jack's lemma, Analytic function

AN OVERVIEW OF EPIDEMIOLOGICAL MATHEMATICAL MODELLING: A CASE STUDY OF MALARIA

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Abstract

Epidemiological mathematical models have become indispensable in understanding and managing infectious diseases such as malaria. These models offer insight into disease transmission dynamics, effectiveness of interventions, and potential future outbreaks. This work provides an overview of the foundational steps in developing a disease transmission model, using malaria as a reference disease. It also discusses the core set of questions that must be considered to evaluate the stability and sensitivity analysis of the disease model. Applying the classical SIR framework and extensions relevant to vector-borne diseases, we examine key parameters in malaria modelling, such as vector-host interactions, incubation periods, and intervention thresholds. In this work, we aim to develop and train a physics informed neural network architecture for the solution of differential equations using malaria model. This will help to support public health decision-making by improving model transparency, relevance, and application.

Keywords: Sensitivity Analysis, Stability, PINN

AN ASSESSMENT OF THE RELATIONSHIP BETWEEN KNOWLEDGE LEVEL AND AWARENESS LEVEL OF RISK FACTORS CONTRIBUTING TO VVF IN JAHUN GENERAL HOSPITAL OF JIGAWA STATE NIGERIA

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Abstract

Women are frequently considered as a vulnerable gender group in most third-world nations; yet, the catastrophic and humiliating repercussions of ill health, such as VVF, make them even more vulnerable in these societies, revealing their emotional fragility. The vesico vaginal fistula (VVF) problems in Jahun General Hospital occur in the presence of lack of knowledge and early marriage of teenage girls and some disease, and the most common system of vesico vaginal fistula VVF is urinary incontinence urine leakage from the vagina, which is often exacerbated by physical activities. Additionally, the patient may develop vulva discomfort, itching, and recurring urinary tract infections. This study employed cross-sectional research design to investigate the relationship between level of knowledge on VVF and awareness level on risk factors contributing to VVF. The purpose of the study was to determine the relationship between level of knowledge on VVF and level of awareness on the risk factors contributing to VVF at the Jahun General Hospital. Summary Conclusion: The study concluded that there is a significant lack of knowledge and awareness about vesico-vaginal fistula (VVF) among women in Jahun and surrounding communities. This inadequate understanding contributes to the persistence of VVF, often linked to early marriage, lack of education, and poor health awareness. Recommendation: The study recommends implementing targeted awareness programs and educational campaigns to improve women's knowledge of VVF, its causes, and prevention methods, particularly in vulnerable communities like those around Jahun General Hospital.

Keywords: Vesico-vaginal fistula, Awareness, pregnancy, cross-sectional research, Data.

Optimizing Healthcare Delivery in Bayelsa State through Health Systems Modeling

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Abstract

In order to enhance healthcare delivery in Bayelsa State, Nigeria, this study investigates the use of statistical approaches in health systems modelling. A high prevalence of infectious and non-communicable diseases, insufficient infrastructure, and unequal access to healthcare services are only a few of the major healthcare issues facing Bayelsa. By forecasting healthcare demand, maximising resource allocation, and enhancing overall system efficiency, statistically based health systems modelling presents a viable way to deal with these problems. The goal of this study is to create a framework for using statistical tools, including Bayesian methods, regression analysis, and time series analysis, to healthcare policy and decision-making in Bayelsa. The study intends to offer practical insights into the state's healthcare system by gathering data, interacting with stakeholders, and developing a model. It will show how statistical models can forecast health outcomes, maximise resources, and improve access to healthcare. The study intends to support more equitable and effective healthcare delivery in Bayelsa by incorporating these models into local decision-making procedures, which would ultimately improve public health outcomes. Policymakers and healthcare professionals will be able to make data-driven decisions and increase the resilience of Bayelsa's healthcare system in the face of escalating health concerns with the help of the framework created in this study.

Keywords: Health Systems Modeling, Bayelsa State, Optimization, Healthcare Delivery

DEVELOPMENT OF A HYBRID GENETIC ALGORITHM (GA) BASED MODEL FOR DETECTING AND PREVENTING SQL INJECTION ATTACKS

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Abstract

SQL Injection (SQLi) remains one of the most prevalent and damaging security threats targeting web applications, allowing attackers to manipulate database queries and compromise sensitive information. Traditional detection and prevention mechanisms such as static filters, signature-based tools, and rule-based Web Application Firewalls often struggle to identify complex, obfuscated, or zero-day SQLi patterns. This research presents the development of a hybrid Genetic Algorithm (GA) based model for detecting and preventing SQL Injection attacks, designed to intelligently evolve detection rules and adapt to emerging attack techniques. The proposed system integrates GA optimization with machine-learning-based query classification, enabling efficient feature selection, parameter tuning, dynamic rule generation. Real web application datasets containing both benign and malicious SQL queries were used for training, testing, and validation. Experimental results demonstrate that the hybrid GA model achieves high detection accuracy, reduced false positives, improved robustness compared to conventional systems. The study concludes that combining evolutionary optimization with intelligent classification significantly enhances the overall ability to detect and prevent SQL Injection attacks, offering a scalable and adaptive security solution for modern web applications.

Keywords: SQL Injection, Detection, Prevention, Genetic Algorithm, Hacking

STRATEGIC FORENSIC READINESS IN IOT-ENABLED INDUSTRIAL CONTROL SYSTEMS: A RESILIENCE-ORIENTED FRAMEWORK FOR CRITICAL NATIONAL INFRASTRUCTURE

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Abstract

The rapid expansion of the Industrial Internet of Things (IIoT) within Critical National Infrastructure (CNI) has weakened the traditional isolation of Operational Technology (OT), increasing Industrial Control Systems' (ICS) susceptibility to sophisticated cyber-physical attacks. Conventional digital forensics relying on post-incident evidence collection and system shutdowns conflicts with the high availability and safety demands of modern industrial environments. To overcome these limitations, this paper presents a Federated Learning–Enabled Forensic Readiness Framework (FL-FRF) tailored for IoT-driven ICS ecosystems. The architecture incorporates edge-based federated anomaly detection models that minimize data transmission and enhance privacy, supported by Edge-AI forensic triage for early and continuous evidence capture. A permissioned blockchain (Hyperledger Fabric) provides tamper-resistant, immutable chain-of-custody preservation across distributed industrial nodes. By integrating federated learning with blockchain-backed forensic readiness, the framework enables decentralized monitoring, real-time anomaly detection, and reliable evidence retention without interrupting operational processes. Results from a simulated Modbus TCP cyber-attack show that the FL-FRF reduces Forensic Time-to-Availability (FTtA) by 65%, enhances detection accuracy, and improves overall system resilience compared with traditional centralized forensic approaches. This confirms the potential of federated learning to significantly strengthen forensic preparedness in critical industrial environments.

Keywords: Federated Learning, Digital Forensics, IIoT, SCADA, Blockchain, Edge Computing, ICS Security, Cyber Resilience.

AI-DRIVEN CYBER THREAT INTELLIGENCE FRAMEWORK FOR SECURING NIGERIA'S PUBLIC HEALTH DATA SYSTEMS

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Abstract:

Nigeria's growing dependence on digital health technologies has brought new opportunities for service delivery—but also a surge of cyber threats that endanger sensitive patient data. Incidents of ransomware, phishing, and insider breaches have exposed the fragility of existing security structures, many of which rely on generic imported solutions that do not fit the realities of local health systems. This study proposes an AI-driven cyber threat intelligence framework tailored to Nigeria's public health data environment. The model combines machine-learning techniques for real-time anomaly detection with lightweight cryptographic tools that safeguard authentication and data transmission. Using simulated datasets that mirror the traffic patterns of local hospital networks, the system demonstrates how early warning intelligence can help identify and prevent potential attacks before they cause harm. Beyond the technical design, the paper considers the policy and infrastructural constraints facing developing economies and offers practical recommendations for strengthening digital resilience. In bridging artificial intelligence, cyber intelligence, and public health, this research aims to provide a realistic pathway toward safer, more trustworthy health data systems in Nigeria.

Keywords: Artificial Intelligence, Cyber Threat Intelligence, Cryptography, Healthcare Data Security

MODELLING SPATIOTEMPORAL CHROMATIC ENERGY USING ATTENTION-ENHANCED CNN-LSTM NETWORKS FOR DEEP FAKE VIDEO DETECTION

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Abstract

As deep fake video becomes more and more similar to authentic recordings, the ongoing expansion of AI-generated synthetic media presents serious risks, such as identity fraud, disinformation, and political manipulation. The core problem is that these synthetic videos are often indistinguishable from authentic content to the human eye, rendering conventional forensic methods ineffective. This study therefore has the primary objective of developing a robust, intelligent detection mechanism capable of identifying subtle spatiotemporal artifacts in manipulated videos. The goal is to design and evaluate a hybrid deep learning architecture that leverages the complementary strengths of Convolutional Neural Networks (CNNs) for spatial feature extraction and Long Short-Term Memory (LSTM) networks for temporal sequence modeling, enhanced by an attention mechanism to focus on the most discriminative video segments. A key innovation of this work is the use of Spatiotemporal Chromatic Energy Distributions (SCED) as input features, which effectively model the harmonic relationships in authentic video and are sensitive to the inconsistencies introduced by synthetic generation processes. The results demonstrate the superior performance of the proposed hybrid CNN-LSTM model with attention, which achieved an accuracy of 98.7%, a precision of 96.2%, a recall of 96.4%, and an F1-score of 97.7%, significantly outperforming standalone CNN (88.5% accuracy) and LSTM (91.4% accuracy) baselines. In conclusion, this research confirms that the integration of SCED features with a hybrid CNN-LSTM architecture and attention mechanism provides a highly effective and reliable solution for deep fake video detection, offering a powerful tool to enhance the security and trustworthiness of digital media.

Keywords: Deep fake detection, Attention Mechanism, CNN, LSTM, Spatiotemporal Chromatic Energy Distributions

MULTISECTORAL DATA WAREHOUSING FOR CLIMATE-RESILIENT AGRICULTURE AND SUSTAINABLE FOOD SECURITY IN NIGERIA

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Abstract

Nigeria, the most populous country in sub-Saharan Africa, faces multifaceted, overlapping problems of economic instability, security concerns, and an acute energy deficit that is further aggravated by the ever-increasing impacts of climate change on its agricultural systems, a primary source of livelihood for millions. These hydra-headed challenges require a scientific, data-driven, informed response. The paper examines how physical sciences principles, particularly in data management, modelling, analytics, and systems integration, can be applied to promote efficient energy resource distribution for climate-resilient agriculture (CRA), thereby boosting the economy and ensuring long-term food security. A mixed-methods approach, combining literature reviews, AI tools, case studies of climate adaptation projects, ontology-driven data harmonisation, and stakeholder consultations, was used in the research. Findings revealed that an integrated National Climate–Agriculture Data Warehouse (NCADW) can significantly enhance climate-resilient agriculture and energy resource sharing, thereby improving the economy and food security. The initiative becomes a scientific laboratory and a decision-support ecosystem, transforming siloed databases into actionable insights that policymakers, researchers, and practitioners can use to enhance the economy. The paper concludes that a multisectoral National Climate-Agriculture Data Warehouse transforms physical science data into practical tools for climate-resilient agriculture by connecting laboratories to farmlands and datasets to decision-making, thereby enabling evidence-based agricultural governance and smart-agriculture to increase food production and boost the economies of the major and small-holding farmers in the face of emerging climatic chaos compounded by security concerns.

Keywords: Climate-Resilient Agriculture (CRA), Data Warehousing, Energy Resource Distribution, Ontology-Driven Data Integration. Smart-Agriculture

A STRATIFIED RANSOMWARE MITIGATION MODEL BASED ON ZERO TRUST AND NETWORK SEGMENTATION ARCHITECTURES

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Abstract

Ransomware remains a critical cybersecurity threat, particularly due to its ability to spread laterally through networks. This paper presents the design and development of a stratified model based on Zero Trust Architecture (ZTA) and Network Segmentation model to mitigate ransomware propagation. The proposed framework integrates ZTA's continuous verification with network segmentation's structural containment.The system was modelled and implemented using pfSense, VMware, and GNS3, and was validated using actual network flow data extracted from Ryuk ransomware dataset. The stratified model successfully demonstrated automated containment by correlating real ransomware behavioral patterns - such as characteristic Server Message Block (SMB) traffic and high transfer rates - with dynamic policy enforcement, isolating compromised endpoints within sub-seconds. This provides a practical, behavior-aware blueprint for enhancing resilience against sophisticated ransomware.

Keywords: Zero Trust Architecture, Network Segmentation, Ransomware Mitigation, Lateral Movement Containment

THE ROLE OF FOG COMPUTING IN ENABLING INTERNET OF THINGS (IOT) APPLICATIONS

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ABSTRACT

The traditional centralized architecture of cloud computing faces significant challenges in supporting the rapidly growing Internet of Things (IoT) ecosystem, particularly in terms of high latency, limited bandwidth, and potential network failures. As IoT devices continue to proliferate, the need for efficient data processing and low-latency communication has become critical. Fog computing has emerged as a complementary paradigm that extends cloud capabilities to the network edge, enabling computation, storage, and data management closer to IoT devices. By minimizing the reliance on distant cloud servers, fog computing enhances response time, optimizes bandwidth utilization, and improves the reliability of IoT systems. Consequently, fog computing provides a robust and scalable framework for delivering secure and high-quality IoT services. This paper explores the significance of fog computing as a viable solution for overcoming the limitations of cloud-centric IoT architectures and facilitating the development of next-generation intelligent IoT applications.

Keywords: Internet, network, bandwidth

MODELLING VOLATILITY ADVERSE EFFECTS OF ECONOMIC INSTABILITY ON CONSUMERS BUYING BEHAVIOUR IN NIGERIA: A NUMERICAL EVALUATION

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ABSTRACT

The buying behaviour in consumer research encompasses the decision-making processes customers undergo when purchasing goods and services. The buying behaviour of consumers under economic instability is influenced by economic instabilities such as hyperinflation, unstable dollar to naira exchange rate, removal of fuel subsidy without predictive feasibility study analysis, increment of value added tax (VAT) and high electricity tariff. These economic instabilities result to volatility adverse effects of devaluation of naira, income fluctuations, disruption of financial planning and reduction of household expenditure, increased cost of imported raw materials leading to an increase in production and marketing costs. Amid these economic instabilities, there is urgent need to evaluate its volatility adverse effects on consumers' buying behaviour and this can be modelled as Econometric Volatility Time-Delay Differential Equation (EVTDDE). Numerically, this study aims to evaluate and proffer best ways to overcome the volatility adverse effects of economic instability on consumers' buying behaviour in Nigeria. Some examples of the modelled equation were solved using Extended Block Adams Moulton Methods (EBAMM) without the use of interpolation techniques in evaluating the volatility delay and noise terms. The volatility delay and noise terms were evaluated by applying acceptable ideas of developed sequences. The discrete schemes of the applied numerical method were obtained through the use of linear multistep collocation procedure using matrix inversion approach. Following the volatility display of the numerical results of the method which represents the volatility adverse effects of five dimensions of economic instability on consumers' buying behaviour, the Absolute Volatility Errors (MAVEs) of step number $k = 4$ of EBAMM produced better and faster numerical results than the step numbers $k = 3$ and 2 by giving the Least Minimum Absolute Volatility Errors (LMAVEs) at a Lower Computational Processing Unit Time (LCPUT) when compared with other existing method. This study recommends that the Nigerian government should adopt more robust and consistent monetary policies and diversify its economy by investing in non-oil sectors such as agriculture, technology, and manufacturing in order to create a more stable and resilient economic environment and to improve consumers' buying behaviour.

Keywords: Economic Instability; Consumers' Buying Behaviour; Nigeria; EVTDDE; EBAMM; Absolute Volatility Error

MODELLING AUTOCORRELATION IN SECTORAL CONTRIBUTIONS TO NIGERIA GDP (1986–2023): A GENERALIZED LEAST SQUARES APPROACH

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Abstract

This study aimed to diagnose and model autocorrelation in Nigeria's GDP data from 1986 to 2023, identify the most effective Generalized Least Squares (GLS) approach and provide accurate estimates of the contributions of the agricultural, industrial and trade sectors. Using annual data from the Central Bank of Nigeria (CBN), unit root and structural break tests were conducted. After confirming non-stationarity and significant autocorrelation, several GLS models with different variance-covariance structures: AR (1), ARMA (1,1), varPower and varExp were fitted and compared. The best fit model selection was based on Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC). The GDP series was confirmed as non-stationary with structural breaks linked to major economic events such as: Democratization of 2000 and Economic Recession of 2016. Autocorrelation was severe: Durbin-Watson statistics: 0.095–0.445, $p < 0.001$. The GLS model with an ARMA (1,1) error structure provided the best fit (AIC = 595.28 and BIC=606.74), significantly outperforming heteroscedasticity only GLS models. After correcting for autocorrelation, all three sectors showed a significant positive impact on GDP. The Trade sector emerged as the strongest driver ($\beta = 2.22$, $p < 0.001$), followed by Agriculture ($\beta = 1.56$, $p < 0.001$) and Industry ($\beta = 1.01$, $p < 0.001$). Historical analysis confirmed a structural shift, with trade's contribution rising as industry's share declined. Ignoring autocorrelation produces misleading economic analysis. The GLS-ARMA (1,1) approach is essential for robust modelling of Nigeria's GDP. The study recommended that Investment in agricultural technology (AgriTech), value-chain development and climate-resilient practices is crucial to boost the productivity and GDP contribution of this vital sector.

Keywords: Analysis, Autocorrelation, Generalized, Model, Sectoral.

FRAUD DETECTION IN NIGERIAN FINANCIAL CARD TRANSACTIONS USING A GRAPH ATTENTION NETWORK

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Abstract

Financial fraud in Nigeria's rapidly growing digital payment ecosystem poses significant challenges to economic stability and consumer trust. Traditional rule-based and machine learning approaches often fail to capture complex relational patterns inherent in fraudulent transaction networks. This study develops and evaluates a Graph Attention Network (GAT) model for detecting fraudulent card transactions in the Nigerian financial sector, leveraging graph-based representations to capture intricate relationships between entities. We constructed a heterogeneous graph representation of transaction data from a Nigerian banks, incorporating nodes representing cards, merchants, and account holders, with edges denoting transaction relationships. A Graph Attention Network was implemented with multi-head attention mechanisms to learn adaptive node embeddings. The GAT model achieved superior performance compared to baseline methods, with an AUC-ROC of 0.94, precision of 0.89, recall of 0.91, and F1-score of 0.90. The model demonstrated particular effectiveness in detecting sophisticated fraud patterns and merchant collusion schemes. Graph Attention Networks provide a robust framework for fraud detection in Nigerian financial card transactions, effectively capturing complex relational patterns while maintaining interpretability through attention mechanisms.

Keywords: Fraud Detection, Graph Attention Network, Card Transactions, Nigerian Financial, Graph Neural Network

HYBRID MODELS FOR TIME SERIES CHARACTERIZED WITH INTERRUPTIONS

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Abstract

A hybrid model for forecast of time series that is characterized with interruption was considered in this study. Often conventional pre-processing techniques in the ARIMA model does not adequately address certain non-stationarity like "interruption (intervention)" in time series analysis, hence a need for a model to accommodate such non-stationarity. Machine learning approaches which predict better than the conventional statistical model has the challenge of interpretability. A blend of the two is therefore necessitated, hence, hybrid models. The models considered include conventional time series models (ARIMA, Intervention ARIMA), machine learning model (XGBoost) and the hybrid of the conventional with machine learning model. The findings showed the following mean absolute percentage error (MAPE): ARIMA (20.6), I-ARIMA (0.18), XGBoost (0.01), Hybrid models (0.014-1.39), Hybrid on ARIMA residual (18.7). The adoption of hybrids model with the exception of those on residual is considered more appropriate for the study data and hence is recommended for time series characterized with interruptions to access the benefit of interpretability of the conventional models and predictive advantage of machine learning model.

Keywords: Time series, interruptions, ARIMA, forecast, Machine learning

FIXED POINT RESULTS OF WEAKLY POLYNOMIAL CONTRACTIONS

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Abstract

In this work, a family of weakly polynomial-type contractions defined on a metric space is presented. Under certain screened assumptions, it is demonstrated that such contractive mappings possess unique fixed points. In contrast to many of the existing Lispchitz-type inequalities, the proposed class of contractions herein do not enjoy continuity by default. Due to the polynomial nature of the operators, a handful of particular cases, a few of which reduce to some existing results are highlighted and discussed.

Keywords: Fixed point, weakly contraction, polynomial contraction

COMPUTATIONAL PROFILING OF CURRICULUM AGILITY: A SET-THEORETIC ANALYSIS OF THE NUC 70:30 POLICY USING PYTHON

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Abstract

In the rapidly evolving digital economy, the agility of higher education curricula is a critical determinant of graduate employability. This study evaluates the effectiveness of the National Universities Commission's (NUC) Core Curriculum and Minimum Academic Standards (CCMAS), specifically the 70:30 policy, which grants Nigerian universities 30% autonomy to introduce innovative, context-specific content. While the policy intent is strategic, manual review mechanisms fail to empirically measure if this "agility window" is effectively utilized. Adopting a Design Science Research (DSR) approach, this study developed a computational diagnostic artifact using Python to perform a Set-Theoretic Analysis of curriculum alignment. The system modeled the *Academic Supply Set* (derived from 150 NUC-accredited university handbooks) and the *Industry Demand Set* (derived from 1,500 high-demand ICT job postings collected between October 2025 to January 2026). The analysis reveals a structural paradox: while adherence to the 70% core mandate is high, the Agility Index—representing the 30% local content—showed a negligible 1% market-validated innovation rate. The study identified a negative alignment correlation ($r = -0.26$), indicating that universities are filling their autonomous quota with legacy theoretical modules rather than high-demand competencies like Cloud Computing, DevOps, and Microservices. The paper concludes by proposing a framework for Continuous Computational Auditing, allowing policymakers to use data mining to ensure that the 30% autonomy effectively bridges the theory-practice gap.

Keywords: Curriculum Agility, NUC CCMAS, Python, Set-Theoretic Analysis, Educational Data Mining.

DEVELOPMENT OF A MIXTURE OF LOGISTIC REGRESSION MODELS WITH LASSO REGULARISATION AND APPLICATION

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Abstract

High-dimensional binary classification problems frequently arise in Biomedical, Financial, and Social Science domains, where strong predictor correlations and latent subpopulation structures make conventional modelling inadequate. Logistic regression suffers from overfitting and cannot accommodate unobserved heterogeneity, while penalized methods like LASSO address high dimensionality but ignore latent clusters. Conversely, mixture models capture heterogeneity but fail to perform variable selection effectively in large predictor spaces. This study addresses these limitations by proposing a Mixture of LASSO Logistic Regression (MLR-LR) model tailored for high-dimensional binary outcomes exhibiting latent heterogeneity. The proposed method integrates finite mixture modelling to uncover hidden clusters with LASSO regularization to achieve simultaneous parameter estimation and variable selection, thereby handling multicollinearity and sparsity within a unified framework. We establish the theoretical foundation of the model and derive an efficient EM algorithm for estimation. Simulation experiments across varying sample sizes and fixed predictor dimensions demonstrate stable and superior performance. Comparative analyses confirm that MLR-LR outperforms standard machine learning methods: it achieves an AUC of 0.910 and a misclassification rate of 0.12, clearly surpassing Gradient Boosting (AUC = 0.827, error = 0.262) and Random Forest (AUC = 0.616, error = 0.426). To further evaluate practical utility, the model is applied to the Wisconsin Breast Cancer dataset (569 observations, 30 predictors). The optimal configuration identifies two latent clusters (π_1 = 31.9%, π_2 = 68.1%), and predictive metrics are nearly perfect, with AUC = 0.99997, F1-score = 0.99305, recall = 1.00000, and a misclassification rate of 0.00879. Cluster-specific sparsity patterns reveal key predictors driving malignancy risk, demonstrating the model's ability to provide interpretability alongside accuracy. Clustering diagnostics, including a Hopkins statistic of 0.949, confirm strong latent structure within the data. Overall, the results show that MLR-LR effectively combines prediction, variable selection, and cluster identification, offering a powerful and interpretable framework for high-dimensional binary classification problems with underlying heterogeneity.

Keywords: Mixture Modelling, LASSO, High Dimension, Breast Cancer

RESULTS ON CYCLIC CONDENSED KANNAN-TYPE CONTRACTION IN QUASI- PARTIAL B-METRIC SPACES

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Abstract

The fixed point results for condensed Kannan-type contraction in the metric space setting exist in the literature. But then, there are some nonlinear operators that could not be examined in the standard metric structures. Taking this approach forward, we introduce the notion of qpb-cyclic condensed Kannna-type contraction mappings and establish fixed point results on them. The primary aim is to use the novelty approach in the framework of quasi partial b-metric space and to prove existence and uniqueness of fixed point theorem satisfying the qpb-condensed Kannan-type contraction maps. The results are affirmed with practical examples and applications.

Keywords: Condensed Kannan-type map, unique fixed point, non-unique fixed point, quasi-partial b-metric space; fixed point

THE THREE-BODY CLUSTER MODEL IN LIGHT NUCLEI: A REVIEW OF THEORETICAL FRAMEWORKS AND APPLICATION TO NEON-21

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Abstract

The nuclear cluster model represents an efficient approach to understanding nuclear structure. This model complements the shell model by emphasizing the role of nucleon correlations. While two-body cluster models have been extensively explored, the three-body cluster approach offers a more nuanced description for nuclei that do not conform to simple binary or alpha-particle aggregates. This paper provides a comprehensive review of the theoretical underpinnings, historical development and contemporary applications of the three-body cluster model, with a specific focus on light nuclei. The paper presents a survey of the landscape of cluster models, from the fully microscopic Resonating Group Method to the more phenomenological Buck-Dover-Vary (BDV) model, highlighting their respective strengths and limitations. A central case study is the nucleus Neon-21 recently observed to have an alpha-cluster resonance making it a prime candidate for a three-body description as Oxygen-16 core, an alpha particle and a valence neutron. We detail the mathematical formulation of the three-body problem, including the choice of the Jacobi coordinates, effective nucleon-nucleon potentials and methods for solving the Schrodinger equation. The review concludes by synthesizing the expected outcomes and future directions for this field arguing that the three-body cluster model is a powerful and computationally viable tool for probing the structure of light, odd-A nuclei near the drip lines.

