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THE 8TH INTERNATIONAL WORKSHOP/CONFERENCE ON NANOTECHNOLOGY ORGANIZED BY NANOTECHNOLOGY RESEARCH GROUP (*NANO*+), LADOKE AKINTOLA UNIVERSITY OF TECHNOLOGY OGBOMOSO, NIGERIA

AND

CELEBRATION OF EXCELLENCE IN NANOTECHNOLOGY RESEARCH BY *NANO*+ @10

BOOK OF ABSTRACTS OF THE HYBRID CONFERENCE

NANOTECHNOLOGY REVOLUTION FOR SUSTAINABLE DEVELOPMENT: SECURING THE FUTURE FOR THE BENEFITS OF HUMANITY

DATE: MONDAY 18 - FRIDAY 22 NOVEMBER, 2024

VENUE: THE HALL, LAUTECH, OGBOMOSO, NIGERIA & ZOOM

Chairman
Prof. Razaq Olatunde Rom Kalilu
Vice-Chancellor, LAUTECH, Ogbomoso, Nigeria

Host/Convener
Prof. Agbaje Lateef
Head, Nanotechnology Research Group (*NANO*+), LAUTECH, Ogbomoso, Nigeria

Co-LOC Chairperson
Prof. Musibau A. Azeez
Department of Pure and Applied Biology, LAUTECH, Ogbomoso, Nigeria

Special Guest of Honour
Chief Uche Godffrey Nnaji
Honourable Minister of Innovation, Science and Technology, Abuja, Nigeria

Guests of Honour
Senator AbdulFatai Buhari, Chairman, Senate Committee on Land Transportation
Hon. Lanre Oladebo, Deputy Chairman, House Committee on Housing and Habitat

Permanent Secretary, Ministry of Innovation, Science and Technology
Mr. Chris J. Maiyaki, Acting Executive Secretary, National Universities Commission (NUC), Abuja
Arc. Sonny Echono, Executive Secretary, Tertiary Education Trust Fund