Keywords: Nuclear cluster model, Three-body problem, Light nuclei, Neon-21, Nuclear structure

DAILY $PM_{2.5}$ ESTIMATION ACROSS NIGERIA USING SATELLITE AND MACHINE LEARNING APPROACHES

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Abstract

Accurate estimation of fine particulate matter ($PM_{2.5}$) remains a major challenge across Nigeria and West Africa due to sparse regulatory monitoring. This study develops a multi-model satellite meteorology chemistry fusion framework for daily $PM_{2.5}$ estimation across the Sahel, Savannah, and Guinea Coast climatic zones. Ground-based $PM_{2.5}$ observations from seven monitoring locations (Abuja, Anyigba, Ibadan, Benin City, Lagos Lekki, Calabar, and Maiduguri) were integrated with satellite aerosol optical depth (AOD), reanalysis meteorology, and trace gas proxies (NO_2, SO_2, and O_3). A physically informed feature set was constructed, incorporating AOD-humidity interactions, seasonal harmonics, meteorological drivers, combustion and photochemical indicators, and temporal persistence through lagged $PM_{2.5}$, while avoiding predictor leakage. Four models ordinary least squares (OLS), Random Forest (RF), Extreme Gradient Boosting (XGBoost), and Long Short-Term Memory (LSTM) were trained and evaluated using time-aware cross-validation, seasonal stratification, and regional aggregation. Machine learning models substantially outperformed linear regression by capturing nonlinear aerosol meteorology interactions and seasonal variability. RF and XGBoost showed the strongest and most consistent performance across regions (R^2 = 0.72-0.75; RMSE = 11-13 μg m^{-3}), while LSTM captured temporal structure but was sensitive to sample size. OLS coefficients revealed physically interpretable relationships, including positive associations with AOD and NO_2 and negative modulation by wind speed and humidity. Regional results indicate stronger dust influence in the Sahel and humidity-driven aerosol variability along the Guinea Coast. This framework offers a scalable, physics-consistent approach for $PM_{2.5}$ exposure assessment in data-sparse regions of West Africa.

Keywords: meteorology, model, West Africa

A STUDY OF ANALYSIS OF VARIANCE AND MIXED EFFECT MODEL FOR SPLIT-PLOT DESIGN USING SIMULATED DATA

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ABSTRACT

Split-plot designs are widely utilized in experimental research, particularly when factors are applied at different levels of experimental units, such as in agricultural or industrial studies. This project investigates the analysis of split-plot designs using simulated data to evaluate the effectiveness of statistical methods under controlled conditions. Simulated datasets were created to represent a typical split-plot experiment, incorporating one whole-plot factor and one subplot factor with realistic error structures and treatment effects. The data were analyzed using analysis of variance (ANOVA) and mixed-effects models to assess their ability to estimate parameters and detect significant effects. Findings demonstrate that both methods successfully identify significant effects, with mixed-effects models providing greater flexibility in accommodating complex error structures. However, the analysis also reveals that these methods are sensitive to violations of assumptions, such as normality and variance homogeneity, emphasizing the need for careful model specification. This study offers practical guidance for researchers, enhancing the understanding and application of split-plot designs in experimental research.

Keywords: ANOVA, split-plot, mixed-effect, data, homogeneity

SMOTEGAN AND TABNET: A HYBRID FRAMEWORK FOR DETECTING PUMP-AND-DUMP SCHEMES IN CRYPTOCURRENCY MARKET

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Abstract

This paper presents a novel approach for detecting pump-and-dump (P&D) schemes in cryptocurrency markets, a critical challenge for cybersecurity due to the substantial financial losses inflicted on investors. Traditional detection methods struggle with the evolving tactics of these manipulative practices and the inherent class imbalance in transaction data, where legitimate trades significantly outnumber P&D events. We propose a hybrid model leveraging Generative Adversarial Networks and TabNet to address these limitations. Specifically, we employ a smoteGAN to generate synthetic P&D samples, augmenting the dataset and mitigating the class imbalance. These synthetic samples are then combined with real transaction data to train a TabNet model, chosen for its suitability in analyzing tabular data and its ability to capture complex feature interactions through a sequential attention mechanism. We evaluate the performance of our smoteGAN + TabNet model on 25-second chunks of cryptocurrency pump transaction data, comparing it against existing detection methods. The model achieves a precision of 98%, recall of 83%, and F1-score of 90% for P&D detection, outperforming state-of-the-art methods like C-LSTM (94% precision, 89.3% F1-score) and Random Forest (95% precision, 88.8% F1-score). The model demonstrates exceptional confidence, with prediction probabilities exceeding 99% for normal and fraud instances, highlighting its robustness in distinguishing between classes. This research contributes an effective solution for enhancing cybersecurity in the cryptocurrency ecosystem by improving the detection of market manipulation and promoting a more secure trading environment.

Keywords: Cryptocurrency, Pump-and-dump, Fraud Detection, TabNet, SmoteGAN

SUBTHEME 3: EARTH ENVIRONMENTAL AND GEOSPATIAL SCIENCES

(MO + N) AND (W+N) CO-DOPING AS A NOVEL STRATEGY FOR $BATIO_3$ PIEZO-PHOTOCATALYTIC SYSTEMS ($BATIO_3$-PPS): A DFT INVESTIGATION OF ENHANCED WATER SPLITTING IN THE UV-VIS SPECTRUM

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Abstract

In this work, we investigated the potentials of ((Mo+N)) and ((W+N)) based $BaTiO_3$ for efficient hydrogen production by water splitting via DFT approach. Induced strain and chemical co-doping of ((Mo+N)) and ((W+N)) significantly affects the electronic structure, band gap, and defect chemistry of the systems involved, enhancing visible light absorption and piezo-photocatalytic activity. Initially, ((Mo+N)) co-doped $BaTiO_3$ exhibits superior performance because of low overpotential and a redshift in absorption up to 401 nm. However, strain-induced band gap widening and increased energy barriers declined its efficiency. Conversely, piezoelectric response of ((W+N)) co-doped variant is maintained and stabilized across 400–600 nm, which balances energy loss and strain generation. Aspect of polarization revealed strain-sensitive ferroelectric features, coupled by symmetric and asymmetric patterns influencing charge separation. Notably, both co-doped systems exhibit high remanent polarization loops post-field removal, indicating strong internal electric fields. Optimal strain conditions are 0.00% for ((Mo+N)), all ranges for ((W+N)), and 0.04% for pure $BaTiO_3$. These findings bring out the tunable piezo-photocatalytic potentials of ((Mo+N)) and ((W+N)) co-doped $BaTiO_3$ for efficient water splitting applications.

Keywords: Piezo-photocatalysis; water splitting; hydrogen energy; remanent polarization; overpotential

EFFICACY OF *CARICA PAPAYA* LEAF POWDER AS A BIO-SORBENT FOR HEAVY METAL REMEDIATION IN AQUEOUS SOLUTIONS: A LABORATORY INVESTIGATION

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Abstract

Heavy metal contamination in industrial effluents and water bodies remains a critical environmental challenge, exacerbating toxicity in ecosystems and human health. This study evaluates the biosorption potential of *Carica papaya* leaf powder (CPLP) as an economical, biodegradable alternative for removing Pb^{2+}, Cd^{2+}, and Cu^{2+} ions from synthetic wastewater, aligning with sustainable pollution control technologies. Fresh papaya leaves were collected, and processed to obtain CPLP. Batch experiments were performed in 250 mL Erlenmeyer flasks using 100 mL metal solutions. Variables included pH (2-8, adjusted with 0.1 M HCl/NaOH), contact time (0-180 min), adsorbent dosage (0.5-4 g/L), and initial metal concentrations (20-200 mg/L). Post-adsorption, solutions were filtered, and residual metal levels were. Adsorption data were fitted to kinetic models and isotherms. Surface characterization employed scanning electron microscopy (SEM) and Fourier-transform infrared spectroscopy (FTIR). Results indicated optimal pH of 5.5-6.5 for all metals, with equilibrium achieved within 90 min. Pseudo-second-order kinetics best described the process (R^2 > 0.98), suggesting chemisorption dominance. Langmuir isotherm fitted well, yielding maximum capacities of 52.3 mg/g (Pb^{2+}), 41.7 mg/g (Cd^{2+}), and 35.9 mg/g (Cu^{2+}). Removal efficiencies reached 92% for Pb^{2+}, 87% for Cd^{2+}, and 84% for Cu^{2+} at 100 mg/L initial concentration and 2 g/L dosage. FTIR revealed shifts in -OH and -COOH peaks post-adsorption, confirming ion binding. SEM showed increased surface porosity after metal loading. Overall, CPLP exhibits superior biosorption efficacy, driven by functional groups and high surface area, offering a green technology for heavy metal pollution control.

Keywords: Heavy metal, pollution control, *Carica papaya* leaf, Adsorption.

GEOCHEMICAL ASSESSMENT OF SOILS OVER MAFIC INTRUSIONS IN PARTS OF BIDA SHEET 184NE, NORTH-CENTRAL NIGERIA

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Abstract

The geochemistry of soils developed over a NW–SE-trending mafic intrusion and other lithologies in Garatu area, part of Bida Sheet 184NE, Nigeria was investigated to evaluate elemental distribution patterns and their implications for environmental quality. Detailed geological mapping, accompanied by soil sampling and laboratory determination of physicochemical parameters and bulk elemental composition, was the methodology adopted for this work. The results show that the area is mainly underlain by gneisses, intruded by gabbroic diorite that forms a prominent ridge, and granite. The soils are moderately acidic (mean pH 5.35) and exhibit pronounced enrichment in Fe_2O_3 (26.51 %), Cr (mean 558.19 ppm), and V (mean 328.75 ppm) near the mafic ridge. Similarly, inorganic carbon content of the soils is elevated on and near the mafic ridge compared to that overlying the gneiss and granite lithologies. This may indicate the formation of authigenic carbonates in the soils due to the consumption of atmospheric carbon dioxide (CO_2) during the weathering of ferromagnesian minerals. The computed chemical index of alteration (CIA) and the Alumina-Calcium-Sodium-Potassium (ACNK) plot reveal advanced chemical alteration under tropical conditions, while spatial distribution maps confirm the correspondence between mafic lithology and elemental enrichment. These findings provide the first detailed geochemical baseline for soil in the area, establishing a direct link between the parent rock composition and soil chemistry, which is crucial for future environmental and human health risk assessments.

Keywords: Geochemistry, Geogenic contamination, Heavy metals, Chemical weathering, Greenhouse gases

EFFECT OF SOME PROCESS PARAMETERS ON CATION-EXCHANGE PERFORMANCE OF CLAY MINERAL FOR REMOVAL OF LEAD(II) ION IN WASTEWATER

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Abstract

Water pollution by heavy metals, especially lead(II) ion (Pb^{2+}), remains a major environmental and public health challenge due to its toxicity, persistence, and bioaccumulation potential. This research examines the effects of pH, adsorbent mass, and contact time on cation-exchange performance of locally sourced clay from Abakaliki in Ebonyi State in removing pollutant (Pb^{2+} ions) in wastewater. A review of previous work highlighted the limitations of conventional treatment methods such as precipitation, membrane filtration, and chemical coagulation, emphasizing the potential of clay minerals as low-cost, sustainable adsorbents. Laboratory experiments were conducted using synthetic lead solutions. Batch adsorption studies were performed under controlled variations of pH (3–11), clay dosage (0.2–2.0 g), and contact time (15–120 min). The results showed that removal efficiency increased with higher pH and adsorbent mass, reaching optimal performance at pH 7 – 8 and at moderate dosage. Time-dependent studies revealed a multi-stage process consistent with pseudo-second-order kinetics and intraparticle diffusion, suggesting that chemisorption and pore diffusion both influenced uptake behavior. The findings revealed that clay from Ebonyi State is a promising, environmentally friendly, and cost-effective material for wastewater treatment, offering a sustainable alternative to expensive synthetic adsorbents and advanced wastewater purification technologies.

Keywords: wastewater; Pollutants; Adsorbent; Purification; Lead (ii) ion.

DEVELOPMENT OF ECO-FRIENDLY ADSORBENTS FOR REMOVING DYES FROM INDUSTRIAL EFFLUENTS

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Abstract:

The present study focused on the development of eco-friendly adsorbents for removing dyes from industrial effluents using biowastes as adsorbents, i.e., rice husk, coconut shell, sugarcane bagasse, and sawdust. The adsorption study was carried out using four different low-cost adsorbents derived from biowaste, specifically rice husk (RH), coconut shell (CS), sugarcane bagasse (SB), and sawdust (SD). The adsorbent materials were characterized using FTIR, UV Vis spectroscopy techniques. Kinetics and isothermal studies were also carried out to understand the mechanism of adsorption by fitting the data into various kinetic and isothermal models.The adsorption capacity was found to be between 1.5 and 2.2 mg/g for rice husk, coconut shell, sugarcane bagasse, and sawdust for dye removal. It was observed that sugarcane bagasse exhibited an excellent overall dye removal efficiency of 98.26 ± 2% for the dye mixture in 60 min. From a detailed kinetic investigation, it was concluded that the adsorption followed the pseudo-second-order model (R2= 0.99963 to 1 for different dyes and adsorbents) hinting at chemisorption. The isothermal studies demonstrated that the Langmuir adsorption model (R2 = 0.99416) was the best-fitted model, suggesting monolayer adsorption. The adsorption process was predicted to be governed by ion exchange, electrostatic interaction, hydrogen bonding, pi–pi interaction, etc., based on charge, functional groups, and pH of dyes and adsorbent. The results of this study show that sustainable biodegradable and renewable materials can be substitutes for traditional synthetic adsorbents. In alignment with the goals of global environmental sustainability, the advancement of green technologies foster cleaner industrial practices and strengthens pollution control initiatives..

Keywords: Agricultural by-products, dye removal, eco-friendly adsorbents, industrial effluents, sustainability.

EXPIRED PHARMACEUTICALS AS GREEN CORROSION INHIBITORS: EXPERIMENTAL AND DFT-BASED COMPARATIVE ASSESSMENT OF CHLOROQUINE PHOSPHATE AND DICLOFENAC POTASSIUM

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Abstract

This study presents a comparative investigation of two expired pharmaceutical compounds—chloroquine phosphate (CLQ) and diclofenac potassium (DFP)—as corrosion inhibitors for steel substrates in 1 M hydrochloric acid, representative of industrial acid-cleaning environments. Corrosion inhibition performance was evaluated using weight loss measurements, electrochemical techniques, and surface characterization methods, complemented by density functional theory (DFT) calculations to elucidate adsorption mechanisms. Both inhibitors exhibited concentration-dependent inhibition efficiencies exceeding 90% under optimal conditions, with CLQ achieving approximately 91% efficiency at 1 g L^{-1} and 25 °C, while DFP reached about 90% efficiency at 0.5 g L^{-1} across the investigated temperature range (25–60 °C). Potentiodynamic polarization analyses indicated mixed-type inhibition behavior for both compounds. Adsorption studies revealed that DFP follows the Langmuir isotherm, forming a relatively uniform protective monolayer, whereas CLQ displayed enhanced surface coverage with increasing temperature, suggesting improved molecular mobility and defect-filling on the metal surface. Surface analyses (SEM, EDS, 3D profilometry, and FTIR) confirmed the formation of protective films that significantly reduced surface degradation after prolonged exposure. DFT results showed that adsorption for both inhibitors involves synergistic physisorption and chemisorption, primarily mediated by aromatic and amine functional groups, as supported by HOMO, LUMO, and molecular electrostatic potential analyses. The strong agreement between experimental and computational findings underscores the effectiveness of both expired pharmaceuticals as corrosion inhibitors. Overall, this comparative study demonstrates that repurposed pharmaceutical waste can provide efficient, cost-effective, and environmentally sustainable solutions for corrosion control in industrial systems such as pipelines, heat exchangers, and desalination units.

Keywords: Corrosion inhibition, Expired pharmaceuticals, Acidic media, Density functional theory, Green inhibitors

INVESTIGATION OF GEOMAGNETIC STORM FROM MAY 10TH - 11TH 2024 USING WAVELET POWER SPECTRUM

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ABSTRACT

This paper examines the variability of geomagnetic storm on 10–11 May 2024 using wavelet power spectrum from five INTERMAGNET observatories spanning auroral to mid-latitude regions: Uppsala (Sweden), Abisko (Sweden), Belsk (Poland), Budkov (Czech Republic), and Lviv (Ukraine). At high-latitude auroral sites, Uppsala and Abisko recorded the most intense and broadband disturbances, with peak powers exceeding 1500 mm^2 and 800 mm^2 respectively, extending up to 0.25 Hz and persisting for many hours. These signatures reflect substorm activity, auroral intensification, and delayed magnetospheric recovery. At mid-latitude, Belsk exhibited intermediate activity, with power up to 550–580 mm^2, while Budkov showed moderate intermittent bursts (350–380 mm^2) that decayed more quickly. Lviv, the lowest-latitude site, experienced the weakest and briefest fluctuations, with maxima below 320 mm^2, confined to the 0.05–0.1 Hz band. Despite differences in magnitude, all stations displayed synchronous enhancements late on 10 May, again between 22–28 hours, and around 32–36 hours on 11 May, confirming a common solar wind driver. Across all sites, storm activity was dominated by Pc4–Pc5 ULF pulsations (0.05–0.1 Hz), with higher frequencies appearing only in the auroral zone. Overall, the results confirm that geomagnetic storm impacts were strongest, most persistent, and broadband at high latitudes, while becoming weaker, shorter-lived, and narrower in frequency toward mid- and low-latitudes. These findings highlight the critical role of auroral observatories in capturing storm-time magnetosphere–ionosphere dynamics, while mid- and low-latitude stations reflect the attenuation of geomagnetic disturbances with distance from the auroral oval.

Keywords: Geomagnetic storm, wavelet, spectrum

Fe_3O_4 COUPLED TO MIL-100(FE)@PDA FOR THE PREPARATION OF COMPOSITES WITH ENHANCED PHOTO-FENTON DEGRADATION OF CIPROFLOXACIN

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Abstract

Improving the rapid generation and conversion of Fe(II) to Fe(III) is crucial for addressing the challenging recycling and reuse of Iron-metal organic frameworks (Fe-MOFs) when applied to wastewater treatment, thereby enhancing their performance in photo-Fenton activities. The combined utilization of Magnetite (Fe_3O_4) and a sustainable polymer matrix, such as polydopamine (PDA), can effectively address these challenges. Here, Fe_3O_4-coupled MIL-100(Fe)@PDA composites were synthesized at different weight loadings, and their changes in physico-chemical structures and photo-electrochemical properties were investigated. As a photo-Fenton catalyst, the composites could efficiently activate H_2O_2 to degrade ciprofloxacin (CIP) in water, and achieved 81% degradation efficiency within 40 min. Notably, the Fe_3O_4-coupled MIL-100(Fe)@PDA composite evidenced broad pH applicability, good reusability, and the microstructure was maintained after five cycles, demonstrating excellent sustainability for applications in a practical aquatic environment. The active reactive oxidative species (ROS) involved in the removal of CIP in the photo-Fenton pathway were •OH, h^+, and •O2-, which were confirmed through free radical quenching experiments and electron paramagnetic resonance analysis.

Keywords: Iron-metal organic framework, sustainable, Photo-Fenton catalysis, ciprofloxacin

EFFECT OF BUILDING MATERIALS – TYPE ON INDOOR TEMPERATURE

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Abstract

This paper presents the study of inner and outer temperature, the survey was done in Nkaliki - Unuhu in Abakaliki, Nigeria. Two types of buildings were used for the study: mud block with thatch roof and mud block with corrugated iron sheet roof. The outer and inner temperature was taken at interval of 30 min for a period of three months. Our results indicate that the inner room temperature for the thatch roof was lower than that of the corrugated iron sheet roof. Hence, a thatched roof can be used to minimize the temperature of inner room during the higher temperature period of the day thereby serving as an alternative to the conventional air- conditioning system which is expensive.

Keywords: Indoor, thatched, temperature, corrugated, mud block

EXTRACTION AND CHARACTERIZATION OF NANOCELLULOSE FROM PINEAPPLE PEELS FOR SUSTAINABLE PAPER APPLICATIONS

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Abstract

The search for sustainable alternatives to wood-based paper has accelerated interest in nanocellulose derived from agricultural waste. This study reports the extraction and characterization of nanocellulose obtained from pineapple (*Ananas comosus*) peels using sequential alkaline delignification, bleaching, and acid hydrolysis. FTIR confirmed the removal of lignin and hemicellulose, while SEM revealed nanoscale fibrillar structures. XRD analysis showed an increase in crystallinity from 67.09% to 69.4%, indicating the successful formation of cellulose nanocrystals. The nanocellulose recorded a yield of 5.7%, bulk density of 0.55 g/mL, and a water retention capacity of 0.25 g/g. These results demonstrate that pineapple peel-derived nanocellulose possesses desirable physicochemical and structural properties suitable for sustainable paper production. The study highlights a viable approach to converting agro-waste into value-added biomaterials for circular economy applications.

Keywords: Nanocellulose, Pineapple Peels, Agro-Waste, Valorization, Characterization

MOLECULAR DOCKING AND *IN-VITRO* STUDIES OF GC-MS PROFILED EXTRACT OF STEM BARK EXTRACTS OF *FICUS SYCOMORUS* AS A POTENTIAL ANTIBACTERIAL AGENT

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ABSTRACT

The increasing resistance of bacteria to conventional antibiotics has become a major global health concern, prompting the exploration of alternative therapeutic sources. *Ficus sycomorus* has long been recognized for its medicinal properties, particularly its antimicrobial potential. In this study, the ethyl acetate and acetone extracts of *Ficus sycomorus* was subjected to GC-MS analysis to identify its bioactive compounds. *In-vitro* antibacterial activity of the extract was tested against selected pathogenic bacteria using standard microbiological techniques, To further understand the mechanism of action, molecular docking studies were conducted against key bacterial proteins. Phytochemicals with known biological activities such as heterocyclic members of triazole, pyrazole, 1, 3-Benzenedicarboxylic acid, imidazole, thiazole and bis (2-hethylhexyl) ester were detected. *In-vitro* antibacterial activity revealed different zones of inhibition comparable to conventional antibiotics and molecular docking studies against key bacterial proteins demonstrated strong binding affinities of major compounds with bacterial enzymes. This research not only reinforces the traditional use of *Ficus sycomorus* in medicine but also highlights its relevance in modern drug discovery.

Keywords: Antibacterial, *Ficus sycomorus,* GC-MS, molecular docking

ADSORPTIVE REMOVAL OF PHOSPHATE AND NITRATE FROM AQUACULTURE EFFLUENT USING A MELON SHELL-DERIVED ACTIVATED BIOCHAR

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ABSTRACT

The discharge of nutrient-rich effluents from aquaculture, especially fish ponds, it has known to specifically contain nitrate and phosphate, poses a significant environmental risk by contributing to eutrophication. This study investigates the development of a low-cost adsorbent, melon shell-activated biochar (MSAB), for removing these nutrients from fish pond wastewater. The adsorption potential of MSAB was evaluated through batch experiments. The effects of key parameters, including initial ion concentration, solution pH, contact time, temperature, and adsorbent dosage, on removal efficiency were investigated to determine optimum conditions. Adsorption equilibrium for both nitrate and phosphate was achieved within 240 minutes. The process was highly pH-dependent. The equilibrium data were best described by both the Langmuir and the Freundlich isotherm models, and the adsorption kinetics followed a pseudo-second-order mechanism. Thermodynamic analysis confirmed that the adsorption process was endothermic and spontaneous. In a practical application using real fish pond effluent (initial concentrations: 16.75 mg/L NO_3^- and 3.08 mg/L PO_4^{3-}), MSAB demonstrated exceptional removal efficiencies of 98.6% for nitrate and 100% for phosphate. The findings conclusively demonstrate that melon shell-activated biochar is a highly effective, sustainable, and economically viable adsorbent for the remediation of nitrates and phosphates from aquaculture wastewater, offering a promising solution for mitigating environmental pollution.

Keywords: Nitrate, Phosphate, Aquaculture wastewater, Melon shell, Activated biochar

ASSESSSMENT OF RADON CONCENTRATION IN GROUNDWATER SOURCES IN MUBI-NORTH METROPOLIS, ADAMAWA STATE, NIGERIA

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ABSTRACT

Radon is a natural alpha gas emitter, poses significant detrimental health risks when present in drinking water sources. This research assesses the Radon levels of concentration in groundwater in Mubi–North metropolis, Adamawa State, Nigeria, with a view to evaluate potential health implications for the local population. Water samples were collected from five different boreholes, in different sampling locations, the samples were analyzed with MPC2000–DP at center for energy research and training (CERT) Ahmadu Bello University, Zaria. Radon activity concentration were estimated from gross alpha activity concentration results in Bq/L. The results obtained for the five locations were ranged from 0.0082–0.1518 Bq/L. The results showed that location D recorded the highest Radon concentration, while location B recorded the least concentration. The concentration of Randon in all the sampling locations were below the recommended screening limit of 0.5Bq/L by world health organization (WHO) and other radiation protection agencies, therefore the water from the locations is good for drinking and domestic activities.

Keywords: Radon, Gross alpha, Groundwater, Concentration, Health risk

A KIBARAN OROGENIC FINGERPRINT IN THE WEST NIGERIAN SHIELD? U-PB-HF ISOTOPIC EVIDENCE FROM 990 MA XENOCRYSTIC ZIRCONS

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Abstract

The evidence for a Mesoproterozoic (ca. 1100 ± 200 Ma) Kibaran orogeny in the Nigerian Shield remains debated, as it is often obscured by later erosion and the widespread ca. 600 ± 150 Ma Pan-African tectonothermal overprint. Previous evidence, which relied heavily on Rb-Sr isotopes systematics, has proven inconclusive due to the method's susceptibility to post-crystallization disturbance. This study employs cathodoluminescence (CL) imaging and *in-situ* laser ablation inductively coupled plasma-mass spectrometry (LA-ICP-MS) microanalysis of zircon U-Pb-Hf isotopes to investigate the potential presence of Kibaran crust in the Bakoshi-Gadanya area of the West Nigerian Shield. Thirty-seven subhedral, non-corroded xenocrystic zircon grains yielded U-Pb ages from 940 to 1197 Ma, with a major age cluster at 990.7 ± 4.6 Ma. This age is consistent with the ca. 1100 ± 200 Ma Kibaran orogenic event. Their εHf values range from +1.0 to +13.0, indicating a mantle-derived isotopic signature for the source melt. The Hf model ages range from 1106 to 1455 Ma, with an average of 1232 Ma. The minimal disparity between the crystallization age (ca. 990 Ma) and the average model age (1232 Ma) suggests the zircons formed shortly after the extraction of their source material from the mantle. This indicates juvenile crustal addition during the mid-Mesoproterozoic, supporting the likely presence of a hidden Kibaran crustal component in this region of Nigerian Shield.

Keywords: Kibaran Orogeny, Trans-Saharan Belt, Bakoshi Gadanya, Nigerian Shield

CONTRASTING TIMING OF GOLD MINERALIZATION IN THE BAKOSHI-KUNDILA AREA, NORTHERN NIGERIA: EVIDENCE FROM U-PB ISOTOPIC CONSTRAINTS

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Abstract

Constraining the formation age of gold deposits relies on the geochronology of co-precipitated hydrothermal minerals. As with many gold deposits in the Nigerian Shield, the timing of formation of the Bakoshi-Kundila gold deposit in the Precambrian terrain of northern Nigeria remains a subject of ongoing research. This study used in-situ laser ablation inductively coupled plasma-mass spectrometry (LA-ICP-MS) microanalysis of co-precipitated zircon grains from the deposit to determine their U-Pb isotopic compositions and constrain the age of gold mineralization. Analyses of zircons from Au-bearing tourmalinite and a quartz-pyrite vein revealed three primary age groups: ~682 Ma, ~645 Ma, and a younger cluster between 610–606 Ma. The ~682 Ma age is coeval with the emplacement of the Yettiti granite (683 Ma) and is interpreted to represent an early, major period of granite-related, vein-type gold mineralization. The ~645 Ma age correlates with the intrusion of the Bakoshi porphyritic granite (646 Ma), which likely represents a second phase of gold mineralization. The youngest age group (610–606 Ma), from wallrock-hosted disseminated gold, is interpreted not as a distinct mineralizing event, but rather as reflecting a late metamorphic event. This event deformed earlier-formed pyrite and potentially reset the U-Pb isotopic system. This study concludes that gold formation at Bakoshi-Kundila occurred during multiple Neoproterozoic events. Mineralization initiated with a major Cryogenian (~682 Ma) magmatic-hydrothermal phase, was followed by a second Cryogenian (~645 Ma) hydrothermal phase, and was subsequently overprinted by Ediacaran (~610–606 Ma) metamorphism and deformation.

Keywords: Zircon U-Pb Isotopes, Gold Mineralization, Pyrite Texture, Nigerian Shield

2D VISCOACOUSTIC FULL WAVEFORM INVERSION (FWI) FOR IMAGING CO_2 SEQUESTRATION OF THE SLEIPNER FIELD NORTH SEA

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Abstract

Most full-waveform inversion methods carried out to image CO_2 accumulation in the thin layers of the Sleipner Field have typically ignored the effect of attenuation. This oversight can lead to less accurate imaging and characterization of the CO_2-bearing layers, as attenuation significantly impacts the amplitude and phase of seismic waves. Consequently, incorporating attenuation effects is crucial for improving the fidelity of subsurface models in such scenarios. To image both the velocity and attenuation of the CO_2 migration and accumulation of the Sleipner Field, we used the standard linear body theory which describes attenuation. This was used to derive a simplified viscoacoustic equation that characterizes amplitude attenuation and phase distortion. Unlike conventional equations that include memory variables, this simplified equation requires less memory during computation, making the implementation of attenuation compensation easier. The finite difference method is employed to solve the equations, with the attenuation terms addressed in the wavenumber domain and all other terms in the time-space domain. To stabilize the adjoint wavefield, robust regularization operators are applied to the wave equation, effectively eliminating the high-frequency components of numerical noise generated during the backward propagation of the viscoacoustic wavefield. Synthetic velocity models for pre-CO_2 and post-CO_2 injection scenarios in the Sleipner Field, North Sea, were generated. An empirical relationship was used to create the Q model. The results demonstrate that Full Waveform Inversion (FWI) can reconstruct the velocity and Q model of the Sleipner Field with enhanced resolution.

Keywords: Full-waveform, Viscoacoustic, Inversion, Attenuation, Finite Difference

SYNTHESIS AND CHARACTERIZATION OF OPTICAL PROPERTIES OF INORGANIC AND GREEN LEAF EXTRACY DOPED SnO THIN FILMS DEPOSITED USING SPRAY PYROLYSIS

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Abstract

Dye-sensitized Nanohybrid $Zn_xSn_yO_z$ thin films were deposited on glass substrates using spray pyrolysis method. The dye extract from the leaves of *tectona grandis* was used. A concentration of 0.1M of Zn^{2+} and 1% was used respectively. Depositions were carried out at different substrate temperature of 50°C, 100°C, and 150°C. The effect Zn^{2+} ion and dye extract from *tectona grandis* leaves on optical and solid state properties of the films were examined and analysed. The result showed that the absorbance of the undoped SnO thin films at various substrate temperatures vary from about 0.1-0.7. The absorbance generally increased with deposition/ substrate temperature exhibiting a maximum for films deposited at 150°C. The average transmittance of both un-doped and Zn^{2+} doped SnO thin films at 350nm is above 90% regardless of the film thickness. The dye doped samples showed an improvement in optical transmission at 625nm. The reflectance spectra of all films exhibited a similar trend. Peak reflectance was observed at 350nm for un-doped and Zn^{2+} doped samples of SnO thin films while peak reflectance can be observed at 625nm for dye doped samples. It is also observed that the band gaps of the dye doped samples are lower: 1.55eV-1.83eV than those of the Zn^{2+} doped samples: 1.60eV – 2.20eV. This showed that the incorporation of the dye shifted the fundamental absorption edge of the un-doped SnO thin films thus providing tuning effect of the band gap for device applications.

Keywords: Spray pyrolysis, Optical properties, Dopants and Temperature

SYNTHESIS OF CUO–ZNO/BANANA STALK–DERIVED ACTIVATED CARBON COMPOSITE FOR EFFICIENT REMOVAL OF CRESOL RED DYE FROM AQUEOUS SOLUTIONS

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Abstract

This research reports the synthesis and application of a CuO-ZnO composite supported on activated carbon derived from banana stalk as a sustainable and inexpensive adsorbent for the effective removal of Cresol Red (CR) from aqueous solution. The composite was characterised systematically by X-ray diffraction (XRD), Raman spectroscopy (RS), thermogravimetric and differential scanning calorimetry (TGA/DSC), and Bennet Emmet Teller (BET) analyses to elucidate its structural, surface and thermal properties. Batch adsorption studies were conducted to investigate the impact of initial dye concentration, adsorption dose, contact time, and solution pH on the CR removal rate. The maximum adsorption efficiency of 178.8 mg/g was achieved at pH 6 with an adsorbent dose of 0.01 g and an initial concentration of 100.0 mg/L. The adsorption kinetics were best described by a pseudo-second-order model, suggesting that chemisorption is the predominant rate-limiting mechanism. The equilibrium data were consistent with the Freundlich isotherm, indicating multilayer adsorption on a heterogeneous surface with high affinity for CR molecules. Overall, the results highlight the CuO-ZnO-banana carbon composite as a promising, environmentally friendly and cost-effective material for the remediation of dye-contaminated wastewater.

Keywords: Banana stalk, CuO-ZnO composite, activated carbon, adsorption, cresol red dye

PROXIMATE, MINERAL CONTENT, PHYTOCHEMICAL COMPOSITION, AND ANTIOXIDANT POTENTIALS OF JUSCTICIA SECUNDA HARVESTED FRESH FROM TWO LOCATIONS IN OYO STATE, NIGERIA

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Abstract

Juscticia secunda is one of the plants used in the treatment of numerous pathologies in traditional medicine. Environmental variations has effect on biochemical profile of plants, thereby affecting its nutritional and therapeutic potentials This study therefore evaluated the proximate, phytochemical, and mineral composition of *Juscticia secunda* obtained fresh from two different locations (JSVI and JSVE). The samples were authenticated, pulverized and subjected to standard methods of analysis. The results of Proximate analysis revealed comparable protein content in both samples (18.76 ± 0.04% in JSVI; 18.17 ± 0.04% in JSVE), while JSVE exhibited higher moisture (8.91 ± 0.12%) and fibre content (19.08 ± 0.54%). JSVI, however, showed greater carbohydrate (51.81 ± 0.78%) and lipid levels. Phytochemical screening indicated markedly higher phenolic (196.97 ± 3.03 mg/100 g), flavonoid (64.89 ± 4.68 mg/100 g), and cardiac glycoside contents in JSVI, suggesting stronger antioxidant potential relative to JSVE. Mineral analysis showed substantial spatial variation: JSVI had higher potassium, sodium, iron, zinc, and copper, whereas JSVE contained higher calcium (61.32 ± 0.07 mg/100 g) and magnesium (6.67 ± 0.01 mg/100 g). In conclusion, the biochemical composition of *Justicia secunda* varies significantly with location, with JSVI demonstrating superior phytochemical content and mineral diversity, while JSVE shows enhanced fibre and calcium content. These findings highlight the influence of environmental factors on the nutritional and medicinal quality of *J. secunda constituents*, providing a strong overview for ethnopharmacological applications and nutritive potentials of the selected samples.

Keywords: Justicia Secundah, Phytochemical Screening, Mineral Composition, Spatial Variation

DETERMINATION OF THORIUM RADIOACTIVITY CONCENTRATIONS FROM GROSS ALPHA RESULTS IN WATER SAMPLES FROM MUBI-NORTH METROPOLIS, ADAMAWA STATE, NIGERIA

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Abstract

The assessment of natural radionuclides in drinking water is vital for evaluating public exposure to radiological hazards. This study determines the level of thorium radioactivity concentrations from gross alpha measurements obtained from water samples collected across five sampling locations in Mubi-North metropolis, Adamawa State, Nigeria. A total of five borehole water samples were analyzed using a low-background gas-flow proportional counter for gross alpha activity determination at Center for Energy Research and Training (CERT) Ahmadu Bello University Zaria. The measured gross alpha values were used to estimate thorium concentrations based on established radiochemical correlation models. Results revealed that thorium concentrations varied from 0.0039 to 0.0728 Bq/L, with an average value of 0.0293Bq/L, which is below the World Health Organization (WHO) recommended limit of 0.5 Bq/L for radionuclides in drinking water. Spatial variation indicated slightly elevated thorium levels in the different sampling locations, likely influenced by underlying granitic formations known for thorium-bearing minerals. The computed alpha dose rates were within safe limits, suggesting minimal radiological risk to the population. The findings underscore the importance of continuous monitoring of natural radioactivity in water sources within Mubi-North to ensure long-term environmental safety and public health protection.

Keywords: Concentration, Gross alpha, water quality, evaluation, exposure

BIODEGRADATION OF CYANIDE BY *BACILLUS CEREUS* KAZSTA01 AND OPTIMIZATION OF CYANIDASE ACTIVITY USING RESPONSE SURFACE METHODOLOGY (RSM)

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Abstract

The persistent release of cyanide-laden effluents from agro-industrial sources such as cassava processing poses serious environmental and public health risks. Biological treatment approaches utilizing cyanide degrading enzymes, offer significant advantages over conventional treatment methods, eliminating the need for harsh chemicals. This study aimed to isolate, characterize, and optimize indigenous cyanide-degrading bacteria from cassava wastewater. Thirteen bacterial isolates were screened for cyanide tolerance on nutrient agar and on M9 minimal medium supplemented with 50 ppm KCN. Growth was monitored via OD_{600} readings, and the most promising isolates were further evaluated based on colony-forming units (CFU/mL) and cyanide degradation percentage using the pyridine-barbituric acid method. Biochemical and molecular characterization of selected isolates was performed, followed by optimization of enzyme production using Response Surface Methodology (RSM). Out of the 13 isolates, 1A1 (identified as *Bacillus cereus* KAZSTA01 accession number PV992696) exhibited the highest cyanide degradation efficiency of 83.5% and robust growth of 6.7 × 105 CFU/mL by day 5 at 50 ppm KCN. The RSM optimization predicted a maximum enzyme activity of 23.272 U/mL under optimal conditions (35.03°C, pH 8.457, 5.077 g/L carbon source, and 0.695 g/L nitrogen source), with a desirability of 1.000. The validation experiment produced an enzyme activity of 20.17 U/ml, which is closer to the predicted value of 23.272 U/ml. Baseline enzyme activity measured 12.95 U/ml under non-optimized conditions. Following RSM optimization, there was 1.56 fold increase in enzyme activity. The findings demonstrate the potential of *Bacillus cereus* KAZSTA01 as a strong candidate for the biological detoxification of cyanide-contaminated environments and optimization for future industrial-scale bioremediation strategies.

Keywords: Cyanide, Optimization, Bacillus, Biochemical pathway.

ASSESSMENT OF ENVIRONMENTAL RADIATION LEVELS IN FARMLANDS AND ITS HEALTH IMPACT IN SELECTED AREAS OF KOGI STATE, NIGERIA

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Abstract

Monitoring environmental radiation in farming areas is essential for protecting our food supply and the people who depend on it. The ambient gamma radiation levels across nineteen farmland sites in four local government areas of Kogi State, Nigeria has been investigated. A portable radiation inspection meter was used to determine the ambient radiation, a Global Positioning System (GPS), to determine the position coordinates of site selected. At each location, ambient radiation level was determined and average dose rates calculated. Our findings showed an average radiation level of 1.4833 mSv y^{-1}, with values ranging from 0.8766 to 5.1062 mSv y^{-1}. The highest reading was recorded in Ankpa. The average ADR, AEDR, R_{aeq}, $H_{ert.}$, $H_{int.}$, and ELTCR were; 79.4447± 12.87, 0.0975± 0.02, 174.7444± 30.89, 0.4720 ± 0.08, 0.6147 ± 0.10, and 0.3412 ± 0.06 respectively. According to international radiation protection standards, farmers and rural residents face no immediate health risks from current exposure levels. However, some isolated high readings warrant continued monitoring to prevent potential long-term risks. This study underscores the need for ongoing environmental surveillance and provides valuable baseline radiometric data for agricultural zones in Kogi State.

Keywords: Ambient, radiation, dose rate, excess lifetime cancer risk

ECOLOGICAL RISK ASSESSMENT OF HEAVY METALS EXPOSURE IN IRRIGATION WATER IN ZARIA CITY, KADUNA STATE, NIGERIA

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Abstract

The persistence and bio-accumulative nature of heavy metals make them a major ecological concern. This study assessed the ecological risk of heavy metal contamination in irrigation water within Zaria City, Nigeria. Water samples were collected during both the dry and wet seasons and analyzed using standard laboratory methods. Concentrations of chromium (Cr), lead (Pb), cadmium (Cd), and copper (Cu) were quantified using Atomic Absorption Spectrophotometry (AAS). Results revealed that during the dry season, the average concentrations (mg/kg) of metals followed the order: Cr (0.56) > Pb (0.36) > Cd (0.24) > Cu (0.15), while during the wet season, levels were slightly lower: Cr (0.46) > Pb (0.28) > Cd (0.20) > Cu (0.10). The ecological risk index (E_{ri}) indicated low risk for Cu and Cr (E_{ri} < 40), but very high risk for Pb and Cd (E_{ri} = 280–2400). The potential ecological risk index (PERI) classified the irrigation water as severely contaminated, with values of 2,783.15 in the dry season and 2,299.9 in the wet season. These findings reveal significant ecological and agricultural hazards linked to the use of contaminated water for irrigation. The study underscores the urgent need to raise farmers' awareness about the health and environmental implications of heavy metal pollution. It further calls for immediate intervention by governmental and regulatory agencies to enforce stricter control and management of wastewater discharges from domestic and industrial sources into water bodies.

Keywords: Heavy metals, AAS Analysis, Ecological Risk Index, Zaria City

HUMAN HEALTH RISK ASSESSMENT OF DIFFERENT DRINKING WATER SOURCES IN ZARIA METROPOLIS, NIGERIA

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Abstract

This study evaluated the potential health risks associated with heavy metals (Pb, Cr, Fe, and Cd) in drinking water from piped and borehole sources in Zaria, Nigeria. Water samples were collected following standard laboratory procedures and analyzed using Atomic Absorption Spectrophotometry (AAS). The assessment focused on estimating Chronic Daily Intake (CDI), Hazard Quotient (HQ), Hazard Index (HI), and carcinogenic risk for both adults and children. Results revealed that heavy metal concentrations varied across water sources, with piped water showing higher mean levels of Fe (0.78 mg/L), Cr (0.42 mg/L), Cd (0.26 mg/L), and Pb (0.23 mg/L). Iron concentrations in both water sources exceeded WHO permissible limits, while other metals were comparatively lower in borehole water. CDI and HQ values greater than 1 indicated significant non-carcinogenic risks, particularly among children exposed to chromium and iron in piped water. The overall HI values for both water sources exceeded the safe threshold of 1, suggesting potential adverse health effects for all age groups. Chromium posed the highest carcinogenic risk, followed by lead and cadmium, with borehole water showing a higher cumulative cancer risk. The study concludes that treatment and purification of piped water are essential to reduce iron and chromium levels to WHO standards. Continuous monitoring of metal concentrations, chromium speciation analysis, and public awareness campaigns on safe water practices are recommended to mitigate health risks, especially among children.

Keywords: Heavy Metal, Water Sources, Human Health Risk Assessment, Zaria Metropolis

MICROBIOLOGICAL SURVEILLANCE AND ANTIBIOTIC SUSCEPTIBILITY PROFILING OF VIBRIO CHOLERAE IN WATER SOURCES: A STRATEGY TO PREVENT CHOLERA OUTBREAKS AND SAFEGUARD NIGERIA'S ECONOMY

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Abstract

Cholera continues to pose a significant public health and economic burden in Nigeria, with recurrent outbreaks linked to unsafe water sources. Effective microbiological surveillance of Vibrio cholerae in drinking water, coupled with antibiotic susceptibility assessment, is essential for outbreak prevention and informed treatment strategies. This study investigated the occurrence of V. cholerae in selected water sources and assessed their antibiotic resistance profile to guide public health interventions. A total of 120 water samples were collected from rivers, boreholes, streams, and open wells across cholera-endemic communities. Samples were analyzed using culture on thiosulfate-citrate-bile salts-sucrose (TCBS) agar, biochemical tests, and serological confirmation. Antimicrobial susceptibility testing was performed using the Kirby–Bauer disk diffusion method against commonly prescribed antibiotics, including tetracycline, ciprofloxacin, azithromycin, ampicillin, and cotrimoxazole. Results showed that 32% (38/120) of the samples were contaminated with V. cholerae, with the highest prevalence in open wells (45%) and streams (41%). Serogrouping confirmed the dominance of V. cholerae O1 El Tor biotype. Antibiotic susceptibility testing revealed high resistance to tetracycline (65%), ampicillin (72%), and cotrimoxazole (58%). Moderate resistance was observed against azithromycin (39%), while ciprofloxacin remained the most effective, with 82% sensitivity. Multidrug resistance (MDR) was identified in 68% of isolates. The findings underscore the dual threat of contaminated water sources and rising antibiotic resistance in the persistence of cholera outbreaks. Routine microbiological surveillance, including antibiotic resistance monitoring, provides critical early warning signals for targeted interventions such as chlorination of water, improved sanitation, and revision of treatment guidelines. By reducing the incidence and severity of cholera epidemics, Nigeria can safeguard its economy, protect workforce productivity, and enhance national health security.

Keywords: Vibrio cholerae, microbiological surveillance, antibiotic resistance, Nigeria, economic stability

COMPARATIVE ANALYSIS OF CONCRETE STRENGTH UTILIZING QUARRY CRUSHED AND LOCALLY SOURCED COARSE AGGREGATES IN JOS METROPOLIS

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ABSTRACT

This study evaluated and compared the strength and physical properties of concrete produced using machine-crushed and hand-crushed coarse aggregates sourced from different locations within Jos Metropolis, Plateau State, Nigeria. The research was motivated by the increasing use of non-standard hand-crushed aggregates in local construction, which often results in inconsistent concrete quality and premature structural failure. Aggregates were obtained from three machine-crushed sources PW Quarry (Jos South), RicRock Quarry (Jos East), and Moulds Quarry (Jos East) and three hand-crushed sources located at Tudunwada (TW), Building Materials Market (BM), and Domkat Bali (DB). Laboratory analyses were conducted to determine the geological, physical, and mechanical properties of the aggregates using standardized procedures (BS 410, BS 812, and BS EN 12620). Results from sieve analysis revealed that machine-crushed aggregates conformed to BS EN 12620 grading limits, with 95–96% passing the 20 mm sieve and 54–58% passing the 12.5 mm sieve, while hand-crushed aggregates exhibited slightly coarser gradation. The Los Angeles abrasion values ranged from 21.6% to 23.4% for machine-crushed and, 26.8% to 28.5% for hand-crushed aggregates; indicating higher resistance to wear in the former. The Aggregate Impact and Crushing Values were lower for machine-crushed (AIV: 17.5–18.9%; ACV: 19.2–20.4%) compared to hand-crushed (AIV: 21.7–23.1%; ACV: 23.4–24.9%), confirming better mechanical performance. Compressive strength tests showed that machine-crushed aggregates achieved 28-day mean strengths of 28.6 MPa (PW), 29.1 MPa (RicRock), and 27.4 MPa (Moulds), while hand-crushed aggregates recorded 23.7 MPa (TW), 24.0 MPa (BM), and 22.5 MPa (DB). The study concludes that machine-crushed aggregates yield superior and more consistent concrete quality due to their uniform particle size distribution and reduced flaky content. It is therefore recommended that machine-crushed aggregates be prioritized for structural concrete works, while hand-crushed aggregates may be limited to non-structural applications.

Keywords: Machine-crushed aggregate, Hand-crushed aggregate, concrete strength, Aggregate mechanical properties, Los Angeles abrasion

SEASONAL VARIATIONS IN SOIL HEAVY METAL POLLUTION OF A PB-ZN MINING SITE AT ABAKALIKI, SOUTHEASTERN NIGERIA

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Abstract

The study investigates the seasonal variations in heavy metal contamination of soils at a Lead-Zinc mining site in Abakaliki. Heavy metal levels were analysed using inductively coupled plasma-mass spectrometry while health and ecological risks were evaluated using standard models. Spatial distribution was assessed using geospatial mapping. The average metal levels across both seasons followed the order: Fe>Pb>Mn>Zn>Cr>Cu>Ni>Co>Cd. While mean concentrations of Ni and Co aligned with World Health Organization and Department of Petroleum Resources' Cu, Fe, Cd, Cr, and Pb exceeded both regulatory and background thresholds. Health risk models revealed significant non-carcinogenic risk for Cu, Mn, Co, Fe, Cr, and Pb, and carcinogenic risk for Cr and Pb across both seasons and exposure groups. Geospatial mappings recorded minimal seasonal variations for Zn hotspots, but high variability for Fe. The results revealed significant seasonal fluctuations in metal concentrations, with higher levels typically recorded during the dry season. Conversely, the rainy season showed a relative decline in metal concentration. This study sheds light on how changes in seasons affect metal pollution patterns in areas affected by artisanal mining. The findings help improve risk assessments, support efforts to protect public health, and guide policies that promote safer and more sustainable mining practices globally.

Keywords: Mining, Metal pollution, Risk assessments, Toxic metal

UNDERSTANDING THE ROLE OF AURORAL ELECTROJECTS IN SPACE WEATHER DYNAMICS DURING SOLAR CYCLE 24

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ABSTRACT

This study investigates the occurrence and behaviour of auroral electrojets (AE) over the course of solar cycle 24 (2011–2022), with the aim of understanding their role in space weather dynamics. In this research, the AE index is analysed in conjunction with the Disturbance Storm Time (Dst) index, Interplanetary magnetic field (Bx, By, Bz) and sunspot data. Data of these indices were obtained from NASA's OMNI WEB database. Major geomagnetic storm events were identified based on Dst values less than -100nT. A time-series plots, 3D plots and statistical correlation were performed to evaluate the relationship between AE activity and storm intensity. A moderate to strong negative correlation was observed between AE and Dst indices during storm periods, suggesting that auroral electrojet enhancement is a reliable indicator of space weather strength.

Keywords: Auroral Electrojects, Solar Cycle, Space Weather, Interplanetary Magnetic Field, Storm Intensity

CLIMATE-CHANGE TRENDS ACROSS WEST AFRICA USING GEOPHYSICAL TECHNIQUES: A REVIEW

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Abstract

Climate change is like a major disruption to our planet's weather patterns. It is as a result of rising temperatures, mainly due to greenhouse gases like carbon dioxide (CO2) from burning fossil fuels and deforestation. In Africa, climate change is having a huge impact like Droughts and water scarcity, Floods and displacement, Impact on agriculture, Health impacts. In Nigeria specifically, climate change is affecting the Lake Chad Basin, leading to water scarcity, loss of livelihoods, and displacement of communities. This review synthesizes Geophysical observations (satellite gravimetry — GRACE/GRACE-FO, SAR/InSAR, GNSS, satellite soil-moisture missions like SMAP, multispectral/thermal remote sensing, and ground geodetic/groundwater monitoring) applied to climate-change assessment in West Africa (roughly Senegal–Nigeria–Ghana–Mali–Burkina Faso region). Key regional trends emerging from multiple independent geophysical datasets since 2019 include: intensifying hydrological extremes (droughts and episodic floods), declining terrestrial water storage and groundwater in many basins, accelerating coastal hazards compounded by subsidence and sea-level rise, shifting vegetation/land-cover patterns, and increasing heat wave frequency and intensity. Geophysical tools deliver complementary, often region-wide, measurements that are essential where in-situ networks are sparse. Major gaps remain in spatial resolution of some satellite gravimetry products, integration with local hydrogeological models, and seamless multi-sensor fusion for operational monitoring. This review recommends coordinated multi-technique monitoring, improved downscaling methods (for GRACE/GRACE-FO and SMAP), and sustained GNSS/InSAR networks in coastal cities to support adaptation planning.

Keywords: Climate change, West Africa, Geophysics, Temperature, Adaptation

SATELLITE-BASED MULTI-POLLUTANT ASSESSMENT OF PERSISTENT AIR QUALITY AND HEALTH RISKS IN OSHODI, NIGERIA (2019–2024)

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Abstract

Rapid urbanisation in sub-Saharan African cities has intensified concerns about deteriorating air quality and its associated health risks. However, multi-pollutant assessments that capture public health risks remain limited, particularly in dense transport and commercial hubs such as Oshodi in Lagos. This study examined the annual concentrations of atmospheric pollutants in Oshodi from 2019 to 2024 and evaluated the associated trends, classifications and health implications. Annual satellite-derived concentrations of nitrogen dioxide (NO_2), ozone (O_3), formaldehyde (HCHO), carbon monoxide (CO) and the UV Aerosol Index (UVAI) were processed and computed. Descriptive statistics, Mann-Kendall trend tests, and Air Quality Index classifications were utilised to evaluate the levels of pollutants and their potential health impacts. Results from this study indicated a continuous rise in the concentrations of various pollutants, including NO_2 (from 18.75 µg m^{-3} to 22.21 µg m^{-3}), O_3 (from 0.120 ppm to 0.122 ppm) and HCHO (from 203.35 µg m^{-3} to 231.50 µg m^{-3}). There was also a slight increase in the UVAI (from 0.35 to 0.37) and in CO (from 0.051 to 0.055 ppm). These findings underscore the ongoing public health concerns and highlight the necessity for enhanced monitoring quality, source identification, and targeted emission controls.

Keywords: Air Quality Index (AQI), Public Health, Sentinel-5P, Oshodi, Urban growth

SUSTAINABLE WATER MANAGEMENT STRATEGIES IN PARTS MINNA METROPOLIS SHEET 164, NORTH-CENTRAL NIGERIA

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Abstract

Groundwater represents the dominant source of domestic water supply in Minna Metropolis, North-Central Nigeria, yet the increasing abstraction pressure and poor recharge protection threaten long-term sustainability. This forces over 60% of residents to rely on unregulated private boreholes and hand-dug wells, creating a significant and unsustainable imbalance between groundwater abstraction and natural recharge. To develop effective mitigation strategies, a detailed hydrogeological investigation was conducted. This study involved geological mapping on a 1:12,500 scale and a comprehensive hydrogeological inventory of 117 hand-dug wells. Analysis of well data (e.g., elevation, water level, well depth) was used to plot a water elevation map, which revealed the area's flow dynamics. The investigation confirmed the area is a weathered and fractured basement complex, primarily granite, which occupies over 90% of the terrain. Most importantly, the study successfully delineated the primary groundwater recharge zones, located around Tundun Fulani and Maitunbi, and the major discharge area in Kpakungu and its environs. Given the shallow overburden of 0.5-1m and water levels ranging from 0.9-10.3m, the aquifers are highly vulnerable. Based on these findings, a two-pronged sustainable management strategy is proposed: first, the implementation of protective land-use policies to prevent industrial contamination of the vital recharge zones, and second, the siting of Managed Aquifer Recharge (MAR) wells within the discharge areas to artificially replenish the overexploited aquifers.

Keywords: Groundwater, Abstraction, Recharge, Discharge, Minna

A REVIEW OF SILURIAN SHALE GAS POTENTIAL IN NORTH AFRICA'S PALEOZOIC BASINS: GEOLOGICAL FRAMEWORK, RESOURCE ASSESSMENT, AND SUSTAINABILITY OUTLOOK

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Abstract

North Africa possesses a complex geological history characterized by diverse tectonic settings and prolific petroleum systems that include both conventional and unconventional hydrocarbon resources. In recent decades, increasing attention has been directed toward shale gas exploration, particularly within the region's Paleozoic basins, where the Silurian "Hot Shale" serves as a primary source rock. This review evaluates the shale gas potential of North Africa's key sedimentary basins, Ghadames, Berkine, Jeffara, Murzuk, and Chotts, through an integrated synthesis of published literature, industry data, and geochemical analyses. The Silurian units, notably of Rhuddanian, Ludlow–Pridoli, and Frasnian ages, exhibit elevated total organic carbon (TOC), favorable hydrogen indices, and brittle mineral assemblages conducive to hydraulic fracturing. Variations in depositional environments, structural history, and thermal maturity reflect basin-specific heterogeneity that influences exploration strategies. The study also examines environmental challenges associated with shale gas development, including groundwater contamination, methane leakage, and induced seismicity. Identified research gaps include the absence of basin-wide geochemical and petrophysical modelling, real-time environmental monitoring, and standardized data frameworks. Future research should emphasize carbon capture and utilization (CCU) applications in depleted shale reservoirs and numerical well modelling for sustainable development. This review provides a comprehensive framework for advancing shale gas exploration in North Africa through integrated and environmentally responsible approaches.

Keywords: Shale gas, Silurian Hot Shale, North Africa, Paleozoic basins, Sustainable exploration

GEOCHEMICAL CHARACTERIZATION OF ROCKS WITHIN FAULT ZONES FOR MINERALIZATION POTENTIALS IN IKARA SHEET 103, NORTHWESTERN NIGERIA

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Abstract

The fault zones within Ikara Sheet 103 are extensive, with about five identified major fault lines. The prominent lithologies on which these faults occur are migmatitic gneiss, porphyroblastic gneiss, porphyritic granite, and quartzite (which are prominent signatures indicating the occurrence of faults). The geochemistry of these rocks was obtained by Neutron Activation Analysis (NAA) at the Centre for Energy Research and Training, Zaria. Large Ion Lithophile Elements and the Rare Earth Elements (REEs) were used to analyse the mineralisation potential of these rocks within these zones. These lithologies in the study area exhibit enrichment and depletion of LILEs and their ratios based on their average concentrations. The average concentrations of K, Rb, Ba, and Sr within the fault/sheared zones that cross-cut the porphyritic granite are: 5%; 183 ppm; 945 ppm; and 238 ppm, respectively; in migmatitic gneiss: 7%; 205 ppm; 822 ppm; and 0 ppm; in porphyroblastic gneiss: 3.4%; 322 ppm; 890 ppm; and 185 ppm; and in the quartzite: 0.4%; 35.5 ppm; 0 ppm; and 0 ppm. The average concentrations of K/Rb; K/Ba; Ba/Rb; and Rb/Sr in the porphyritic granite are: 273 ppm, 53 ppm, 5.2 ppm, and 0.7 ppm, respectively; in migmatitic gneisses: 341 ppm, 85 ppm, 4 ppm, and 0 ppm; in porphyroblastic gneiss: 80-150 ppm, 15-40 ppm, 3-10 ppm, and 1.5-8.0 ppm; and in the quartzite: 114 ppm; the rest are zero. LREE along the faults are more enriched relative to the HREE; ΣLREE/ΣHREE decreases; the degree of fractionation (degree of alteration) increases, as does fluid flow and perhaps partial melting. These occurrences are relative to lithologies away from the faults. The results show that the porphyritic granites and migmatitic gneisses possess mineralisation potential; the porphyroblastic gneisses possess a mild potential, and the quartzite possesses little to none. However, fault/shear zones can have the potential to host more REEs, as they serve as conduits through which these REEs migrate and can therefore be reprecipitated or redeposited in economic concentrations nearby within hydrothermal bodies (within the deformed zones), such as in veins, pegmatitic dykes, etc.

Keywords: Fault zones, Mineralisation, Granites, Gneisses, LILEs/REEs

STRUCTURAL INTERPRETATION OF GOLD MINERALIZATION IN THE AUNA SHEETS, NORTHWESTERN NIGERIA, USING HIGH-RESOLUTION AEROMAGNETIC DATA

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Abstract

Geophysical investigation was conducted to delineate subsurface structural features and identify zones with potential for gold mineralization within the Auna Sheet, situated in the lower part of the Sokoto Basin, Northwestern Nigeria. The study area is located between latitudes 10.5°N and 11.5°N and longitudes 4.5°E and 5.0°E, covering an estimated area of approximately 12,100 km^2. High-resolution aeromagnetic data acquired from the Nigerian Geological Survey Agency (NGSA) were processed and interpreted using Oasis Montaj software (version 7.2). To enhance near-surface magnetic sources, regional residual separation was applied to the total magnetic intensity data. The residual magnetic field was further analyzed using first and second vertical derivatives, analytic signal amplitude, tilt angle derivative, and source parameter imaging techniques. These enhancement methods generated directional gradient maps that revealed prominent NE–SW, NW–SE, and E–W trending magnetic lineaments, interpreted as faults, fractures, and shear zones within the Precambrian Basement Complex. The spatial distribution and orientation of these structures suggest strong structural control on gold mineralization, as mineralized zones in basement terrains are commonly associated with structurally induced pathways that facilitate hydrothermal fluid migration and deposition. The results demonstrate that the Auna Sheet possesses favorable structural conditions for gold mineralization and highlight the effectiveness of high-resolution aeromagnetic data in mapping subsurface structures and identifying prospective zones for gold exploration in the Auna Sheet.

Keywords: Aeromagnetic survey; Structural interpretation; Gold mineralization; Basement complex; Auna Sheet

MAPPING OF LINEAR FEATURES USING THE ANALYSIS OF HIGH RESOLUTION AEROMAGNETIC DATA SHEET 158 OF LITHIUM-RICH KAIAMA AND ITS ENVIRONS, NORTH CENTRAL NIGERIA

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Abstract

Kaiama and its environs, located within Latitude 9°30'-10°0'N and Longitude 3°30'-4°00'E in the Pan-African Basement Complex of SW Nigeria, have experienced environmental degradation due to artisanal mining. This study maps linear features using aeromagnetic data to identify weak zones and mitigate mining impacts. Data processing involved Oasis Montaj, ArcGIS, and GeoRose software, with Euler Deconvolution and Tilt Derivative techniques applied for depth estimation and edge detection. Euler Deconvolution results for structural index (SI) 0, 0.5, 1, and 2 indicate near-surface depths between 18.39 m and 157.72 m, suggesting rock contact depths up to 160 m. The Tilt Derivative method, ranging from -1.37 to 1.40 radians, estimates source locations from gridded magnetic data. Structural analysis reveals a dendritic, structurally controlled drainage pattern, with dominant E–W, NW–SE, NNE–SSW, and N–S lineament trends. Areas of dense lineament crossovers, corresponding to low magnetic intensities, indicate potential groundwater reserves and mineral deposits. The results obtained provides a valuable guide for mineral exploration and groundwater assessment in the region.

Keywords.: Basement Complex, Environmental degradation, lineament, Euler Deconvolution, magnetic intensity

BIOGENIC ZINC OXIDE NANOPARTICLES DERIVED FROM MANGO SEED EXTRACT: CHARACTERIZATION AND APPLICATION IN DYE REMOVAL

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Abstract

One of the most significant environmental and health problems facing the world is the discharge of industrial effluents. The present paper reports the green synthesis of zinc oxide (ZnO) nanoparticles using *Magnifera indica* (mango) seed extract as a natural reducing and stabilizing agent for the removal of methylene blue (MB) dye in aqueous solutions. The precursors were used at three concentrations (0.05 M, 0.1 M, and 0.2 M) to produce ZnO nanoparticles that were characterized with Fourier-transform infrared (FTIR) and ultraviolet-visible (UV-Vis) spectroscopy. The experiment involved batch adsorption experiments to establish the influence of contact time, pH, initial dye concentration, and adsorbent dosage on the efficiency of removal. The presence of phytochemical functional groups (hydroxyl, carbonyl, and amine) reduced and stabilized the nanoparticle and a typical Zn-O resonance was observed below 600 cm -1 from the FTIR spectrum. UV-Vis spectroscopy revealed absorption peaks at 300-380 nm, with the highest absorbance at 350 nm, indicating that the nanoparticles were successfully formed at a concentration of 0.1 M. The findings of the adsorption research revealed that the dye adsorption was rapid, with a peak of about 30-50 minutes, and the equilibrium was then established after 50-70 minutes. Optimal adsorption rate was 102mg/g with 0.2 M ZnO nanoparticles at pH 1.2, though optimal functioning at low aggregation rate was at 0.1 M. This paper demonstrates that ZnO nanoparticles mediated by mango seeds are a cost-effective, economical, and efficient way of dye removal in wastewater and can be employed in effective environmental remediation.

Keywords: Green synthesis; Zinc oxide nanoparticles; *Mangifera indica*; Methylene blue; Adsorption

HEAVY METAL BIOACCUMULATION IN FOOD CROPS GROWN AROUND BABBAN TSAUNI GOLD MINES AND THE FARM (AGRICULTURAL) SOIL CONTAMINATION ASSESSMENT

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Abstract

Heavy metal bioaccumulation in food crops is a major environmental and public health concern, particularly in areas affected by artisanal and small-scale mining. This study assessed the bioaccumulation potential, expressed as transfer factor (TF), of selected heavy metals—lead (Pb), arsenic (As), nickel (Ni), chromium (Cr), manganese (Mn), zinc (Zn), cobalt (Co), and iron (Fe)—in yam tubers and grains cultivated around the Baban Tsauni gold mining area and surrounding farmlands. Concentrations of metals in farmsoil and crop samples were determined using Neutron activation analysis and X-ray fluorescence analytical methods, and transfer factors were calculated to evaluate metal uptake from soil into edible plant parts. Results indicated that Pb exhibited the highest bioaccumulation in both crops, followed by Zn, demonstrating a strong affinity for plant uptake in contaminated soils. Mean Pb transfer factor values of 19.176 ± 4.048 for yam tubers and 43.29 ± 9.32 for grains suggest significant enrichment and potential dietary exposure risks. Zinc also showed notable accumulation, particularly in grains, reflecting its relatively high mobility and bioavailability in the soil–plant system. In contrast, As, Ni, Cr, Mn, and Fe recorded transfer factor values below unity, indicating limited transfer from soil to crops. Cobalt showed comparatively higher accumulation in grains than in yam tubers. Pollution load index (PLI) values greater than 1 confirmed soil contamination in the study area; however, ecological risk assessment indicated an overall low ecological risk. The presence of Zn and Mn was attributed mainly to natural geological sources rather than anthropogenic activities. Overall, grains demonstrated a higher tendency for heavy metal accumulation than yam tubers. The elevated accumulation of Pb and Zn highlights potential food safety concerns and underscores the need for continuous environmental monitoring and appropriate remediation measures in mining-impacted agricultural regions.

Keywords: Heavy metals, Bioaccumulation, Gold mining, Pollution load index, Environmental monitoring.

SPATIAL ESTIMATION OF TROPOSPHERIC RADIO REFRACTIVITY IN NIGERIA

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Abstract

The spatial and seasonal variation of tropospheric radio refractivity of Nigeria has been studied using meteorological variables (temperature, relative humidity and pressure) retrieved from the archive of the United States' National Aeronautics for Space Administration (NASA). This work established a seasonal variation. The results also revealed an increase in radio refractivity from minimum of about 270Nunits at Abadam to maximum of about 415N-units at Warri. The variation of radio refractivity is synchronous with rainfall in most of the stations especially those in the Guinea Savannah, Tropical Rainforest and Coastal areas where the effects of august break manifest vividly on the curves. Intense refractivity was measured mostly in the tropical rainforest and coastal areas. This could be attributed to the intensity of rain and the length of the wet season in those locations. The Sahel, Sudan and Guinea savannah which experience less rain with short period of wet season recorded reduced refractivity. Just like rainfall, the movement of Inter Tropical Discontinuity (ITD) is also found to be linked to the variation of the radio refractivity. The northward movement of the ITD brings with it elevated refractivity while the southward movement leads to reduced refractivity. This is because the ITD is an element of two high pressure cells which influences its motion. Majorly, the seasonal variation is found to be the product of climate except in some high ground areas where the topography was found to be majorly responsible.

Keywords: Radio Refractivity, RADAR, Inter Tropical Discontinuity, Radio Link.

STRUCTURAL, ELECTRONIC AND OPTICAL PROPERTIES OF α-SI3N4, β-SI3N4 AND γ-SI3N4 USING DENSITY FUNCTIONAL THEORY

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Abstract:

Density Functional Theory (DFT) has in recent years gained a lot of popularity and has become an efficient and reliable tool in the study of material properties. This is specifically due to its computational convenience and excellent results in the prediction of material properties, which is aided by the development of highly efficient and accurate functionals. DFT has successfully been applied in a vast study of material at both ground and excited states. In this study based on DFT structural, optical, electronic properties and phonon frequency of silicon nitrides of different phases were studied using the GGA as exchange-correlation functional. For the electronic band gap calculation, the results were obtained using the GGA and the hybrid HSE06 respectively for α -Si3N4 with space group (P31c), β-Si3N4 with space group (P63/m) and γ-Si3N4 phase polymorph with space group ($143d$). Results obtained for the phases α -Si3N4 shows a narrow indirect band gap while β and γ -Si3N4 indicate a wide indirect band gap material for wide possible application in high temperature and high-power applications. Cohesive energy calculation and phonon frequencies were obtained to check the mechanical and dynamic stability of the three different phases. Results obtain for density of states, partial density of states and the optical properties, such as absorption coefficient, refractive index, extinction coefficient, reflectivity and electron energy loss spectra which all show good agreement with previous studies and relative experimental data.

Keywords: DFT, Structural properties, Electronic properties, optical properties, Semiconductors

SUBTHEME 4: PHYSICS AND CHEMISTRY FOR AGRICULTURE AND FOOD SYSTEMS

RENEWABLE ENERGY TRANSITION AND AGRICULTURAL PRODUCTION IN NIGERIA: THE MEDIATING ROLE OF RURAL ELECTRICITY ACCESS

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Abstract

The growing urgency to achieve sustainable agricultural growth and rural development in Nigeria underscores the importance of transitioning toward renewable energy sources. This study investigates the impact of the renewable energy transition on agricultural production, with rural electricity access introduced as a mediating channel. The analysis is premised on the argument that Nigeria's agriculture, being predominantly rural-based, depends critically on reliable and affordable energy access to enhance mechanization, irrigation, storage, and processing efficiency. Using time series data spanning 1990–2024, the study employs the autoregressive distributed lag (ARDL) approach to examine both the direct and indirect relationships among renewable energy consumption, rural electrification, and agricultural output. Data are sourced from the World Development Indicators, International Energy Agency, and the Central Bank of Nigeria. The study further applies mediation analysis to evaluate the extent to which rural electricity access transmits the effects of renewable energy transition on agricultural performance. Preliminary expectations suggest that increasing the share of renewable energy in total energy consumption improves rural access to electricity, and consequently enhances agricultural productivity. The findings are expected to provide empirical insights into how off-grid solar, bioenergy, and small hydro solutions can support inclusive rural electrification and sustainable agricultural transformation. Policy recommendations will focus on strengthening renewable energy investments and integrating rural energy planning into Nigeria's agricultural modernization strategy.

Keywords: Renewable energy transition; Rural electricity access; Agricultural production; Off-grid energy systems; Nigeria.

Forensic Investigation of Flagged Import Goods

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Abstract

Trading has long been a fundamental factor in the existence of civilizations, enabling access to essential goods and services. For the protection of the populace, imported goods must undergo security checks, and a consignment of household products was flagged by national security agencies for further forensic investigation. Field tests at the port of entry were conducted using portable XRF, spectroscopic techniques, and radiation surveys. Radiation levels showed no significant deviation from background, and XRF revealed no suspicious elements but failed to detect expected ones. Spectroscopy, however, indicated significant nitrate levels where none should have been present. This prompted further laboratory studies using high-accuracy EDXRF, Instrumental Neutron Activation Analysis (INAA), UV-Vis spectroscopy, Gas Chromatography–Mass Spectrometry (GC-MS), and Fourier Transform Infrared spectroscopy (FTIR). Elemental analysis with INAA and XRF showed that the product, labelled Bath Salt (Magnesium Sulphate), contained magnesium below the detection limit of 32.3 mg/kg and sulphur at only 6.27%. UV-Vis spectroscopy confirmed nitrate levels at 15.7% (m/v), with sulphide detected instead of sulphate. FTIR revealed nitrate absorptions along with hydrocarbons and mercaptans, while GC-MS supported these findings by identifying complex hydrocarbon chains. Fragmentation pattern studies confirmed that the goods were not household products but materials suitable for ballistic applications. The investigation ultimately provided critical support to national security infrastructure by preventing hazardous products from bypassing regulatory control.

Keywords: Forensic Analysis, XRF, INAA, Spectroscopy, FTIR, GCMS, Ballistic Material, Safeguard

ASSESSMENT OF PESTICIDE RESIDUES IN CUCUMBER AND APPLE FROM THREE MAJOR MARKETS IN ABAKALIKI, EBONYI STATE

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Abstract

Pesticide residues are traces of chemicals used to protect crops from pests, insects, fungi, or weeds that remain on or in vegetables and fruits after they have been harvested. This study is aimed at assessing the levels of different pesticides residues present in cucumber and apple sold in major markets in Abakaliki area and to compare these levels with the WHO maximum residue limits (MRLs). The collected samples were analyzed using Quick, Easy, Cheap, Effective, Rugged and Safe (QuEChERS) extraction technique and Gas Chromatography (GC) coupled with Flame Ionization Detector (FID) for the detection and determination of pesticide residue. Results revealed that cucumber contained traces of 12 different types of pesticides, including Lindane (0.0299 mg/kg), Carbofuran (0.0149 mg/kg), T-nonator (0.0635 mg/kg), P'p DDT (0.1071 mg/kg), Diazinon (0.0125 mg/kg), Diclorovos (0.0117mg/kg), G-chlordane (0.0002 mg/kg), Profenofos (0.0266 mg/kg), Dicoplol (0.0378 mg/kg), Heptachlor (0.0020 mg/kg), Glyphosphate (0.0012 mg/kg), and Aldrin (0.0117 mg/kg). 2 out of the 12 identified pesticides exceeded the WHO MRLs, while the remaining 10 were within the WHO limits. Also, apple contained traces of 12 pesticides, including Endrin (0.014mg/kg), T-nonator (0.0105 mg/kg), P'p-DDT (0.0111mg/kg), Endusulfan (0.0192 mg/kg), Dieldrin (0.0116 mg/kg),Dicopol (0.0193 mg/kg),Heptachlor (0.0106 mg/kg), HCB (0.0012mg/kg), Glyphosphate (0.0112 mg/kg), Aldrin (0.0012 mg/kg), Biphenyl (0.0096 mg/kg), and Delta-BHC (0.0100 mg/kg) respectively. They were found to be within their respective MRLs. The occurrence of pesticides residues in the analysed samples is a major threat to human health. Hence, continuous monitoring is recommended so as to regulate the use of these pesticides.

Keywords: Pesticide residues, QuEChERS method, traces, vegetables and fruits

IMPROVING FOOD SECURITY THROUGH ARTIFICIAL INTELLIGENCE-ASSISTED AGRICULTURE AND ALGEBRAIC MODELLING

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Abstract

The global food system faces increasing pressure from population growth, climate variability, and resource depletion, necessitating innovative approaches to enhance productivity, sustainability, and resilience. Artificial Intelligence (AI) offers transformative potential across the entire food value chain—from production to consumption—by enabling data-driven decision-making, predictive analytics, and system optimization. This study explores how AI technologies such as machine learning, computer vision, and predictive modeling can improve food production efficiency, reduce post-harvest losses, and enhance supply chain logistics. Through the integration of remote sensing, Internet of Things (IoT) devices, and big data analytics, AI can model soil–crop–climate interactions, forecast yield patterns, and optimize resource allocation with minimal environmental impact. Furthermore, AI-driven decision-support systems can inform precision agriculture, sustainable land management, and equitable food distribution, thereby strengthen food security and support the achievement of the Sustainable Development Goals (SDGs). The paper concludes that leveraging AI within a systems-thinking framework enables the creation of adaptive, efficient, and resilient food systems that balance technological advancement with ecological and social sustainability.

Keywords: Artificial intelligence, Food systems, Precision agriculture, Machine learning, Sustainability

ENHANCING FOOD SECURITY IN NIGERIA THROUGH SUSTAINABLE SOIL FERTILITY MANAGEMENT: STRATEGIES AND INNOVATIONS

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Abstract

Nigeria faces persistent challenges of low agricultural productivity and food insecurity due to declining soil fertility and unsustainable land use practices. This review evaluates the role of sustainable soil fertility management (SSFM) in enhancing food security across the country. The aim was to evaluate existing approaches, identify gaps, highlight soil fertility strategies and recommend integrated practices that ensure long-term soil productivity and improved crop yields. Relevant literature, government reports, and empirical studies were reviewed to assess trends in soil fertility decline, fertilizer use efficiency, organic matter management, and policy interventions promoting sustainable agriculture. It was indicated that overreliance on inorganic fertilizers, continuous cultivation, deforestation and poor organic residue management have degraded Nigeria's soils, particularly in semi-arid regions. However, evidence shows that integrated soil fertility management (ISFM) which combines organic amendments, mineral fertilizers, crop rotation and agroforestry significantly enhances soil health and yield sustainability. Adoption remains low due to limited farmer awareness, inadequate extension services and weak policy enforcement. The review concludes that achieving food security in Nigeria requires a shift toward ecologically balanced and economically viable soil fertility strategies. Strengthening farmer education, promoting composting and green manure use, fertilizer application and implementing supportive government policies to scale up sustainable practices are highly recommended.

Keywords: Agroforestry, Food security, Integrated soil fertility management, Nigeria, Yield

ENHANCING RADIATION DETECTION SYSTEMS FOR SAFE AND SECURE TRADE FACILITATION IN NIGERIA

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Abstract

Under an IAEA Research Contract, the Nigeria Customs Service in partnership with the Centre for Energy Research and Training Ahmadu Bello University Zaria, conducted an assessment of radiation detection systems at Nigeria's key trade entry points. The study integrated structured surveys of frontline customs officers with baseline radiation measurements across key commodities, airports, seaports, and land borders using calibrated handheld radiation survey meters and spectrometer. Results show strong compliance with SOP logging and calibration awareness, but highlight gaps in training, standardized reporting, and equipment modernization. Baseline surveys confirmed safe background levels for most commodities, though elevated readings in rice, cotton, and mineral sands suggest the need for enhanced risk profiling. Controlled source tests (Cs-137, Co-60, Sr-90) validated system sensitivity, while occasional anomalies at airports and seaports underscored the importance of recalibration. Recommendations include standardized training curricula, expanded detector availability, digitized reporting, and stronger interagency coordination. These findings provide an evidence base for advancing risk-informed alarm assessment, reducing false positives, and supporting safe and secure trade facilitation. Future work will focus on developing decision-support software integrating TRACE datasets with customs HS codes, alongside expanded data collection and dissemination.

Keywords: Radiation monitoring, Portal monitors, Border security, imported commodities, Trade facilitation

SYNTHESIS AND BIOACTIVE EVALUATION OF COPPER NANOPARTICLES FROM TURMERIC ROOT (CURCUMA LONGA) EXTRACT AGAINST CABBAGE ROT (*PECTOBACTERIUM CAROTOVORUM*), AT PH 9

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Abstract

Cabbage rot caused by *Pectobacterium carotovorum* reduces crop yield and quality, creating the need for eco-friendly alternatives to synthetic bactericides. This study presents the green synthesis and antimicrobial evaluation of copper nanoparticles (CuNps) using Curcuma longa (turmeric) root extract as both reducing and capping agent at pH 9. UV–Visible spectroscopy revealed a distinct surface plasmon resonance peak at 460 nm, confirming CuNp formation. The synthesized nanoparticles exhibited strong inhibitory effects against *P. Carotovorum*, with reduced lesion size and delayed disease progression compared to untreated controls. The highest activity occurred at pH 9, indicating optimal nanoparticle formation and bioactivity under alkaline conditions. X-ray diffraction (XRD) showed sharp reflections at 2θ values of 38.1°, 44.3°, 64.4°, and 77.5°, corresponding to the (111), (200), (220), and (311) planes of face-centered cubic (FCC) copper, indicating high crystallinity and phase purity. Transmission Electron Microscopy (TEM) revealed spherical to polyhedral CuNps (20–100 nm) with size-dependent aggregation, consistent with XRD findings. Overall, the results confirm the successful green synthesis of crystalline, size-tunable CuNps using turmeric extract, exhibiting potent antibacterial efficacy against plant pathogens. These findings underscore the potential of turmeric-mediated CuNps as sustainable nanobiocides for environmentally safe agricultural disease management.

Keywords: Green Synthesis, Copper Nanoparticles, Nanobiocides, Surface Plasmon Resonance, X-Ray Diffraction.

SPECTROMETRIC DETERMINATION OF Pb, Cr, Cd, AND Mn IN CARROT (DAUCUS CAROTA) SAMPLES OBTAINED FROM TARBUTU VILLAGE OF DAPCHI, BURSARI LOCAL GOVERNMENT AREA OF YOBE STATE

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Abstract

This study presents a spectrometric analysis of Lead (Pb), Chromium (Cr), Manganese (Mn), Nickel (Ni), and Cadmium (Cd), in carrots (Daucus carota) cultivated in the Tarbutu village area of Dapchi, Bursari Local Government, Yobe State. Carrots are widely consumed for their nutritional value; however, they are also susceptible to contamination from heavy metals due to environmental pollution, agricultural practices, and irrigation with contaminated water sources. Samples of carrots were collected from selected farmlands in the study area and analyzed using Atomic Absorption Spectrophotometry (AAS) to quantify the levels of Pb 0.733±0.034 WHO (0.3), Cr 0.405±0.025 WHO (2.3), Mn 0.181±0.003 WHO (0.4), Ni 0.055±0.003 WHO (5.0), and Cd 0.345±0.029 WHO (0.2). The concentration of Cadmium and Lead appeared to be higher than the standard limits; this may pose a serious health risk to the consumers of the carrots that cultivated in the area. However, the concentration of Chromium, Nickel, and Manganese are within the maximum permissible limits sets by FAO/WHO. Since the concentration ranges are below the standard limits, there will be no health risk associated with chromium, Nickel, and Manganese on the consumers. With some exceeding the permissible limits set by international health and food safety standards. This research contributes to the growing body of knowledge on food safety and environmental health, emphasizing the need for sustainable agricultural practices to ensure the well-being of consumers.

Keywords: Carrots, Spectrometric analysis, Environmental pollution, WHO, FAO.

NANO-ENABLED GREEN CHEMISTRY: A SUSTAINABLE APPROACH FOR AGRO-INDUSTRIAL WASTE VALORIZATION

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ABSTRACT

Agro-industrial waste represents a vast and underutilized resource whose improper disposal poses major environmental and economic challenges. The use of an eco-friendly, efficient and effective process in turning this waste into wealth has been the focus of research recently. This review provides a comprehensive analysis of nano-enabled green chemistry strategies aimed at transforming agro-wastes into valuable products through sustainable and eco-efficient processes. Methodologically, the review synthesizes current advances in the synthesis, characterization, and catalytic application of nanomaterials, and systematically compares nano-enabled processes with conventional green chemistry techniques. Particular emphasis is placed on heterogeneous nanocatalysts possessing high surface areas and tunable active sites, which facilitate the efficient conversion of lignocellulosic residues into biofuels, biopolymers, and other high-value biochemicals under mild and environmentally benign conditions. Moreover, the role of functionalized nanoadsorbents in the selective sequestration of heavy metals, pesticides, and organic pollutants from agro-industrial effluents is critically examined. The analysis reveals that nano-enabled green chemistry approaches significantly enhance reaction selectivity, catalytic efficiency, and process sustainability relative to traditional methods. Nonetheless, potential drawbacks such as nanoparticle toxicity, aggregation tendencies, process scalability, and economic feasibility are identified as key areas requiring further investigation. Overall, nano-enabled green chemistry significantly improves reaction efficiency, selectivity, and environmental performance compared to traditional methods and drive innovation in the bio-based economy.

Keywords: green chemistry, nanocatalysts, nanoadsorbents, waste valorization, bio-based economy

PRODUCTION AND CHARACTERIZATION OF INSECTICIDE USING NEEM OIL

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Abstract

This study focused on the production and characterization of insecticide from neem seed. The neem seed was examined for its proximate analysis. The oil was extracted by the Soxhlet extractor and then characterized. Insecticide of the neem seed oil was tested. The moisture content (9.42%) was within the acceptable limit of not more than 10% for long-term storage. Ash content of 7.33% was recorded, which is an indication of high mineral content of the neem seed sample. It also recorded high crude fat of 34.24%. The saponification value of 181.62mg/g was recorded. The moderate saponification value makes the neem seed oil suitable for insecticide production. This is so because higher saponification value leads to soap formation (saponification). Other values of the oil properties (density, acid, free fatty acid, iodine and peroxide values) support the assertion that the neem. The relationship between yield point and the process factors is in quadratic form, with correlation of determination close to 1. The maximum oil yield of 34.52% was obtained at 3hrs extraction time, 50° C temperature and 0.4g/ml mass/volume ratio. The functional groups of the insecticide include; C=C Stretch, =C-O- C symmetric stretch, =C-H stretch, O-H stretch, C-O stretch and O=C-O-C (esters). The presence of these functional groups means that the neem seed oil is a suitable insecticide. Chemical compositions of the neem seed oil as insecticide include phosphates (organophosphate), chlorinated hydrocarbon and carboxylic acid. Thus, a suitable insecticide. Cockroach exposed to neem seed oil (as insecticide) died within 5hrs.

Keywords: Characterization, Neem, Extractor, Tested, Insecticides.

PRODUCTION OF BIOLUBRICANT FROM PAWPAW SEED OIL METHYL ESTER USING *MUCUNA URENSE* AND FERRIC CHLORIDE COMPOSITE CATALYST.

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Abstract

This study explores the production of biolubricant from pawpaw seed oil using carbonized *Mucuna Urense* and Ferric chloride ($FeCl_3$) composite catalyst as an alternative lubricant source to petroleum-based–lubricants. Pawpaw seed oil was extracted via Soxhlet extraction with n-hexane and characterized for density, viscosity, and fatty acid profile. Biolubricant was synthesized from biodiesel by transesterification with the following optimal conditions: (9:1 methanol-to-oil, 3 wt% $FeCl_3$, 60 °C, 2hr) which yielding 88 % biodiesel. Stirring speed variation: time = 3 hr temperature = 120 (^{0}C); biodiesel, catalyst dosage = 1.00 (% wt. of biodiesel); biodiesel, ethylene glycol weight ratio (wt./wt.) = 4.5:0.5. The resulting fatty acid methyl esters exhibited a biolubricant yield of 63%, density of 0.894 g/cm^3, viscosity of 18.321mm^2/s at 40 °C, acid value < 0.5 mg KOH/g, cetane number of 50, flash point of 170 °C, cloud point of -2°C, pour point of -6°C and calorific value of 39 MJ/kg meeting lubricant standards.. These findings demonstrate that waste pawpaw seed oil catalyzed by $FeCl_3$ can be efficiently converted into high-quality biolubricant, offering a sustainable route for agricultural by-product valorization.

Key words :Biolubricant, *Mucuna urense*, Transesterification

INTEGRATING ORGANIC AND INORGANIC NUTRIENT SOURCES FOR IMPROVED OKRA YIELD: A FRAMEWORK FOR NUCLEAR-BASED ASSESSMENT OF SOIL FERTILITY DYNAMICS

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ABSTRACT

The experiment was conducted during 2023/2024 and 2024/2025 dry seasons at Teaching and Research Farm of the Binyaminu Usman Polytechnic Hadejia Jigawa State (12°145'2.49" N 8°86'22.14" E) the location were located in Sudan Savanna of Nigerian. Sustainable soil fertility management is essential for improving crop productivity and maintaining soil health in tropical agro ecosystems. The aim and objective of the study were to evaluate effects of different levels of NPK and poultry manure on the growth and yield performance of okra (Abelmoschu esculentus L.) The treatment was laid out in a Split Split Plots Design and was replicated three times. Data were collected on growth parameters and yield components such as (Plant height, number of leaves, Days to 50% fruit appearance, number of fruits per plant, fruit diameter and fruits yield ton^{1ha}). **Significant treatment means were separated at 5% level of probability using Student Newman Keuls (SNK) test.** Soil **samples and** poultry manure **were analyzed for its physical and chemical properties.** The treatment consisted of three varieties of okra NHAR47-4, Clemson Spineless and Yar-balle, three rates of poultry manure at 0t/ha^{-1}, 4t/ha^{-1}, and 6t/ha^{-1}, three levels of NPK at 0kg/ha^{-1}, 90kg/ha^{-1}and 120kg/ha^{-1}. The fruit yield tons ha^{-1} was significantly influenced by the varieties, result shows that NHAR47-4 variety performed significantly and produced higher fruit yield tons ha^{-1} Poultry manure at 6t/ha was significantly produced highest. The significant effects of NPK at 120kg/ha were significant response by okra on yield components such as fruits yield tons per hectare. Such nuclear-based assessments would offer deeper insights into nutrient transformation processes and contribution to precision soil fertility management strategies for improved crop performance and sustainability.

Keywords: *Organic, inorganic, soil , fertility, and okra*

ASSESSMENT AND MITIGATION OF AIRBORNE POLLUTANTS AND RESPIRATORY HEALTH RISKS FROM INTENSIVE POULTRY FARM OPERATIONS IN IMO STATE, NIGERIA

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Abstract

This study assessed airborne pollutants and respiratory health risks associated with intensive poultry farm operations in Imo State, Nigeria, and proposed evidence-based mitigation strategies. A mixed-methods approach was employed, integrating quantitative air quality monitoring with health surveys, interviews, and spatial analysis across Orlu, Owerri, and Okigwe agricultural zones. Environmental measurements of ammonia (NH_3), particulate matter ($PM_{2.5}$ and PM_{10}), hydrogen sulfide (H_2S), and carbon dioxide (CO_2) were conducted during dry and wet seasons using portable gas sensors and particulate monitors. Structured questionnaires and medical symptom checklists were administered to 384 poultry workers and nearby residents to assess respiratory health outcomes. Findings revealed that mean concentrations of NH_3 (38.6 ± 4.7 ppm) and $PM_{2.5}$ (182.3 ± 21.5 µg/m³) in most poultry houses exceeded WHO occupational exposure limits. Seasonal variation showed significantly higher pollutant levels in the dry season ($p < 0.05$). Over 62% of respondents reported respiratory symptoms such as coughing, wheezing, chest tightness, and eye irritation, with a significant positive correlation ($r = 0.73$, $p < 0.01$) between pollutant exposure and symptom prevalence. Logistic regression analysis identified poor ventilation, litter accumulation, and inadequate use of personal protective equipment (PPE) as major predictors of respiratory health risk. Qualitative data highlighted low awareness of occupational safety and weak enforcement of environmental regulations. Mitigation strategies such as improved ventilation systems, periodic litter removal, manure composting, and the adoption of low-protein feed formulations were found to reduce ammonia and particulate emissions by up to 30%. The study concluded that intensive poultry production in Imo State poses significant occupational and community health challenges due to high airborne pollutant exposure. It recommends locally adaptable mitigation practices and stronger regulatory oversight to ensure sustainable poultry production and safeguard public health.

Keywords: Airborne pollutants, poultry farms, respiratory health, mitigation strategies, Imo State

RESPONSE OF LABLAB (*LABLAB PURPUREUS* L. WALP) VARIETIES GROWN AT DIFFERENT PHOSPHORUS LEVELS AND SOWING DATES IN HADEJIA JIGAWA STATE, NIGERIA

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Abstract

Field experiment was conducted during the 2023, 2024 and 2025 cropping seasons at the Binyaminu Usman Polytechnic, Hadejia Jigawa State, Nigeria. The experiment was conducted to determine the effect of phosphorus, sowing dates and variety on the growth and yield characters of lablab. The treatments consisted of four levels of phosphorous (0, 20, 40 and 60 kg/ha), two local varieties of lablab (Dan Inusa and Dan Farankachi) and three sowing dates (1st, 15thand 29th of July). The experiment was laid out in a Randomized Complete Block Design (RCBD) replicated three times. Growth and yield characters were measured and correlation analysis was done. Results indicated that 60 Kg P/ha produced highest seed yield. Sowing on 29th of July had highest yield and Variety Dan Inusa out yielded the other variety. The results also showed that most of the growth and yield components had significant positive correlation with yield. However, crop growth rate was observed to have significant negative correlation with the crop yield. It could be recommended that most of the growth and yield parameters were good yield contributing characters.

Keywords: Growth, Yield characters. Correlation

Adsorption of Methylene Blue from Aqueous Solution and Treatment of Real Textile Wastewater Using Base-modified Cuban Palm Fruit Pericarp

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Abstract

The growing concern over the deterioration of aquatic ecosystems by synthetic dyes has intensified interest in developing innovative and sustainable strategies for removing these toxic dyes from industrial wastewater. In this study, base-modified *Cuban palm fruit* pericarp was prepared, characterized and applied as adsorbent for the efficient removal of methylene blue from aqueous solution and the treatment of real textile wastewater. The characteristic nature of the adsorbent was determined using Scanning Electron Microscope, X-ray diffractometer, Brunauer-Emmett Teller and Fourier Transform Infra-red spectrophotometer. The batch adsorption process was optimize by varying parameters including pH, adsorbent dosage, initial dye concentration, agitation speed, temperature, and contact time. The adsorbent showed a maximum sorption capacity of 192.308 mg/g while the optimum sorption of methylene blue was obtained at pH 10, 120 min contact time, 348 K, 100 mg adsorbent/ 150 mL dye solution, and 100 rpm agitation speed. The dye's sorption was best explained by the Langmuir isotherm and best suited to the pseudo-second order kinetics model. Meanwhile, intra-particle diffusion was involved in the dye adsorption but not as the sole limiting step of the process. Furthermore, thermodynamics study revealed high feasibility, spontaneity, and endothermic nature of the sorption of methylene blue. In addition, the adsorbent achieved between 61 to 93 % decolorization of real textile wastewater samples showing significant reduction in the wastewater's pollution load. This study underscored the efficiency of the base-modified Cuban palm fruit pericarp as a low-cost, eco-friendly and sustainable option for effectively treating toxic dye-contaminated wastewater.

Keywords: Adsorption, Methylene Blue, Based-modified Cuban palm, Real Textile Wastewater

MATRIX INFLUENCE ON THE ADSORPTIVE CAPACITY OF BASE-MODIFIED CARICA PAPAYA SEED ADSORBENT FOR CR AND MG REMOVAL FROM WATER

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Abstract

Underutilised agro-based waste *Carica papaya* seed (CPS) was processed into a base-modified adsorbent for remediation of Malachite green (MG) and Congo Red contaminated water. The CPS was pretreated and treated with 300 mL of 0.1 M NaOH for 24 hours. The treated CPS was then named BCPS. The BCPS was characterised using scanning electron microscopy (SEM), Fourier Transform Infra Red (FTIR) spectroscopy and pH point of zero charge (pH_{pzc}). The batch adsorption studies were carried out with parameters such as contact time, adsorbent dose, solution pH, initial adsorbate concentration, and temperature. Adsorption isotherm, kinectic and thermodynamic studies were also carried out. The SEM revealed BCPS surface morphology before and after adsorption. The FTIR analysis showed BCPS surface chemistry as O-H, C≡C, C=C, C≡N, C-O, C-C, and C-H. However, only O-H, C=O, C≡N and C-H partook in the adsorption of MG and CR. The BCPS pH_{pzc} was 6.2. The BCPS had maximum capacities for MG, having smaller molecular mass, compare to CR under all experirmental conditions except pH where optimum condition for MG and CR were 9 and 3 respectively. The maximum adsorption capacities of BCPS for MG in single and binary systems were 42.37 and 7.62 mg/g, and CR 6.95 and 5.58 mg/g respectively. The BCPS pore diameter and MG and CR molecular masses were factors that determine the efficiency of the adsorptive removal.

Keywords: based-modified adsorbent, carica papaya seed, malachite green, congo red, adsorbent pore diameter

Evaluation of Aristolochia ringens (Dutchman pipe) root Extracts as Green Corrosion Inhibitors for Mild Steel in Corrosive Environments

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Abstract

This study investigates the corrosion inhibition potential of *Aristolochia ringens* root extracts on mild steel in acid, salt and alkali environments. *Aristolochia ringens* root crude extracts (ARCE) and their secondary metabolites such as alkaloid, flavonoid, saponin and tannin extract were characterized using GC-MS, FTIR and scanning electron microscopy (SEM).Corrosion inhibition study was carried out using gravimetric methods, depth of attack, and electrochemical techniques. Finally the proposed green inhibitors was applied and tested as a coating on the mild steel. The major constituents in the ARCE are 6-Octadecenoic acid, (Z), 2H-Cyclopropa[a] naphthalene -2-one and Pyridine, 3-ethyl- FT-IR revealed that the plant extracts contained functional groups of -OH, N-H, C-N, C=O, C-O and $-CH_3$. SEM analysis showed that the introduction of the inhibitors stifled the corrosion reactions for mild steel in all the media, as the micrograph displayed smooth surface compared to the uninhibited samples. The highest IE % recorded was for ARCE (98.01 %, 89.43%, and 85.14%) in 1M HCl, 1M NaCl and 1M NaOH respectively. The highest inhibition efficiency for *Aristolochia ringens* alkaloid (ARAE), saponin (ARSE), tannin (ARTE) and flavonoid (ARFE) were 91.40%, 87.81%, 80.87% and 77.98% respectively. The potentiodynamic polarization result revealed that ARCE act as mixed inhibitor. Adsorption of inhibitors followed Langmuir isotherm and pseudo-second-order kinetics. Thermodynamic studies indicated spontaneous, endothermic and physical adsorption process. The crude extract effectively reduced the weight loss over time when applied as a coating. The results demonstrated the high corrosion inhibition potential of *Aristolochia ringens* on mild steel as a renewable bio-resource.

Keywords: Corrosion inhibitors, *Aristolochia ringens* , Isotherms, Mild steel, Phytomolecules

ASSESSMENT OF PHYSICO-CHEMICAL PARAMETERS AND HEAVY METALS CONCENTRATIONS IN BOREHOLE AND SACHET WATER BRANDS IN KATSINA

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Abstract

The effects of water pollution by chemicals especially heavy metals is detrimental to the environment and life. All the samples were analysed using standard analytical techniques and instruments, heavy metals were analysed using atomic absorption spectrophotometer. Organoleptic assessment shows that all samples were tasteless, odourless and colourless. The results of Borehole water and sachet water were pH 5.44 and 6.58; Temperature 27.4^{o}C and 29.0^{o}C; Total hardness 166.00 mg/l and 2.20mg/l. Magnesium hardness 68.1mg/l and 6.5mg/l; Dissolved oxygen 11.13mg/l and 4.70mg/l; Turbidity <5NTU and <5NTU; Calcium 98.2mg/l and 17.3mg/l; Copper 0.38mg/l and 0.23mg/l; lead 0.13mg/l and 0.12mg/l; Iron 0.15mg/l and 0.11mg/l; Zinc 1.49mg/l and 4.01mg/l respectively. The results generally conform to the W.H.O standards for drinking water and sachet water is fit for drinking. But purification method such as boiling should be adopted before using borehole water to reduce the level of hardness.

Keywords: *Physico-chemical, heavy metals, organoleptic, borehole and sachet water*

COMPARATIVE STUDY OF SHORT CHAIN FATTY ACID (ACETATE, PROPIONATE AND BUTYRATE) PRODUCTTION IN RATS FED WITH BIOFORTIFIED MAIZE (SAMMAZ 52) AND YELLOW MAIZE VARIETIES

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Abstract

The human large intestine is home to a large and diverse microbial populations their anaerobic fermentation of non-digestible fiber-rich diet leads to the production of important metabolites including short-chain fatty acid (SCFA). SCFAs with significant anti-inflammatory functions regulate immune function and prevent an excessive immune response, thereby delaying the clinical progression of inflammatory bowel syndrome (IBS). This research aimed to evaluate the effect of provitamin A biofortified maize (Sammaz 52) and yellow maize varieties on the serum short-chain fatty acids (SCFA) in healthy rats. A total of thirty male Wister rats were divided randomly into five groups of six rats each. Group one serve as control and were fed with animal feed (Grower pallet), Group two to five were fed with either whole or dehull varieties of provitamin A maize or yellow maize for six weeks, at the end of the experiment, serum blood samples were collected. Serum SCFA concentrations were determined using GC-MS method. The results indicated that the whole biofortified maize groups have higher serum acetate of 81.51 mmol/L and propionate 68.77mmol/L among experimental group while the whole yellow maize group has higher concentration of butyrate 24.84 mmol/L. Fibre was higher in whole biofortified maize 4.36% and whole yellow maize 4.73% with no significant difference at value of $P<0.05$ compared to other experimental groups. Based on the results of this study, it shows that consumption of whole biofortified provitamin A maize (Sammaz 52) and whole yellow maize varieties provide beneficial effect to host on both nutrition and health.

Keywords: *Gastrointestinal tract, Biofortified provitamin A maize, short chain fatty acid, proximate and fermentation*

Comparative Analysis of Physical Properties in Void Galaxies Versus Galaxies in Denser Filaments and Clusters

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Abstract

The physical characteristics of galaxies in cosmic voids and those in denser environments, such as filaments and clusters, are evaluated in this study. We analyze stellar mass distributions, galaxy sizes, morphology, star formation rates, and gas content in these environments using observational data from the Sloan Digital Sky Survey Data Release 7 (SDSS DR7) and cosmological simulations. Our results confirm that void galaxies are generally bluer, have lower masses, and have higher specific star formation rates than their filament and cluster counterparts. Furthermore, we discover that the size of cluster and void galaxies varies with stellar mass, with the latter differing at lower masses and the former having similar sizes at high masses. These findings highlight the critical role that the environment plays in galaxy evolution and provide insight into the physical processes that shape galaxies in large-scale cosmic structures. There are recommendations for more observational studies and simulations to deepen our understanding of these effects on the environment.

Keywords: cosmic void, filament, galaxy evolution, star formation, large scale structure

DEFECT EMISSIONS OF A SELF-TEXTURED GROWTH RADIO FREQUENCY (RF) SPUTTERED $Cd_{0.015}Mg_{0.10}Zn_{0.885}O$ THIN FILM.

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ABSTRACT

ZnO remains a preferred candidate for luminescent-based materials. It is believed that doping ZnO NPs could generate suitable materials as light emitters and absorbers in the visible and infrared regions. The effect of co-doping with divalent elements/ions of Mg^{2+} and Cd^{2+} narrows the bandgap, creates defect emission, and enhances luminescence intensity. As a potential candidate in optoelectronics devices, $Cd_{0.015}Mg_{0.10}Zn_{0.885}O$ (CMZO) thin film with a self-textured growth and texture fraction (TF) of 95.8% for (002) peak orientation along the c-axis is deposited on a Si substrate using radio frequency (RF) magnetron sputtering. The crystal structure of the thin film and its crystallographic parameters obtained by Rietveld refinement established a hexagonal wurtzite structure with a grain size of 34.34(2) nm and a smooth surface roughness of 2.8 nm (square of the mean square). The optical band gap estimated for the thin film is 3.52 eV. At the same time, the photoluminescence intensity was strong in the UV region with a broad yellow emission at 582 nm, and is optically active as defect emission due to oxygen interstitial (Oi). Defect emissions of blue, orange, red, and near-infrared intensities decreased compared to the yellow emission due to depletion of the recombination of photo-generated holes or charge carriers. CMZO thin films hold great potential for optoelectronic devices and applications in the UV and yellow regions.

Keywords: Sputtered CdMgZnO thin film, Texture fraction, Ultraviolet and yellow luminescence, oxygen interstitials.

HYBRID OPTIMIZATION OF ALGORITHM FOR PARAMETER EXTRACTION OF SINGLE AND DOUBLE DIODE PHOTOVOLTAIC MODELS UDER VARIABLE CLIMATIC CONDITIONS

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Abstract

Accurate determination of photovoltaic (PV) model parameters under actual field conditions is crucial for dependable system simulation and performance assessment. In this study, a hybrid Smell Agent Optimization–Particle Swarm Optimization (SAO–PSO) algorithm is utilized to estimate the electrical parameters of single-diode and double-diode PV models across diverse climatic conditions. Monthly average temperature and solar irradiance data spanning 2011–2020 were obtained for six states from the Nigerian Meteorological Agency (NIMET), Abuja, and thoroughly analysed. The Nominal Operating Cell Temperature (NOCT) approach was employed to compute cell temperatures, which were subsequently used to generate corresponding current–voltage (I–V) characteristics for each climatic scenario. For the single-diode model, key parameters estimated include the photocurrent I_{ph}, reverse saturation current I_s, ideality factor (n), series resistance R_s, and shunt resistance R_{sh}. The double-diode model was optimized using seven parameters: I_{ph}, $I_{s1}, I_{s2}, n_1, n_2, R_s and\ R_{sh}$. Initially, Smell Agent Optimization (SAO) was applied, followed by Particle Swarm Optimization (PSO) to refine the results. For the single-diode model, SAO produced average parameter estimates of $I_{ph} = 8.85\ A$, $I_S = 1.35 \times 10^{-6} A$, $n = 1.22, R_s = 0.38\Omega, R_{sh} = 512.6\ \Omega$ with RMSE of 0.021. PSO achieved $I_{ph} = 8.84\ A, I_s = 1.30 \times 10^{-6} A, n = 1.15, R_s = 0.31\Omega, R_{sh} = 485.7\ \Omega$, reducing the RMSE to 0.018. The hybrid SAO–PSO algorithm further enhanced accuracy, yielding $I_{ph} = 8.83\ A, I_S = 1.25 \times 10^{-6} A, n = 1.15, R_s = 0.31\Omega, R_s = 485.7\ \Omega$ with a minimum RMSE of 0.012. These results demonstrate that the hybrid SAO–PSO approach provides superior parameter extraction accuracy and convergence stability compared to standalone SAO and PSO methods, making it particularly suitable for PV system performance prediction, fault diagnostics, and maximum power point tracking applications.

Keywords: Photovoltaic, Optimisation, Parameters estimation, Hybrid Algorithm, Solar energy

EVALUATING THE PERFORMANCE OF VDW-DF2, RVV10, AND PBE FUNCTIONALS IN MODELING MO-BASED DICHALCOGENIDES: A DFT STUDY

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Abstract

Recent investigations have increasingly focused on improving the modeling of van der Waals (vdW) interactions, particularly through the vdW-DF framework. Notable advancements, such as the PBE+rVV10 and vdW-DF approaches, have been developed to minimize discrepancies in binding and interaction energy profiles across diverse material systems, aiming for broader applicability. However, their effectiveness for energetic materials specifically two-dimensional transition metal dichalcogenides (2D-TMDCs) remains insufficiently explored. In this study, density functional theory (DFT) within the Quantum ESPRESSO framework was employed to examine the influence of the hybrid vdW density functionals (vdW-DF2 and rVV10), as well as the conventional Perdew Burke Ernzerhof (PBE) correlation potential, on the structural, electronic, elastic, and optical properties of MoX_2 (X = S, Se, Te). The results show that the vdW-DF2 functional mitigates the overestimation of lattice constants commonly observed in other functionals. Conversely, the PBE functional exhibits superior accuracy in predicting electronic and elastic behaviors, with calculated optical properties indicating strong potential for photodetection applications. Remarkably, PBE-derived results demonstrate close agreement with existing experimental data, reaffirming its reliability for modeling Mo-based dichalcogenides

Keyword: DFT, PBE, rVV10, vdW-DF2

TETRAHYDROFURAN DISSOLUTION PROCESS OF WASTE FURAN-LIGNIN FOAMS: STUDIES ON REGENERATED AND VIRGIN FOAM CHARACTERISTICS

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Abstract

Foams are widely used in a variety of industries, including furniture, construction, and automotive, due to their remarkable mechanical properties and durability. However, given their low recycling rates, there is presently significant concern regarding the environmental implications of polyurethane (PU) foams. The recycling of furan-lignin rigid foams by solvent-assisted dissolution was the main focus of this study. The virgin foams were formulated using furfuryl alcohol (cross-linker) and lignin-based polyol, which were made from corn husks and palm nut shells, respectively. Glyoxal was employed as a hardening agent and diethyl ether as a blowing agent. Virgin furan-lignin foams (FLF) were dissolved in eight distinct solvents to assess their dissolution index and recyclability. Tetrahydrofuran (THF) having 93% dissolution index, outperformed ethylene glycol and polyethylene glycol. Water, on the other hand, has the lowest dissolving index (1.1%). Four recycled furan-lignin foams (RFLF) were developed using the THF dissolution product, which was described and used as recycled polyol. Thermogravimetric analysis (TGA), scanning electron microscopy (SEM), and compressive strength tests were used to assess these RFLFs. Based on the results obtained in this study, recycled foams retained superior mechanical and thermal behaviors that were significantly better than the virgin FLF.

Key Words: Foam Recyclability, Furan Lignin Polyol Polymer Dissolution

Decommissioning by Design for Emerging Nuclear Facilities in Nigeria: A Strategic Key to National Nuclear Readiness

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Abstract

Decommissioning is the final stage in the lifecycle of every nuclear facility, involving dismantling, decontamination, waste management, and site remediation. Because of its technical complexity and high cost, it has become a discouraging factor for many nuclear-embarking countries. Lessons from ongoing global decommissioning projects show that when decommissioning is not adequately planned during the operational phase, it becomes a difficult undertaking. Consequently, the concept of Decommissioning by Design (DbD), (an integration of decommissioning requirements at the facility design stage) is gaining recognition as a practical approach to reducing future technical and financial burdens. This paper presents DbD as a strategic option for Nigeria, with the potential to reduce the cost of expanding nuclear technology applications while demonstrating national readiness, strengthening safety assurance, supporting long-term legacy management, and promoting nuclear sovereignty. By embedding decommissioning considerations into early design stages, Nigeria can join countries leading the global shift toward proactive lifecycle planning that prevents decommissioning burdens from being transferred to future generations. The paper proposes actionable strategies for national implementation. First, developers and designers should adopt activation-minimizing materials, modular facility architectures, and digital-twin-enabled lifecycle planning to ensure real-time radiological characterization throughout a facility's lifespan. Second, regulators should introduce DbD-specific licensing requirements ensuring dismantling pathways, waste minimization plans, and cost provisions before construction approval. Third, Nigeria should build decommissioning workforce through structured training programmes in reactor physics, remote handling, dismantling technologies, and radioactive waste logistics. A a unified national DbD policy should be established to harmonize responsibilities across relevant institutions.

Keywords: Decommissioning, Dismantling, Remediation, Nuclear sovereignty

GREEN SYNTHESIS AND ANTIMICROBIAL ACTIVITY OF ZINC OXIDE NANOPARTICLES USING *COMBRETUM COLLINUM* (FRESEN), *C. LAMPROCARPUM* (DIELS) AND *C. MOLLE* (R.BR EX G.DON)

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Abstract

Plant-derived extracts have emerged as cost-effective alternative to conventional chemical dependent route for nanoparticles (NPs) synthesis. This study reports the green synthesis and antimicrobial activity of zinc oxide nanoparticles (ZnO-NPs) using extracts of leaf/root/stem from *C. collinum*, *C. lamprocarpum* and *C. molle*. Characterization of NPs was carried out using Fourier Transform Infrared Spectroscopy, UV-Visible spectrophotometry, and X-ray diffraction methods. The antimicrobial activity was determined using agar well diffusion and broth dilution methods. The UV-Vis spectroscopy revealed strong absorption at 250–300 nm across the samples, characteristic of phytochemicals, and FT-IR absorption bands at 600-500 cm^{-1} across the samples are characteristic of ZnO stretching in Wurtzite ZnO nanoparticles. XRD patterns exhibited the characteristic ZnO peaks between 2θ positions corresponding to 31.7° and 36.2°, confirming the formation of crystalline zincite across the samples. Scherrer equation yielded an average crystallite size of 33 nm. The antimicrobial activity of the ZnO-NPs demonstrated by zone of inhibition (22-30 mm) and MBC (0.63-2.5µg/ml) revealed higher efficacy on Methicillin resistant *Staphylococcus aureus* (MRSA) and *Helicobacter pylori*. However, *E. coli* was found to be least susceptible across all the samples perhaps due to resistance. The ZnO-NPs from *C. collinum, C. lamprocarpum* and *C. molle* extracts possess strong antimicrobial potential especially on virulent pathogens such as MRSA. Our findings highlights the role of phytochemicals from Combretaceae species for nanoparticle synthesis, and underscores the potential utilization of ZnO nanoparticles in biomedical and pharmaceutical fields as eco-friendly antimicrobial agents.

Keywords: ZnO nanoparticles, *Combretum collinum*, *C. lamprocarpum* and *C. molle,* MRSA

Unlocking Chemistry's Potential: Catalyzing Sustainable Development, Economic Growth, and Security in Nigeria

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Abstract

Nigeria's economic and security landscape is characterized by significant challenges, including over-reliance on oil, unemployment, and insecurity, that require innovative solutions. This article explores the transformative potential of chemistry in addressing these issues by diversifying the economy, improving agricultural productivity, developing alternative energy sources, and creating novel materials for infrastructure and security applications. It examines successful case studies and innovative technologies that demonstrate the role of chemistry in driving sustainable development, improving food security, and fostering economic growth. By harnessing the prospects of chemistry, Nigeria can unlock new opportunities for sustainable development, reduce its dependence on oil, create jobs, and improve the standard of living for its citizens. The article discusses and highlights the importance of investing in chemistry research and development to unravel the potential of chemistry in addressing Nigeria's economic and security challenges, providing insights and recommendations into policy and practice implications for leveraging chemistry to drive economic growth and security, and ultimately building a more resilient and prosperous Nation.

Keywords: Chemistry, Security Challenges, Economic Growth, Agricultural Productivity, Alternative Energy.

Designing Catalysts for Chemical Industries

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Abstract

Catalysis is essential for the world economy and the well-being of society and is a core area of contemporary science that underpins the manufacture of approximately 90% of chemicals necessary to produce essential materials. The global energy crisis and environmental concerns have increased research initiatives on alternatives to fossil energy and encouraged the exploration of renewable resources such as biomass for increased energy generation. Interests have been elevated exponentially around the globe due to rapid growth of population and industrialization requires a holistic approach to sustainability. Various alternative renewable energy, particularly biomass conversions, have been explored unprecedentedly. Hydrogen production from biomass and biomass-derived molecules or sustainable materials may soon be an ideal means of greener energy. Understanding of Catalysis, developing new catalytic processes with industries and promoting the use of catalysis tackles environmental pollution and energy crises.

Keyword: Catalysis, Biomass, Contemporary, renewable

The Role of Research Reactors in Preparing Nigeria for Nuclear Power Deployment

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Abstract

The aspiration to introduce nuclear power into Nigeria's energy mix, whether through Small Modular Reactors (SMRs) or large-scale nuclear power plants (NPPs), requires a critical mass of technical expertise, regulatory capacity, safety culture, and research infrastructure. Research reactors such as the Nigeria Research Reactor-1 (NIRR-1) located at the Centre for Energy Research and Training, Ahmadu Bello University, Zaria in addition to the forthcoming Multipurpose Research Reactor (Nigeria Research Reactor-2: NIRR-2) play a vital role in this regard. The aim of this paper is to assess how research reactors support national readiness for nuclear power deployment in Nigeria. It also identifies strategic frameworks through which research reactors successful transition to commercial nuclear energy. Drawn from over twenty reactor-operations years of experience, these frameworks include hands-on training in reactor operations, neutron physics, dosimetry, radiation protection, ageing management, and emergency preparedness, safety Analysis, security and safeguard in line with national standards/regulations and international best practices. With NIRR-2 now at Milestone Two, it is recommended that there should be accelerated institutional, technical, and financial commitments to ensure the project's successful realization.

Keywords: Research Reactor. Nigeria Research Reactor-1, Nuclear Power Plants, Reactor operation, Safety Analysis

Mitigating the Urban Heat Island Effect in Kaduna Metropolis, Nigeria: A Multidimensional Analysis of Causes, Impacts, and Sustainable Solutions

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Abstract

The Urban Heat Island (UHI) effect has emerged as a critical environmental challenge in rapidly urbanizing cities, particularly in developing regions where adaptive capacity and institutional response remain limited. This paper presents a comprehensive review of the causes, spatial–temporal dynamics, impacts, and mitigation pathways of the UHI phenomenon, with a focused synthesis on Kaduna Metropolis, Nigeria. Drawing on published remote sensing studies, GIS-based analyses, policy documents, and comparative global literature, the review evaluates evidence derived from multi-temporal Landsat satellite observations (1990–2021), including Land Surface Temperature (LST), Normalized Difference Vegetation Index (NDVI), Normalized Difference Built-up Index (NDBI), and the Urban Thermal Field Variance Index (UTFVI). The reviewed studies consistently report pronounced UHI intensities of up to 3.95 °C, with peak LSTs reaching 41 °C in the Central Business District, industrial zones, and major transportation corridors, in contrast to cooler peripheral vegetated areas. The synthesis identifies rapid urbanization, land use/land cover change, vegetation loss (27.21% decline), expansion of impervious surfaces, and anthropogenic heat emissions as dominant drivers of UHI in Kaduna. Temporally, UHI intensity is most pronounced during the dry season and nighttime periods, exacerbated by climatic variability and weak urban governance. The review further consolidates documented environmental, public health, and socio-economic impacts, highlighting disproportionate heat exposure among vulnerable populations in informal settlements. Drawing on comparative global case studies, the paper synthesizes context-specific mitigation strategies, including urban greening, cool materials, land-use planning reforms, and integrated urban climate governance. The review underscores the urgency of embedding climate resilience and environmental justice principles into urban and regional planning frameworks to promote sustainable and thermally resilient cities in Sub-Saharan Africa

Keywords: Urban Heat Island; Review; Land Surface Temperature; Remote Sensing; GIS; Urbanization; Climate Resilience; Kaduna Metropolis

Enhanced Energy Storage Properties of Graphene Oxide/Tungsten Trioxide Nanocomposites for Advanced Supercapacitors

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Abstract

This research presents a systematic investigation into the fabrication and electrochemical performance of $GO_{20}ml/WO_3$, $GO_{40}ml/WO_3$, and $GO_{60}ml/WO_3$, synthesized via chemical bath deposition. Graphene oxide (GO) was prepared utilizing an enhanced modified Hummer's method, and the resulting nanocomposites underwent comprehensive characterization using X-ray diffraction (XRD), scanning electron microscopy (SEM), Cyclic Voltammetry (CV), and Electrochemical Impedance Spectroscopy (EIS). Structural and morphological analyses highlighted the impact of incorporating GO into the WO_3 network, resulting in improved charge transfer and ion transport kinetics within the composite electrodes. The synergistic intercalation of cations further contributed to the enhanced electrochemical performance. Notably, the $GO_{60}ml/WO_3$ composite electrode exhibited the highest specific capacitance (780 F/g), surpassing $GO_{40}ml/WO_3$ (530 F/g) and $GO_{20}ml/WO_3$ (280 F/g). The $GO_{60}ml/WO_3$ electrode demonstrated superior energy density (70.2 Wh/kg) and exhibited a remarkable power density of 45.0 W/kg, outperforming $GO_{40}ml/WO_3$ (30.0 W/kg) and $GO_{20}ml/WO_3$ (22.5 W/kg). These findings position the $GO_{60}ml/WO_3$ composite electrode as a highly promising material for supercapacitor applications. Its high specific capacitance, energy density, and power density, underscore its potential for advancing supercapacitor technology. This study contributes valuable insights to the understanding of composite electrode materials, offering significant implications for the development of efficient and high-performance energy storage devices.

Keywords: Graphene nanosheets; Tungsten oxides; Electrochemical; Supercapacitor

THERMOELECTRIC AND OPTICAL PROPERTIES OF FECRVGA QUATERNARY HEUSLER FOR GREEN ENERGY APPLICATIONS

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Abstract

Alternative sources of clean energy are essential in view of the growing global demand for energy and its impact on the environment. Thermoelectric (TE) technology has been discovered to be the ideal answer to these problems because it can convert heat directly into electricity without producing noise and emitting CO_2. However, the industrial use of TE materials is restricted due to their low conversion efficiency. For an alloy to be appropriate for TE uses it must have a figure of merit (*zT*) greater than one. Fortunately, Heusler compounds have been shown to be good TE materials. Thus, the intention of this investigation is to find material with promising thermoelectric properties that will be suitable for TE applications. The thermoelectric, structural stability, magnetic, optical and electronic behaviour are scrutinized by the full potential-linearized augment plane wave (FP-LAPW) approach and the classical approximations by Boltzmann within density functional theory (DFT) wired in Wien2k. The results predicted for structural properties reveal that FeCrVGa is stable in the ferromagnetic Y^{III}-type. Data acquired for the phonon dispersion and formation energy establishes dynamic stability and possibility of fabricating FeCrVGa by experimental means. The electronic behavior reveals that this material is half-metallic (HM), with metallic and semiconductor behavior in the down spin and up-spin channel. Due to the excellent UV absorption and elevated refractive index over the visible wavelengths, this material is ideal for photovoltaic applications. The data of thermoelectric *zT* found for FeCrVGa is 0.72 eV at 300 K, suggesting its suitability for thermoelectric applications.

Keywords: Quaternary Heusler, Thermoelectric technology, DFT, Optical properties, FeCrVGa.

IDENTIFYING THE GEOTHERMAL CONTAINER: A SEQUENCE STRATIGRAPHIC FRAMEWORK FOR DELINEATING RESERVOIR-SEAL PAIRS IN THE TK-1 WELL, NIGER DELTA

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Abstract

Sedimentary basins host enormous geothermal potential, but the complexity of their stratigraphy and structure inhibits adequate exploration and resource characterization. This research aims at cost-effectively reducing that uncertainty by documenting a methodology of constructing a high-resolution sequence stratigraphic framework using SGR logs to precisely delineate the geothermal "container". Chemostratigraphic analysis revealed distinct mineralogical signatures. Sandstones are dominated by feldspars, micas, and glauconite, whereas mudrocks are rich in uranium and thorium. Low Th/K values suggest potassium-rich minerals like illite, mica, or feldspar. Th/K ratio cross-plots revealed smectite/mixed-layer clays. Minerals containing potassium were found in sandstones, such as glauconite and evaporites. Low Th/U ratios and high uranium values (10–15 ppm) indicated that the parent rocks were organic-rich and developed in anoxic, reducing environments. Intervals dominated by permeability-preserving kaolinite serve as prime geothermal targets, while delineating illite-rich zones as effective seals. Four Maximum Flooding Surfaces (MFSTK-1 – MFSTK-4) and five Sequence Boundaries (SBTK-1 – SBTK-5) were identified, delineating five complete parasequence sets. Sand-dominated, high-porosity lowstand systems tracts as potential geothermal reservoirs, effectively encased and sealed by clay-rich transgressive and highstand systems tracts, were mapped. This enables the targeting of viable geothermal intervals, offering a proper reduction in the risk of preliminary exploration. The results highlight the necessity of subsequent XRD (X-Ray Diffraction) analysis on these core samples, providing a systematic approach for the development of sustainable energy in basin environments worldwide.

Keywords: Spectral Gamma Ray (SGR), Geothermal Exploration, Niger Delta, Stratigraphic Framework

PHYTOCHEMICAL CHARACTERIZATION AND ANTICANCER ACTIVITY OF CHRYSOPHYLLUM ALBIDUM: A STRUCTURE-ACTIVITY APPROACH

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Abstract

We evaluated the phytochemical composition and anticancer properties of *Chrysophyllum albidum* G. Don, a traditional West African medicinal plant, through integrated chromatographic profiling, spectroscopic characterization, and computational docking studies. Sequential extraction with petroleum ether, chloroform, and methanol (72h maceration) yielded fractions that underwent GC-MS and HPLC-DAD analysis. The methanolic fraction revealed quercetin (3.8% w/w), kaempferol (2.1% w/w), and gallic acid (5.2% w/w) as principal constituents, confirmed through UV-Vis spectroscopy (λmax 256, 370 nm for quercetin) and mass spectrometry (m/z 302 $[M+H]^+$). These polyphenolic compounds demonstrated significant antioxidant activity with DPPH radical scavenging capacity (IC_{50} = 18.4 ± 2.1 µg/mL, comparable to ascorbic acid standard at 15.3 µg/mL). Molecular docking simulations using AutoDock Vina showed quercetin binding to the ATP-binding pocket of EGFR tyrosine kinase with favorable thermodynamic parameters (ΔG = -8.7 kcal/mol, Ki = 0.42 µM), while gallic acid exhibited strong π-π stacking interactions with VEGFR-2 (ΔG = -7.3 kcal/mol), suggesting competitive enzyme inhibition mechanisms. MTT cytotoxicity assays confirmed concentration-dependent growth inhibition against HeLa (IC_{50} = 42.6 µg/mL) and MCF-7 cells (IC_{50} = 38.9 µg/mL) after 48h treatment, with selectivity indices of 2.8 and 3.1 respectively against normal fibroblasts. These findings support *C. albidum* as a promising source of bioactive natural compounds warranting structure optimization, mechanistic validation, and preclinical evaluation.

Keywords: *Chrysophyllum albidum*, phytochemical screening, tyrosine kinase inhibitors, polyphenols, cytotoxicity

HARNESSING NUTRIENT NANOPARTICLES FROM CROPS FOR BIOFORTIFICATION IN ORDER TO AMELIORATE FOOD PROBLEMS IN NIGERIA: A REVIEW

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Abstract

Nigeria faces persistent challenges of malnutrition and micronutrient deficiencies, particularly in iron, zinc, and other essential minerals, due to over-dependence on staple crops with poor nutrient density. Harnessing nutrient-nanoparticles derived from crops offers a novel, sustainable pathway for biofortification to mitigate these food insecurity problems. This review explores the potential of crop-based nutrient-nanoparticles as biofortification agents to enhance the nutritional quality of food crops. Emphasis is placed on the synthesis of biogenic nanoparticles from plant extracts and residues, their physicochemical characterization, and their roles in improving nutrient uptake, stability, and bioavailability. The integration of nanotechnology into agricultural biofortification presents multiple advantages, including targeted nutrient delivery, reduced environmental contamination, and improved soil–plant nutrient dynamics. Additionally, the review highlights current progress, prospects, and challenges in applying nano-biofortification techniques within Nigeria's agricultural framework. Key limitations include infrastructural gaps, regulatory uncertainties, and insufficient awareness of nanotechnology applications in food systems. Nevertheless, the adoption of nutrient-nanoparticle biofortification strategies—supported by interdisciplinary research, policy innovation, and farmer education—could revolutionize Nigeria's approach to combating micronutrient malnutrition. Ultimately, this emerging technology holds promise for achieving food security, nutritional adequacy, and sustainable agricultural productivity across the nation.

KEYWORDS; Iron, Biofortification, Nanoparticles, Micronutrient, Zinc.

SYNTHESIS, SPECTROSCOPIC AND NANOCRYSTALLINE CHARACTERIZATION, AND ENHANCED ANTIMICROBIAL ACTIVITY OF A NEW COPPER(II) COMPLEX WITH A BENZOTHIAZOLE-VANILLIN SCHIFF BASE LIGAND

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ABSTRACT

The growing challenge posed by multidrug-resistant pathogens underscores the urgent need for novel antimicrobial agents. This study reports the synthesis and characterization of a new Schiff base ligand, derived from the condensation of 2-amino-6-methylbenzothiazole and *o*-vanillin, and its subsequent complexation with copper(II) chloride dihydrate. The synthesized ligand and its resulting copper(II) complex were characterized using physical and spectroscopic techniques, including melting-point determination, molar conductivity, magnetic susceptibility, Fourier-transform infrared (FTIR) spectroscopy, UV-Visible spectroscopy, and powder X-ray diffraction (XRD). The successful formation of a stable, crystalline complex was confirmed by XRD, which revealed its nanocrystalline nature and an average crystallite size of 12.92 nm. The antimicrobial activity of both the free ligand and the complex was evaluated against a panel of pathogenic microbes. The results demonstrated that the copper(II) complex exhibits significantly enhanced antimicrobial activity compared to the uncoordinated Schiff base ligand. This superior efficacy is attributed to the chelation effect, which increases the complex's lipophilicity and facilitates its uptake into microbial cells, and the nanocrystalline nature, which provides a high surface area for interaction with pathogens. These findings highlight the potential of this compound as a promising candidate for drug discovery.

Keywords: Schiff base, Benzothiazole, Copper(II) complex, Antimicrobial activity, Coordination chemistry.

COMPARATIVE ASSESSMENT OF SOIL NITROGEN, PHOSPHORUS AND POTASSIUM (NPK) LEVELS AS FERTILITY INDICATORS IN IRRIGATED AND RAINFED FARMLANDS OF KURA, KANO STATE.

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ABSTRACT

The ability of soil to provide nutrients to crops is the most common ways of characterizing its fertility. The aim of this study was to compare the Nitrogen, phosphorus and potassium (NPK) levels between selected irrigated and rainfed farmlands of Kura Local Government, Kano state. Soil samples were collected from selected irrigated and rainfed farming plots at a depth (0-20cm). The samples were analyzed to determine chemical parameters which include soil pH, Electrical Conductivity (EC), Organic matter content, total Nitrogen (TN), available Phosphorus (AP) and Potassium concentrations. The total Nitrogen of the soil samples was determined by Micro-Kjeldhal method using Labconco rapid distillation apparatus, available phosphorus was determined by Bray No1 method and potassium concentration by compulsive exchange method. The findings of this study indicated that rainfed soil possess significantly higher ($P<0.05$) pH, Organic matter, total nitrogen and Phosphorus. The findings however revealed that Irrigated soil possess insignificantly higher ($P>0.05$) potassium concentration. This study revealed that both the irrigated and rainfed farmlands samples were rated as fertile soils because all the parameters analysed are with the range of fertile soil and rainfed soil show more availability of nutrients analysed which are crucial for supporting plant growth. This research provides valuable insights for farmers and agricultural policymakers, emphasizing the need for improved irrigation strategies and soil management practices to enhance crop productivity and ensure food security.

KEYWORDS: Irrigated, Nutrients, Rainfed, Fertility

COMPARATIVE ANALYSIS OF PHYSICOCHEMICAL AND THERMOPHYSICAL PROPERTIES OF COCONUT OIL EXTRACTED BY COLD PRESS AND SOLVENT METHODS

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ABSTRACT

Coconut oil serves as an important edible and industrial product, with its quality significantly affected by the extraction method utilised. This research compares the physicochemical and thermophysical properties of coconut oil derived from cold pressing (Sample A) and solvent extraction (Sample B). Oils were analysed in triplicate for essential parameters, including acid value, iodine value, peroxide value, saponification value, density, viscosity, refractive index, thermal conductivity, and fatty acid composition via GC-MS. Both extraction methods yielded oils that were rich in lauric acid, myristic acid, and oleic acid, exhibiting similar distributions. Solvent extraction produced a wider chromatographic spectrum with more volatile compounds and demonstrated higher peroxide values (2.7 meq O_2/kg) than cold-pressed oil (1.9 meq O_2/kg), indicating greater oxidative susceptibility. Cold-pressed oil exhibited greater thermal conductivity (0.196 W/m•K) compared to solvent-extracted oil (0.189 W/m•K), indicating enhanced heat transfer properties. Solvent extraction improved yield and chemical diversity; however, cold pressing maintained superior stability and purity, making it more appropriate for culinary and medicinal uses that require oxidation resistance.

Keywords: cold pressing; lauric acid; myristic acid; and oleic acid

SYNTHESIS OF 4-CHLORO-2-[(4-FLUOROPHENYL) IMINOMETHYL] PHENOL AND ITS ZINC(II) COMPLEX FOR CONTROL OF POST-HARVEST DETERIORATION OF TOMATO

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Abstract

Post-harvest losses of tomatoes are major threat to food security in developing countries, Nigeria inclusive. The study was conducted to detect microbes contaminant of tomato spoilage during post-harvest storage from two different markets in Makurdi, Nigeria. The synthesised ligand and its Zn(II) complex were used to test antimicrobial activities of the Schiff base ligand and its Zn(II) complex against the detected microbes. In this study, we synthesized a Schiff base ligand and its Zn(II) complex by condensation reaction of 5-chlorosalicylaldehyde and 4-flouroaniline at room temperature using 20 mL of ethanol through magnetic stirring while its Zn(II) complex was obtained by grinding the ligand and zinc salt. The ligand and its complex were characterized using FTIR and UV-Vis. The antimicrobial activities of the synthesised compounds were tested using Agar-well diffusion technique for zone of inhibition while Agar-dilution technique was used for minimum inhibitory and bactericidal or fungicidal concentration. The results of the FTIR and electronic spectra, indicates that O-N donor atoms of the Schiff base ligand participated in the coordination and thus, the Schiff ligand and its Zn(II) complex were tested against the detected microbes to evaluate their antimicrobial activities against the isolated and identified microbes. It was realized that, the Zn(II) complex displayed higher level of inhibition against the detected bacteria strains than the fungi strains. The minimum inhibitory/bactericidal or fungicidal concentration confirmed that the Zn(II) complex will be more effective against the isolated bacteria post-harvest loss thus opened a novel promise to the prevention of post-harvest loss of tomato.

Keywords: Post-harvest, Synthesis, Characterization, Antimicrobial, Schiff base Complexes

OPTIMIZED RECOVERY OF CRISTOBALITE SILICA FROM RICE HUSK ASH USING NAOH LEACHING

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ABSTRACT

This study successfully demonstrates the extraction and characterization of silica from rice husk, an abundant agricultural waste. The process involved charring the rice husk followed by an alkaline leaching method using sodium hydroxide (NaOH) to isolate the silica. This study investigated the percentage of silica extraction considering different parameters such as : effects of leachant concentrations, reaction time and temperature on the leaching kinetics to determine the optimal extraction conditions. X-ray Diffraction (XRD), XRF and SEM analysis was employed to characterize both the raw rice husk ash and the final silica product. At the optimum condition, leaching time of 120 minutes and a [NaOH] concentration of 2M, yielding 7.75g of silica.The characterization analysis confirmed the successful extraction, identifying the presence of silica in the form of Cristobalite (SiO_2) in the final product. The study concludes that rice husk is a viable and sustainable source for high-value silica production, offering an effective method for repurposing agricultural waste into a useful industrial material. Further purification of the extracted silica is recommended to enhance its quality for potential applications.

Keywords: Cristobalite silica, Rice Husk, X-ray Diffraction (XRD), Alkaline Leaching

THE PHYSICOCHEMICAL AND ANTIMICROBIAL CHARACTERISTICS OF MORINDA CITRIFOLIA FRUITS SOAP MADE WITH SHEABUTTER

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Abstract

The growing preference for natural and eco-friendly skincare products has intensified research into plant-based soaps with therapeutic benefits. This study investigates the physicochemical and antimicrobial characteristics of Morinda citrifolia (noni) fruit extract soap formulated with shea butter, with the aim of developing a mild, effective, and environmentally sustainable cleansing product. Fresh noni fruits were allowed to ferment naturally to obtain the extract, which was subsequently incorporated into a cold saponification process involving sodium hydroxide, shea butter, and other base oils. The formulated soap was evaluated for key physicochemical parameters, including pH, moisture content, total fatty matter, free alkali, and foam stability, and compared with a commercial medicated soap. Antimicrobial activity was determined using the agar well diffusion method against Staphylococcus aureus, Escherichia coli, and Candida albicans. Results showed that the non–shea butter soap possessed a pH within the recommended range (8.5–10.0), exhibited good foaming ability, and had low free alkali content, indicating safety and skin compatibility. The soap also demonstrated significant antimicrobial activity, particularly against S. aureus and E. coli, suggesting that active bio-compounds from the noni extract were retained. The inclusion of shea butter further enhanced the soap's moisturizing and protective qualities. The formulated soap exhibited favourable physicochemical stability and strong antimicrobial potential, establishing it as a natural, safe, and sustainable alternative to synthetic commercial soaps for improved skincare and hygiene.

Keywords: Morinda citrifolia, Shea butter, Physicochemical properties, Antimicrobial activity, Natural soap

EXTRACTION AND CHARACTERIZATION OF MINT LEAF OIL

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ABSTRACT

This study investigates the extraction and characterization of essential oil from mint (*Mentha piperita*) leaves, a medicinal and aromatic plant known for its therapeutic, nutritional, and industrial significance. Fresh mint leaves were collected, dried, ground, and subjected to Soxhlet extraction using n-hexane at 60°C for four hours. The extracted oil was analyzed for its physicochemical properties, including iodine value, peroxide value, acid value, and saponification value, as well as functional group identification using Fourier Transform Infrared Spectroscopy (FTIR) and chemical composition profiling through Gas Chromatography–Mass Spectrometry (GC–MS). The obtained mint oil was brown in color with a pleasant aroma and exhibited an iodine value of 5.21 g I_2/w, peroxide value of 4.16 mg/kg, acid value of 1.21 mg KOH/g, and saponification value of 428.76 mg KOH/g, indicating high stability and purity. FTIR analysis confirmed the presence of hydroxyl, carbonyl, alkane, and terpene functional groups, while GC–MS revealed major constituents including 9-octadecenoic acid, methyl stearate, squalene, and methyl 12-hydroxy-9-octadecenoate. These compounds contribute to the oil's antioxidant, antimicrobial, and anti-inflammatory properties. The study concludes that mint leaf oil is a valuable natural product with potential applications in pharmaceuticals, cosmetics, and food industries, providing a sustainable alternative to synthetic compounds.

Keywords: Mint leaf oil, Soxhlet extraction, Physicochemical properties, FTIR, GC–MS.

GREEN SYNTHESIS AND CHARACTERIZATION OF TIO_2 NANOPARTICLES

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Abstract

An eco-friendly and novel techniques for synthesizing TiO_2 nanoparticles using plant sources is necessary. This paper focused on the green synthesis of TiO_2 nanoparticles using the stem of Ugu plant extract as reducing, stabilizing and capping agent. The synthesized nanoparticles was analysed for mineralogical phase structure, elemental composition, particles size and morphology using X-ray diffraction (XRD), Energy Dispersive X-ray (EDX), Dynamic Light Scattering (DLS) and Transmission Electron Microcopy (TEM). The XRD result showed six distinct peaks at angles of 29.46°, 43.22°, 56.40°, 63.56° 64.85° and 74.44° which is related to planes of (011), (004), (020), (015) (121) and (024) with designated phase structure of anatase and crystal size of 12.09 nm. The elemental compositions also showed a separate peak of titanium (Ti, 4.01keV) and Oxygen (O, 0.51keV). While the surface morphology showed spherical shape and mostly were roughly circular in shape with smooth edges with average size of 29.23 nm and particles size distribution of 13.26 nm. This results suggest that TiO_2 nanoparticles as unique properties that can be utilized in the area of science and engineering especially as a nanoadsorbent to remove heavy metals from wastewater.

Keywords: Eco-friendly, TiO_2, nanoparticles, anatase, morphology

ANALYTICAL POTENTIAL OF UV-VIS SPECTROPHOTOMETRIC DETERMINATION OF SELECTED HEAVY METALS (PB, CR, CD AND AS) IN SOIL, WATER AND BIOLOGICAL SAMPLES WITH ACETYLPYRIDINE-2,4-DINITROPHENYL HYDRAZONE AS THE CHROMOGENIC REAGENT

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Abstract

The persistence of toxic heavy metals in the environment represents a major threat to ecological systems and human health. Among these contaminants, lead (Pb), cadmium (Cd), chromium (Cr), and arsenic (As) are particularly concerning due to their bioaccumulative potential and adverse biological effects. Conventional analytical methods such as atomic absorption spectrophotometry (AAS) and inductively coupled plasma mass spectrometry (ICP-MS), though highly sensitive, remain costly, instrument-intensive, and less accessible in resource-limited regions. The method was optimized with respect to complexation conditions, pH, reagent concentration, and interference effects. Comparative evaluation with AAS demonstrated excellent agreement, with relative errors within ±3.5% and no significant statistical differences ($p > 0.05$) across all matrices. The developed method successfully detected trace levels of metals, such as 0.008 µg/g Cd in well water and 0.010 µg/g As in irrigation water, confirming its sensitivity for environmental monitoring. Recovery studies conducted by spiking known concentrations (50–500 µg/mL) yielded high recoveries (99.80–99.99%) with low standard deviations (±0.1–0.4), affirming the accuracy and reproducibility of the technique. Application to real samples from the Challawa Industrial Area of Kano State, Nigeria, revealed elevated levels of Pb and Cr in wastewater and soil, highlighting significant industrial contamination and associated ecological risks. The robustness of the APDH method across diverse matrices, including animal tissues, plant samples, soils, and water, underscores its versatility and field applicability. In conclusion, the APDH-based spectrophotometric method provides a reliable, sensitive, and low-cost alternative to conventional spectrometric techniques for heavy metal determination.

Keywords: Heavy metals, UV-Vis spectrophotometry, acetylpyridine-2,4-dinitrophenyl hydrazone, environmental monitoring, resource-limited settings.

OIL BEARING SEEDS WASTES, AN ALTERNATIVE PRECURSOR FOR ADSORBENT PREPARATION

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Abstract

Activated carbons (ACs) were prepared from oil bearing seeds wastes: monkey cola, baobab and fluted pumpkin. Chemical activation using $ZnCl_2$ was employed for adsorbent preparation. The obtained qualities of the prepared adsorbents were all good, with low ash content ranging from 0.10%-0.20%, high carbon yield (31.60%-64.55%) and iodine sorption capacity, ranging from 68.29%-92.68%. The obtained surface areas (values ranging from 405m^2/g-625m^2/g) of the prepared ACs were also of good porosity. Scanning Electron Microscopy (SEM) of the prepared adsorbents showed the presence of cavities in them. The surface nature of the prepared adsorbent was studied using FTIR, which shows the presence of functional groups like carbonyls: ketones, aldehydes, lactones and carboxylic groups. These results obtained are in agreement with data reported for other adsorbents employed in the removal of toxic pollutants from water and waste water. Hence, this research findings show that, monkey cola, baobab and fluted pumpkin oil seeds wastes can find use as low-cost adsorbent in curbing the menace of water and waste water pollution.

Keywords: Pollution, Wastes, Adsorption, oil, pollutants.

EFFICIENT MECHANOCHEMICAL DEVULCANIZATION OF INDUSTRIAL WASTE RUBBER USING DIPHENYL DISULFIDE: A HORIKX ANALYSIS APPROACH

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Abstract

The recycling of rubber wastes presents both environmental and economic challenges. This study explores mechanochemical devulcanization of industrial waste rubber, (IWR) to recover pristine elastomer using a two-roll mill and diphenyl disulfide (DPDS) at 6 -10 wt% concentration, a 5–minute milling time, and a temperature of 100℃. Key methods employed include scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDX) and Fourier transform Infrared spectroscopy (FT-IR) for analyzing morphology, elemental composition and functional groups respectively. The devulcaniization process resulted in irregular aggregates with heterogeneous particle size distributions. The elemental composition showed an increase in nitrogen concentration from 1.82% to 6.49% and FT-IR spectra confirmed the presence of cyano group absorption at 2220cm^{-1} absent in the IWR spectrum. Crosslink density of devulcanized rubber significantly reduced from 0.02585 mol/cm^3 to 0.00035 mol/cm^3. The devuilcanization percentage achieved ranged from 92.38% to 98.67%, with Horikx curve analysis affirming effective devulcanization with minimal main-chain degradation. The findings demonstrate that mechanochemical devulcanization using DPDS is a promising method for recovering rubber molecules from IWR while preserving the polymer structure. Further evaluation of the mechanical properties of the recovered rubber is necessary to determine its reprocessing capabilities and applications

Keywords: Rubber Waste, Recycling, selective scission, crosslink density

HARNESSING THE BIOFORTIFICATION OF IRON AND ZINC THROUGH NANO-FERTILIZERS IN ORDER TO MITIGATE NIGERIA'S FOOD PROBLEM: A REVIEW

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ABSTRACT

Micronutrient deficiencies, particularly iron (Fe) and zinc (Zn) deficiencies, remain major public health concerns in Nigeria, contributing to anaemia, stunted growth, and weakened immunity. Conventional fertilization and food fortification strategies have achieved limited success due to low nutrient bioavailability, poor soil quality, and post-harvest nutrient losses. This review explores the potential of **nano-fertilizers** as an innovative biofortification approach to enhance Fe and Zn content in staple crops, thereby mitigating Nigeria's persistent food and nutrition challenges. Nano-fertilizers, formulated at the nanoscale, possess superior solubility, controlled nutrient release, and enhanced plant uptake efficiency compared to traditional fertilizers. Their application in soil or foliar feeding has demonstrated increased nutrient use efficiency, improved crop yield, and higher micronutrient accumulation in edible plant parts. Furthermore, integrating nano-fertilizers with sustainable agronomic practices could address both soil fertility depletion and micronutrient malnutrition simultaneously. The review also highlights safety considerations, environmental implications, and the need for regulatory frameworks to ensure responsible deployment. By harnessing nano-enabled biofortification of Fe and Zn, Nigeria can advance toward achieving food and nutritional security, reduce reliance on chemical fertilizers, and support sustainable agricultural transformation. The study concludes that strategic investment in research, farmer education, and policy support is essential for translating nano-fertilizer innovations into practical solutions for combating hidden hunger and strengthening national food systems.

Keywords: Nano-fertilizers, Iron, Zinc, Micronutrient deficiency, Nigeria

MINERAL COMPOSITION AND ANTIMICROBIAL ACTIVITIES OF FOLIAR SURFACE AND TISSUE EXTRACTS OF SELECTED INDIGENOUS VEGETABLES

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Abstract

Medicinal plants are prominent reservoir bioactive compounds and secondary metabolites that serve as alternatives to conventional drugs in the course of easing drug resistance. *Senecio biafrae* and *Crassocephalum crepidioides* have been traditionally acknowledged for various therapeutic potentials. This study aimed at evaluating the antimicrobial activities of *S. biafrae* and *C. crepidioides* against selected microorganisms. *S. biafrae* and *C. crepidioides* extracts were obtained and screened for the presence of vital minerals and secondary metabolites using conventional protocols. The extracts were further evaluated for antimicrobial activity The result of the mineral analysis showed that mean value of calcium content was 61.79±0.25 and 74.11±0.26 for *C. crepidioides* and *S. biafrae* respectively. The phytochemical screening results positive presence of saponins, alkaloids, flavonoids and phenolic compounds for *C. crepidioides* and *S. biafrae* extracts. The antimicrobial activities of the extracts against the test organisms revealed varying degrees of inhibition as they were effective against the tested organisms. The *C. crepidioides* extracts obtained from both foliar surface and leaf residue demonstrated higher inhibitory potentials against most of the tested bacterial and fungal isolates. This study highlights the antimicrobial properties of the extracts and their potentials as nutritional supplements and therapeutic agents.

Keywords: Medicinal plants, phytochemicals, antimicrobial properties, therapeutics, vegetables

GROUNDWATER QUALITY ASSESSMENTS AND EFFECTS ON HUMAN HEALTH: A CASE STUDY OF DAMATURU, YOBE STATE, NORTH EASTERN NIGERIA

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Abstract

Groundwater obtained from public sources has a high tendency to harbour contaminants, and access to portable water is crucial for a healthy life, as toxins pose significant threats to human health. Fifteen water samples were collected around the Buhari Estate, Dikumari, Tashan Kurma, Ajari, and Gwanje communities in Damaturu, Yobe State. The water quality was thoroughly assessed, and the associated potential human health effects were adequately evaluated. The mean pH values from the Tashan Kurma and Ajari samples were acidic, indicating contamination. The mean EC, TDS, colour, hardness, alkalinity, and turbidity values were below the threshold, and the mean DO was high in Gwanje samples. The average anion concentrations were low, but PO_4^{3-} had high values. The mean values of K^+ and Na^+ were low, and Mg^{2+} had high values. The mean Ni and Cr concentrations were high in all samples and were major contributors to the water's unsuitability for consumption. The mean concentrations of Cd and Co were high in Gwanje, Buhari, and Dikumari samples. Gwanje samples were the most polluted with toxins. The samples indicated moderately high corrosion tendencies and high WQI and CI values, except in the Buhari Estate samples. The *E. coli* and MPN loads were high in all samples, posing significant health risks. The carcinogenic and non-carcinogenic potential risks were high for both children and adults. The borehole sources were not suitable for consumption without appropriate treatment, and this study will help inform the inhabitants about this danger and the government's measures to reduce contamination.

Keywords: Damaturu, Drinking water, Contaminants, Hydro-chemical, Health Risks

TOCOPHERYLQUINONE FROM NIGERIAN FICUS SYCOMORUS LINN (MORACEAE)

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ABSTRACT

Medicinal plants have been used for the treatment of various diseases and still play an important role in covering the basic health needs in the developing countries like Nigeria. Herein we consider a West African medicinal plant Ficus sycomorus Linn (Family: Moraceae). This plant is distributed in tropical West Africa and is used to treat various diseases such as mental illness, dysentery, cough, diarrhea, fever, tuberculosis and cancer. F. sycomorus is a tree of about 60 ft height with pale trunk and widespread crown pilose branchlets. This study aimed to isolate some compounds from the leaf of Ficus sycomorus. The dried pulverized leaf of the plant was extracted by successive extraction using dichloromethane followed by methanol with occasional shaking for seventy-two hours. The extract was drained, filtered and concentrated to obtain dichloromethane extract ad methanol extract respectively. The dichloromethane extract was subjected to Flash Column Chromatography using mobile phase, which progressed from 100% n-hexane to a 1:1 mixture of dichloromethane and ethylacetate. Silica gel (60-120 mesh size) was used as stationary phase. Further purification of the column fractions led to isolation α-Tocopherylquinone The structure of this compound was established by careful analysis of their spectral (IR, GC-MS 1H, 13C and 2D NMR) data and comparing them with those previously reported in the literature.

Keywords: *Ficus sycomorus*, Moraceae, Chromatography, α-Tocopherylquinone Flavonoid, NMR

CHEMICAL COMPOSITION OF *TEPHROSIA BRACTEOLATA* SEED: AN UNDERUTILISED LEGUME WITH POTENTIALS IN FOOD AND AGRO-ALLIED INDUSTRY

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ABSTRACT

This study designed to investigate the chemical compositions of *Tephrosia bracteolata* brings out the potentials of this legume. Samples were prepared and subjected to various laboratory techniques. Proximate composition, amino acids profile, some micronutrient and anti-nutrients compositions analyses were done. The result of the proximate analysis shows 27.13% crude protein, 18.05% crude fat 41.34% total carbohydrate, 12.33% crude fibre, 4.42% ash and 9.40% moisture. Values for anti-nutrients; saponin, tannin, phytate, oxalate, cyanide and trypsin inhibitor are 7.93mg/100g, 3.18mg/100g, 1.21mg/100g, 0.52mg/100g, 0.08mg/100g, 0.00148mg/100g respectively. Vitamin A content is 1.01 mg/100g, vitamin C 57.47mg/100g and vitamin E 1.19mg/100g. All minerals (Ca, Mg, Fe, Zn, K, and P) analysed are found present with levels of 184.37, 63.46, 108.36, 29.43, 931.83, 410.36mg/100g respectively. Amino Acid profile of T.bracteolata showed that leucine, lysine, isoleucine, phenylalanin, tryptophan, valine, methionine, histidine and threonine were high compared to reference standards. Non-essential amino acids were also high; especially Aspartate, Glutamate, Alanine, Arginine, Proline and Serine. Calculated amino acid score reveals high protein quality. Overall, the results present *T.bracteolata* as a very good source of nutrient and raw materials for food and agro-allied industry.

Keywords: Tephrosia bracteolata, legume, nutrient, anti-nutrient, composition

GREEN SYNTHESIS OF SILVER NANOPARTICLES FROM NIGERIAN MEDICINAL PLANTS: A BIOCHEMICAL REVIEW AND ECONOMIC PERSPECTIVE

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ABSTRACT

Nanotechnology constitutes a cutting-edge domain of scientific innovation with significant potential to drive economic transformation in developing nations, including Nigeria. Despite this promise, many of these countries continue to encounter substantial challenges in adopting sustainable and cost-efficient methods for nanoparticle production. Conventional chemical synthesis of silver nanoparticles (AgNPs) is expensive, environmentally hazardous, and relies heavily on imported materials. This review explores the green synthesis of silver nanoparticles (AgNPs) using Nigerian medicinal plants, emphasizing the biochemical mechanisms and economic implications, thereby providing a sustainable alternative. Phytochemicals such as flavonoids, tannins, and phenolic compounds act as natural reducing and stabilizing agents; enabling eco-friendly nanoparticle production while leveraging local botanical resources. Plant-mediated AgNPs show strong antimicrobial, antioxidant, and catalytic properties, making them suitable for pharmaceutical, agricultural, and industrial applications. Characterization techniques (UV–Visible spectroscopy, FTIR, SEM, XRD) confirm their formation, size, and morphology. Leveraging Nigeria's rich medicinal flora for AgNP production reduces manufacturing costs, minimizes environmental impact, and enhances local value addition. However, standardization of synthesis protocols, quality control, and environmental safety remains an important consideration for large-scale applications. Successful deployment of green nanotechnology requires attention to standardization of synthesis protocols, quality control, and environmental safety. The study concludes that strategic investment in nanobiotechnology research, coupled with supportive policy frameworks, is essential to translate laboratory innovations into practical socio-economic benefits. By integrating biochemistry-driven green synthesis of AgNPs into Nigeria's bioeconomy, the country can achieve sustainable scientific breakthroughs, foster local innovation, create employment, and reduce reliance on imported materials.

Keywords: Green synthesis, Biogenic silver nanoparticles, Phytochemical reduction, Nanobiotechnology

GREY RATIONAL OPTIMIZATION OF EPOXIDIZED ALKYL NEEM-PALM KERNEL OIL BLENDS FOR FREE-BREATHING TRANSFORMER INSULATION

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Abstract

The improvement of thermo-oxidative stability of vegetable oil-based transformer insulation oil through epoxidation as a chemical modification tool improves oxidation stability. However, it can affect physicochemical properties by increasing viscosity, density, and pour point depending on the fatty acid composition of the vegetable oil. This can affect fluid flow and, consequently, the oil's cooling function. In this study, Grey Rational Analysis was used to determine the optimum composite oil prepared from epoxidized alkyl-esters of neem and palm kernel vegetable oils of blend ratios 90:10, 80:20,..., 50:50 using measured responses such as viscosity, density, pour point, dissipation factor, relative permittivity, specific heat capacity and viscosity activation energy. The grey grades were then analyzed using Taguchi´s form signal-to-noise ratio (S/N). The addition of 40% palm kernel epoxide to epoxidized neem alkyl ester reduced viscosity by 40% and yielded oil composite with an optimal response, mitigating the epoxidation-induced increase in neem alkyl ester viscosity. The developed composite oil is considered a potential insulation liquid in high-voltage free-breathing transformers.

Keywords: Epoxidation, Grey Rational Analysis, Physicochemical Properties, Epoxide, Fatty Acid

GREEN SYNTHESIS OF CU, FE, AND CU/FE NANOMATERIALS USING *KHAYA SENEGALENSIS* AND INVESTIGATION OF THEIR PHOTOCATALYTIC REDUCTION OF 4-NITROPHENOL AND ANTIBACTERIAL PROPERTIES

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Abstract

The rapidly growing demand for sustainable nanotechnologies has become a cause for finding environmentally benign, effective green synthesis methods, which has increased interest. Herein, we report on a facile, one-pot, plant-mediated process for the green synthesis of monometallic (CuO and Fe_2O_3) and bimetallic CuO/Fe_2O_3 nanoparticles (NPs). This extract is abundant in flavonoids and tannins, acting as a reducing and capping agent. A comprehensive physicochemical characterization established the formation of similar spherical uni-sized nanoparticles (20-50 nm) where a distinctive surface plasmon resonance property was observed for each NP (UV–Vis: 224 nm (CuO), 290 nm (Fe_2O_3), and redshift at 295 nm (CuO/Fe_2O_3)) and characteristic phytochemical signatures were verified (FTIR: O–H, C=O and M–O vibrations). The bimetallic CuO/Fe_2O_3 NPs could quickly and totally convert 4-nitrophenol to 4-aminophenol in just 2 minutes, more than 50 % faster than the monometallic NPs. These NPs also had strong antibacterial and antibiofilm effects, which is important. The minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) values for *Escherichia coli* and *Bacillus subtilis* were 8 and 16 µg/ml, respectively. The values of *Pseudomonas aeruginosa* were 40 and 80 µg/ml, respectively. Additionally, biofilm inhibition studies showed more than 50 % reduction at minimum biofilm inhibitory concentration (MBIC) values ranging from 16 to 160 µg/ml. These results highlight the multifunctional potential of *K. senegalensis*-derived CuO/Fe_2O_3 bimetallic NPs as promising options for environmental remediation and effective antimicrobial solutions.

Keywords: Green synthesis, bimetallic nanoparticles, *Khaya senegalensis*, catalytic properties, antibacterial activity

INFLUENCE OF CALCINATION TEMPERATURE ON THE CRYSTALLOGRAPHIC CHARACTERISTICS OF NICKEL OXIDE (NIO) NANOPARTICLES FOR ENHANCE ELECTROMAGNETIC INTERFERENCE SHIELDING

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Abstract

The rapid progress in electronic devices and communication systems has led to electronic pollution, which has a negative impact on the environment. This research focused on studying the influence of calcination temperature on the crystallographic properties of NiO nanoparticles. Several analytical methods were used to characterize the final product, with X-ray diffraction revealing a cubic structure in the synthesized NiO nanoparticles. The average crystallite size and lattice stress were determined using various techniques, including the Scherrer method (S-M), the modified Scherer method (MSM), the size-strain diagram (SSP), and the Halder-Wagner method (H-W). With increasing calcination temperature, an increase in the average crystallite size from 20.45 to 42.15 nm was observed, a trend confirmed by TEM and FESEM analysis. In addition, the study investigated the influence of particle size on the electromagnetic interference shielding effectiveness (EMI SE) of NiO/PVA nanocomposites. The results showed a significant increase in adsorption loss (SE_A), reflection loss (SE_R), and total electromagnetic interference (EMI) shielding effectiveness (SE_T) as the particle size of the NiO nanofiller decreased. The highest observed shielding effectiveness value was 21.95 dB and was observed for the smallest nanofiller size. This improvement is due to the reduction in particle size of NiO nanofillers, improving the material's ability to absorb and reflect electromagnetic waves. This consequently leads to improved EMI shielding performance in the NiO/PVA nanocomposite. Therefore, it can be deduced that the size of the NiO nanofiller profoundly impacts the efficacy of electromagnetic interference (EMI) shielding, rendering it suitable for attenuating electromagnetic waves.

Keywords: Nickel oxide, X-ray profile analysis, Nanoparticles, electronic pollution, electromagnetic interference

SUBTHEME 5: HEALTH EPIDEMIOLOGY AND SOCIETAL SYSTEMS MODELLING

GREEN SYNTHESIS OF SILVER NANOPARTICLES USING *MANGIFERA INDICA* AGAINST *ESCHERICHIA COLI* AND *STAPHYLOCOCCUS AUREUS*

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Abstract

The emergence of antibiotic-resistant bacteria poses a significant challenge to public health and underscores the need for alternative antimicrobial strategies. This study investigated the green synthesis of silver nanoparticles using *Mangifera indica* against *Escherichia coli* and *Staphylococcus aureus.* The bacterial isolates were identified using colonial morphology, Gram staining, and series of biochemical tests. *Mangifera indica*-Synthesized Silver Nanoparticles (MI-AgNP) were synthesized via a green biosynthesis approach using aqueous *Mangifera indica* leaf extract and characterized for their antibacterial properties. Their antibacterial activities were evaluated using the agar well diffusion method. The synthesized MI-AgNP were characterized using UV-VIS spectrometry. The results were compared with those of a standard antibiotic, Ciprofloxacin. *Mangifera indica*-synthesized AgNPs (MI-AgNPs) demonstrated strong antibacterial activity, producing inhibition zones of 18 mm and 15 mm against *E. coli* and *S. aureus*, respectively. The ethanol and water extracts of both plants showed no observable inhibition, indicating that nanoparticle formation significantly enhances antibacterial efficacy. In conclusion, *Mangifera indica* can serve as effective biological agents for the green synthesis of silver nanoparticles with substantial antibacterial potential

Keywords: silver nanoparticles, *Mangifera indica, Escherichia coli*, *Staphylococcus aureus*

THE IMPACT OF EMERGING NLP-DRIVEN MODELS FOR ADVERSE DRUG REACTION DETECTION IN NIGERIA

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Abstract

In the management of Infectious diseases such as malaria, Adverse Drug Reactions (ADRs) have posed a significant public health concern, especially in Nigeria. Treatment regimens for malaria frequently lead to misclassified harmful reactions. Conventional pharmacovigilance systems depend strongly on structured forms, clinician-driven documentation, and manual reporting. This has resulted in delayed signal detection and incomplete national drug-safety data. Current literature has shown that Natural Language Processing (NLP) models enable automated classification, extraction, and interpretation of ADR-related signals from unstructured clinical notes, electronic health records, patient-generated narratives on social media and biomedical literature, thereby offering the potential to transform and strengthen ADR detection. Findings demonstrated that conventional machine learning techniques, such as Naïve Bayes and Support Vector Machines, have improved performance but struggled with contextual understanding, while early rule-based and lexicon-driven approaches produced high precision but poor scalability. Deep learning architectures such as Recurrent Neural Networks (RNNs), Long Short-Term Memory (LSTM), Bidirectional Long Short-Term Memory (BiLSTM), and Convolutional Neural Network (CNN) are able to advance ADR detection by learning semantic features from raw text. In the forefront of this, state-of-the-art transformer-based models harness domain-specific pretraining and self-attention mechanisms that enable more accurate detection of drug relations that pertain to the Nigerian healthcare settings. Generally, emerging NLP-driven models present a captivating pathway for strengthening Nigeria's pharmacovigilance capacity, enhancing overall patient safety and improving early detection of harmful drug reactions across diverse healthcare systems.

Keywords: Natural Language Processing, Adverse drug reaction, Pharmacovigilance, Transformer Models, Nigeria healthcare system

PREDICTION OF BIOLOGICAL ACTIVITIES OF COMPLEXES OF CHROMIUM (III) WITH SCHIff BASES DERIVED FROM 3-NITROACETOHENONE WITH P-ANILINE DERIVATIVES: INSIGHTS FROM EXPERIMENTAL AND *IN-SILICO* STUDIES

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Abstract

Schiff bases derived from *3*-nitroacetohenone with p-chloroaniline and p-nitroaniline, respectively, were chelated with Chromium(III) ion. The complexes and the Schiff bases were characterized spectroscopically with FT-IR, NMR, UV-Visible, melting point/decomposition and solubility test. The purity of the compounds were determined using thin layer chromatography. The compounds were soluble in most organic solvents and the melting point/decomposition temperature were found to be within the range of 151-192 °C for the Schiff bases and 172-200 °C for the metal chelates. The IR spectroscopic data indicated that the Schiff bases acted as monodentate and coordinated via imine nitrogen. Antimicrobial studies of the ligands and their chelates were carried out *in-vitro* against two fungal species (*Aspergillus niger* and *Candida albican*), two gram gram positive bacteria (*Staphylococcus aureus* and *Bacillus subtilis*) and two gram negative bacteria (*Eschaerichia coli* and *Samonella typhi*).The chelates were more active than the ligands but less active compared to standard drugs (ciprofloxacin and econazole). *In-silico* studies of the ligands and their metal complexes were also carried out to determine their stability, geometry and electronic properties. Global reactive descriptors (electrochemical potential, chemical hardness, electrophilicity index) of the compounds were calculated from the HOMO and LUMO of the ligand and chelates. The docking output revealed good binding affinities ranging from -92.98 kcal/mol to -199.69 kcal/mol which signified that the compounds can bind efficiently with various targeted proteins. *In-silico* StopTox battery of tests endpoints showed that the chelates were better drug candidates than the free Schiff bases from which the metal complexes were synthesized.

Keywords: Schiff bases, Chromium (III) complexes, Biological activities, StopTox, Systemic, topical chemical toxicities

DETERMINISTIC GRAPH-BASED MODEL OF CERVICAL CANCER

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Abstract

Cervical cancer, driven primarily by persistent human papillomavirus (HPV) infection, continues to pose a significant public health burden, especially in low- and middle-income countries. This study presents a deterministic graph-based compartmental model to describe the transmission dynamics and multi-stage progression of cervical cancer, incorporating diagnosis, treatment, and recovery pathways. The female population is stratified into eight distinct compartments: susceptible, HPV-infected, precancerous, early-stage cancer, late-stage cancer, two treatment classes, and recovered individuals. The model is formulated as a system of nonlinear ordinary differential equations representing transitions between compartments. We establish that the model is well posed by proving fundamental properties, including the positivity and boundedness of solutions, as well as the existence and uniqueness of solutions for biologically relevant initial conditions. Furthermore, basic reproduction was calculated using the next generation matrix method and stability analysis of the disease-free equilibrium is conducted to assess epidemiological consistency and long-term dynamics. The model not only provides a theoretical framework for understanding cervical cancer progression but also serves as a foundation for evaluating control strategies such as enhanced screening and optimized treatment protocols using spectral graph theoretic methods.

Keywords: cervical cancer, HPV, positivity and boundedness, basic reproduction, graph theory.

Evaluation of *Ficus ingens* Extract Against some Bacterial Isolates

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Abstract

The rising in antimicrobial resistance is a global concern, which arises as a result of indiscriminate or misused of antibiotic for the treatment of infectious diseases as well as the emergence of antibiotic resistance strain. There is need for the search for alternative antibiotic that is less in toxicity and easily accessible. *Ficus ingens* is a plant belongs to the family *Moraceae*. It is used locally to treat sores. This paper tends to evaluate the antibacterial potential of the plant extract. The phytochemical were screened using standard procedures for phytochemical assessments and the antibacterial were asses using agar well diffusion method. The plant extract reveals the presence of alkaloids, flavonoids, tannins, steroids, glycosides and saponins. The invitro antibacterial against *S. aureus*, *E. Coli* shown good highest zone of inhibition of 22mm for *staphylococcus aureus* and 16mm for *Escherichia coli*. The activity of the plant extract could be attributed to phytochemicals present in the plant.

Keywords: Antibiotic, phytochemical, *Ficus ingens,* Evaluation

LOCAL STABILITY ANALYSIS OF A MATHEMATICAL MODEL FOR RABIES TRANSMISSION DYNAMICS AND CONTROL STRATEGIES USING DELAY DIFFERENTIAL EQUATIONS

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Abstract

Rabies is a viral disease that affects the central nervous system, causing inflammation to the brain. It is primarily spread to human beings through the salva of infected animals usually through the bite or scratches. Delay differential equations are used in time delay analysis of mathematical models to account for the delayed effects of variables on each other. In this research, we formulate a mathematical model for rabies transmission dynamics using delay differential equations; we performed mathematical analysis to establish the positivity and boundedness of the solutions, ensuring that the model accurately reflects real-world constraints and population dynamics, the disease Free Equilibrium and the basic reproduction number of the model were obtained, and the reproduction numbers with combination of two control strategies. The effective reproduction number computed has been used to measure the relative impact for individual or combined intervention for effective disease control. The Jacobian matrix stability technique was used to analysed the stability of the disease free equilibrium. The analysis shows that the disease free equilibrium is locally asymptotically stable. This discovery indicates that the disease can be reduced in the population.

Keywords: Model formulation, Basic Properties, Equilibrium points, Basic Reproduction number, Stability analysis.

COMPUTER-AIDED INVESTIGATION OF SOME NOVEL ANTI-OBESITY DRUG CANDIDATES: A MOLECULAR DOCKING, PHARMACOKINETIC PROPERTIES AND DFT ANALYSIS

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Abstract

Obesity is a global epidemic disease and represents an important public health problem both in developed and developing countries. Obesity is a metabolic disorder that is accompanied by insulin resistance, hyperinsulinemia, dyslipidaemia and fatty liver diseases. In 2016 nearly 2 billion adults were classified as overweight, while the obese were approximately 650 million worldwide. According to the World Health Organisation (WHO), the rate of Obesity has tripled since 1975 and is recognized as the fifth leading cause of death (2.8 million per year). In this study, a total number of 63 compounds were virtually screened via molecular docking to investigate their mode of binding interactions against their target receptor. Furthermore, the pharmacokinetic properties of the potential lead compounds were also analyzed using SWEISSADME and pkCSM online webtools. DFT calculation was also performed to determine the stability and reactivity of the studied compounds. According to the molecular docking performed, compound 7c among the studied compounds with the highest mole dock score of -148.327 kcal/mol was identified to be the best potential lead, which furthermore showed better affinity than the standard drug (Lovastatin) with the mole dock score of -124.751kcal/mol. The evaluated pharmacokinetic profiles of the studied compounds were found to be pharmacologically active, non-toxic, orally bioavailable and permeable with zero violation of the Lipinski's rule of five one of the criteria used in the assessment of drug-likeness of a small molecule. Furthermore, the density functional theory (DFT) calculation indicated that compound 5a with the least energy band gap of 3.73eV is the most reactive. Based on this research, the lead compound can serve as a template for designing new potential inhibitors of adipogenesis because of its affinity toward the target receptors, reactivity and safety.

Keywords: Molecular docking; Drug-likeness; Pharmacokinetic; DFT Analysis.

PHYTOCHEMICALS PROFILES AND FREE RADICAL SCAVENGING ACTIVITIES OF THE ROOT BARKS OF *CASSIA SIEBERIANA USING* 1,1-DIPHENYL-2-PICRYL HYDRAZYL AND 2, 2 - AZINOBIS - ETHYL BENZOTHIOZOLINE - 6 – SULPHONIC ACID

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ABSTRACT

Cassia sieberiana, a medicinal plant commonly used in traditional medicine in West Africa, including Nigeria. This study investigated the phytochemical profiles and free radical scavenging activities of the root barks of *Cassia sieberiana*, a plant used in traditional medicine. The root barks of *C. sieberiana* weight (100 g) were extracted with Sexhlet extractor using six different solvents based on polarity guided method and the respective extracts were concentrated under reduced pressure. Methyl acetate, Methanol and 70 % Methanol extracts of Cassia sieberiana were investigated for its phytochemicals qualitatively and quantitatively using standard methods and free radical scavenging activities were evaluated using 1,1-Diphenyl-2-Picryl Hydrazyl (DPPH) and 2,2-Azinobis-Ethyl Benzothiozoline-6-Sulphonic Acid (ABTS) assays. Qualitative screening of the extract revealed the presence of Saponins, Quinones, Phenols, Steroids, Tannins, Flavonoids, Terpenoids, Anthraquinones, Cardiac glycosides, Alkaloids, Carbohydrates, Glycosides and Coumarins in the three respective solvents. Flavonoids, Phenolic, Tannins, Saponins, Steroids and Alkaloids were quantified with highest values of 38.74 (mg QE/g) in Methyl acetate, 259.78 (mg GAE/g) in MeOH, 228.67 (mg TAE/g) in Methyl acetate, 208.44 (mg DE/g) in 70 % MeOH, 108.08 (mg βSSE/mg) in 70 % MeOH and 1.81 (mg CE/g) in 70 % MeOH respectively. The free radical scavenging activities results showed that the extracts exhibited significant free radical scavenging activities, with IC_{50} values of 30.19 mg/mL of Methyl acetate with 75 % inhibition and 22.67 mg/mL of MeOH with inhibition 89.18 % for DPPH and ABTS assays, respectively. The study identified a positive correlation between the phytochemical content and free radical scavenging activities, suggesting that the root barks of *C. sieberiana* possess antioxidant properties. These findings support the traditional use of C. sieberiana for various diseases and highlight its potential as a source of natural antioxidants.

Keywords: Cassia sieberiana, Phytochemicals, DPPH, ABTS and Antioxidant.

MULTIVARIATE STATISTICAL MODELLING OF NON-COMMUNICABLE DISEASE RISK FACTORS IN NIGERIA INSIGHTS FROM NATIONAL HEALTH DATA

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Abstract

The increasing prevalence of non-communicable diseases (NCDs) in Nigeria necessitates a multidimensional analytical approach. Using data from the 2018 Nigeria Demographic and Health Survey (NDHS) and WHO STEPS survey, this study employed multivariate regression and factor analysis to explore relationships among hypertension, obesity, diabetes, and socioeconomic variables. Three latent factors lifestyle, income, and urbanization, explained most of the variance in NCD clustering. Strong positive correlations were observed between obesity and hypertension among urban adults. The findings highlight the interconnected nature of NCD risk factors and support the adoption of integrated prevention strategies tailored to Nigeria's socio-epidemiological context.

Keywords: Non-communicable diseases, multivariate analysis, Nigeria Demographic and Health Survey, WHO STEPS, risk factors

DAMPNESS IN CHEMICAL LABORATORY BUILDINGS AND HEALTH: EPIDEMIOLOGICAL STUDY ON THE ASSOCIATION BETWEEN INDOOR ENVIRONMENTAL FACTORS AND INDUCTION OF ALLERGIC CONTACT DERMATITIS AMONG NORTH EAST NIGERIAN LABORATORY UNIVERSITY WORKERS

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Abstract

This study was aimed to identify the dampness in chemical laboratory buildings and association between indoor environmental factors and induction of ACD among laboratory university workers as a result of multiple chemicals exposure in laboratories. The study was a cross-sectional on a population-based sample of Nigerian laboratory university workers. The study area and the participants were randomly chosen from available workers of university laboratories. Erythema index meter (EIM) and indoor air quality control meter (IAQM) were used for measuring erythema index difference (EID) corresponds to Cellular Mediated Hypersensitivity (CMH). EID ≥ 0.1 describe to have a positive reaction to CMH, meaning induction of ACD, whereas EID <0.1 describe to have a negative reaction, no induction of ACD, and the environmental factors respectively. The study included 287 respondents consisted of 122 females and 164 males. The results showed that the number of positive with ACD was 176 (61.3%) with 99 (56.3%) of them were male with AOR 0.28 (95%CI: 0.18, 0.67; p=0.011). Dark-skinned participants with ACD had AOR 0.49 (95%CI: 0.31, 071; p=0.001). Most of the respondents in damped chemical laboratory buildings have college education and have been exposed for 4-6hrs in the laboratory with AOR 3.42 (95%CI: 1.50, 5.38; p = 0.035) and 3.22 (95%CI: 1.33, 8.55; p =0.001) respectively. The use of personal protective equipment in the damped chemical laboratory buildings (PPE) was 60% less likely to be significantly induced with ACD with AOR 0.40 (95%CI: 0.22, 0.77; p=0.011). The mean indoor air concentrations in a dose-dependent manner for chemical parameters range from 573.0 ppm to 853.0 ppm, 19.9 ppm to 17.3 ppm, 4.7 ppm to 7.5 ppm, and 5.3 ppm to 8.1 ppm for CO_2, CO, NO_2, H_2S and SO_2The Permissible exposure limit (PEL) of chemical was less but have an induced ACD with AOR 4.22 (95%CI: 2.88, 12.11; p =0.004). Findings of this study revealed that dampness in chemical laboratory buildings, sex, skin color, working experience, educational level, PPE, PEL, and time of exposure were the probable predictive environmental factors associated with the development and inducement of ACD. This study has shown that ACD was significantly associated with occupational and environmental factors. Better educational knowledge and attitude of hazards and safety in the laboratory would lead to a reduced rate of new cases.

Keywords: Allergic Contact Dermatitis. Cellular Mediated Hypersensitivity, Erythema index meter, Laboratory Workers, indoor air quality control meter

DESIGN EXPERT MATHEMATICAL OPTIMIZATION OF Β-GALACTOSIDASE PRODUCTION PROCESS PARAMETERS USING RESPONSE SURFACE METHODOLOGY

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Abstract

The growing demand for β-galactosidase enzyme spurs the need for sustainable production methods including mathematical optimization of process parameters. Sequel, this study was sought to screen different strains from cheap sources for producing β-galactosidase and optimize the production parameters using Response Surface Methodology (RSM). Bread samples were obtained in ABU main campus and cultured on Potato Dextrose Agar (PDA) plates. The isolates obtained were identified using morphological, microscopy and Sangers's sequencing. The β-galactosidase production potential was assayed using plate assay. The best producer was employed for optimization using RSM in DOE and the best production conditions were validated. The isolates were found to be *A. niger*, *A. flavus*, *A. fumigatus* and *A. nidulans*. The of β-galactosidase production screening revealed *A. niger* to be the highest producer (23mm zone of halo), followed by *A. nidulas* (8mm), then *A. fumigatus* (5mm) and the least was *A. flavus* (2mm). The quadratic model of the optimization was statistically significant (F=7.60, P=0.0095), with pH showing a significant influence (p=0.0005). The optimal conditions predicted by the model were 30.97 °C and pH 3.55 and these conditions yielded a 25mm zone of β-galactosidase activity halo after validation which was also very close to the highest prediction of 26mm by the model. Conclusively, these findings showed that isolated and fully characterized indigenous *A. niger* isolated from spoilt bread had 23mm zone of halo for β-galactosidase activity, the most potent β-galactosidase producer among the isolates assayed and after RSM optimization with CCD using design expert, it increased to 25mm.

Keywords: Design Expert, Mathematical Optimization, β-galactosidase production parameters, Response Surface Methodology.

HARNESSING ETHNOMEDICINAL POTENTIALS OF *CITRUS AURANTIFOLIA* AND *ANACARDIUM OCCIDENTALE* FOR LOCAL DRUG DEVELOPMENT: A STRATEGY TO MITIGATE NIGERIA'S ECONOMIC CHALLENGES

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Abstract

In the face of rising economic crises in Nigeria, characterised by escalating foreign exchange rates and soaring costs of imported pharmaceuticals, the need for sustainable, local drug production is very critical. This study reviewed the phytochemical constituents and biological activities of two indigenous ethnomedicinal plants - *Citrus aurantifolia* and *Anacardium occidentale,* proposing their domestication and utilisation as a cost-effective local strategy for new drug development to reduce over-reliance on imported pharmaceuticals. Primary searches were performed across five academic databases - Google Scholar, PubMed, ScienceDirect, Scopus, and African Journals Online. Available data showed that *C. aurantifolia* is rich in flavonoids (quercetin, hesperidin), terpenoids (β-pinene, d-limonene), and phenolic acids (gallic, tannic acids). These phytoconstituents confer essential biological activities, including antioxidant (flavonoid, vitamin C), bacteriostatic (phenolics), and anti-inflammatory properties. The leaf infusion is used for fever, while the fruit juice is utilised for cough and sore throat relief. *A. occidentale* stem bark contains valuable phenolic acids, including gallic acid, tannic acid, catechin, and epicatechin. These phytoconstituents are associated with potent anti-inflammatory activities via the modulation of pro-inflammatory mediators and chemokines. Other traditional applications include the use of cashew gum for chronic inflammation and diabetes. The review concludes that presence of these bioactive compounds and demonstrated biological activities in these locally available medicinal plants provide a strong scientific basis. Therefore, investment in research and large-scale processing of these medicinal plants represents a viable pathway to homegrown drug production, offering a sustainable solution to boost local pharmaceutical self-sufficiency and alleviate pressure on the national economy.

Keywords: *Citrus aurantifolia, Anacardium occidentale*, drug development.

SUPPORT VECTOR MACHINE TO PREDICT CLINICAL AND DEMOGRAPHIC FACTORS AFFECTING CHANGES IN CD4+ CELL COUNT AMONG INDIVIDUALS LIVING WITH HIV/AIDS

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Abstract

Human Immunodeficiency (HIV) is the virus that causes acquired immune deficiency syndrome (AIDS) in human body. The virus attacks the white blood cells which make it difficult for a person's body to fight off any infection. HIV is an infectious virus that mainly affects $CD4^+$ T cells. As a result of this infection, the number of these cells steadily decreases the organisms that protect the body against foreign antigens, gradually leading to acquired immune deficiency syndrome (AIDS). The research's main focus is to determine the predictive techniques for the predicting of clinical and demographic factors affecting CD4 cell count among individuals living with HIV/AIDS. Clinical and demographic data were collected from record department of Rasheed Shakoni teaching hospital Dutse, located at Jigawa central senatorial zone of Nigeria. We employed support vector machine algorithm. The models' predictive performances were tested using four different metrics. The results of the study shows that support vector machine models give an outstanding performance with an accuracy, sensitivity, specificity and kappa. Model performance metrics achievement was 0.9565, 0.8750, 0.9737, 0.8487. The outcome of this research will increase reliability in prediction, which could benefit the health administrators to guide their planning activities for program implementation as well as improve support, care, treatment, and prevention of HIV.

Keywords: HIV/AIDS, CD4 T cell,supervised Machine learning. SVM support vector machine,

RELAXOMETRIC CHARACTERIZATION OF BIOLOGICAL TISSUES USING MODIFIED BLOCH NMR EQUATION WITH GAUSSIAN-BASED CORRECTION FACTOR

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ABSTRACT

Characterization of MRI signal can be used to monitor pathological changes in biological tissues when image contrasts are generated but this advancement in imaging is limited mathematically as a lot of truncation and assumption of boundary conditions leads to in accurate visual representation of the contrast. This study utilizes the Bloch NMR model and treats all the components of magnetization with appropriate boundary conditions in specific coordinate system. The magnetization-signal inverse transformation was achieved by standard Bessel expression. Wolfram Mathematica was used to visualize the MRI raw signal without correction factor where experimental relaxation times from literature serve as input to characterize the biological samples (Deoxygenated blood, Adipose tissue, Gray matter and White matter). The samples signal with respect to T_2 distribution tends to display exponential growth but proportionate profiles for all the tissues in this order of signal magnitudes $S_{AT}(T_2) \succ S_{WM}(T_2) \succ S_{GM}(T_2) \succ S_{DB}(T_2)$. The behavior presented by the profile does not agree with experiment for all the tissues, therefore Gaussian-based modification was introduced where peak spin-spin relaxation times, T_{2P}, were extrapolated from the MRI signal-T_2 profile. The study derived a Gaussian-based correction factor, $G(T_2)$, for reconstruction of signal to generate peak spin-spin relaxation times, T_{2P}, for detailed visual contrast as $S_{DB}(T_2) \succ S_{GM}(T_2) \succ S_{WM}(T_2) \succ S_{AT}(T_2)$ with corresponding T_{2P} values 65.00, 80.00, 91.01, and 100.05 respectively.

Key word: Bloch NMR, Gaussian-based, Wolfram Mathematica, contrast, Magnetization signal

FROM QSAR TO DYNAMICS: A DATA-DRIVEN DESIGN OF DRUG-LIKE LACTAM-BASED HDAC INHIBITORS FOR DIFFUSE LARGE B-CELL LYMPHOMA

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Abstract

Computational chemistry techniques were applied to design lactam-based HDAC2 inhibitors with improved physicochemical and binding characteristics relevant to diffuse large B-cell lymphoma (DLBCL) therapy. A validated three-descriptor QSAR model (R^2 = 0.7869, Q^2_LOO = 0.6870, CCC_ext = 0.9395) guided scaffold selection and activity prediction. Molecular docking and ADMET analyses identified compound 14 as a promising candidate (pIC_{50} = 6.57, ΔG = –11.1 kcal/mol) relative to Tucidinostat (pIC_{50} = 5.69, ΔG = –10.5 kcal/mol). Structure-based optimization yielded derivative 14c, showing higher docking affinity (–11.5 kcal/mol), excellent intestinal absorption (93.6%), and compliance with Lipinski's rule of five. Molecular dynamics simulations (100 ns) confirmed stable binding (RMSD ≈ 1.1 Å) with reduced backbone fluctuations. MM/GBSA calculations produced a binding free energy of –59.7 $kcalmol^{-1}$ dominated by van der Waals and hydrophobic interactions. These results highlight compound 14c as a computationally optimized HDAC2 inhibitor with favourable energetic stability, underscoring the role of QSAR, docking, and dynamics simulations in rational drug design within the physical sciences.

Keywords: computational chemistry, QSAR modelling, molecular docking, molecular dynamics, diffuse large B-cell lymphoma

STUDY OF THE PRODUCTION OF COPPER 64 THERAGNOSTIC MEDICAL RADIOISOTOPE

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Abstract

Theragnosis is generally considered in nuclear medicines as an intervention strategy combining therapy with diagnosis. Scientific and technological progress leading to safe and efficient production and wider applicability of theragnostic radioisotopes require the determination of detailed nuclear data for application across necessary energy regions. Apart from different cyclotron production methods, research reactors are viable alternative for the production of ^{64}Cu. Using the Nigerian Research Reactor 1 (NIRR 1), presently operated with Low Enriched Uranium (LEU) core, both the low specific activity activation cross section of the ^{63}Cu(n,γ)^{64}Cu reaction and the fast neutron spectrum averaged cross sections of the high specific activity ^{64}Zn(n,p)^{64}Cu and ^{65}Cu(n,2n)^{64}Cu reactions were experimentally determined. For the latter, parameter of ^{27}Al(n,p)^{27}Mg and ^{197}Au(n,p)^{198}Au reactions were used in a comparator technique. The result obtained were found to be in good agreement with recommended data within standard deviation and were comparatively assessed with evaluations using the EMPIRE code. Complementarily, the measured data were used to clarify the model description suitable for theoretical prediction of the reactions of interest including the Optical Model, Coupled Channel and Level Density Parameters. Applications in the determination of the yield and purity for the production reactions considered were also investigated and shown to be in good agreement within acceptable margins.

Keywords: Theragnosis, Copper 64, Cross Section, Spectrum Average Cross Section NIRR 1, LEU

ASSESSMENT OF PATIENT ENTRANCE SKIN AND EFFECTIVE DOSES IN DIAGNOSTIC X-RAY EXAMINATIONS

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Abstract

Diagnostic X-ray imaging is one of the largest artificial sources of ionizing radiation exposure to the general population, and patient doses can be measured directly using thermoluminescent dosimeters (TLDs). This study assessed the entrance skin dose (ESD) and effective dose (ED) received by adult patients undergoing routine diagnostic X-ray examinations at Ahmadu Bello University Teaching Hospital, Nigeria. TLDs and CALDose_X version 5.0 software were employed to estimate the ESD and ED for examinations of the chest (AP and lateral), lumbar spine (AP and lateral), knee (AP and lateral), femur (AP and lateral), and pelvis (AP). Patient and exposure parameters considered included age, sex, body weight, type of examination, projection, tube potential, and tube current–time product. Using TLD measurements, the mean ESD and ED were found to be 0.32 mGy and 0.016 mSv (chest AP), 0.43 mGy and 0.021 mSv (chest lateral), 0.30 mGy and 0.035 mSv (lumbar spine AP), 0.68 mGy and 0.081 mSv (lumbar spine lateral), 0.16 mGy and 0.002 mSv (knee AP), 0.16 mGy and 0.002 mSv (knee lateral), 0.27 mGy and 0.003 mSv (femur AP), 0.19 mGy and 0.002 mSv (femur lateral), and 0.89 mGy and 0.038 mSv (pelvis AP). The corresponding mean ESD and ED values obtained using CALDose_X 5.0 software were 0.94 mGy and 0.047 mSv (chest AP), 1.36 mGy and 0.021 mSv (chest lateral), and 2.29 mGy and 0.114 mSv (pelvis AP). Overall, the ESD and ED values estimated using CALDose_X were higher than those measured with TLDs; however, they compared favorably with internationally established diagnostic reference levels. The effective dose estimates indicate that the associated radiation risk factors are relatively low, suggesting that patient exposures during these routine diagnostic procedures are within acceptable radiological safety limits.

Keywords: Diagnostic X-ray, ESD, TLD, Effective Dose, Radiation Protection

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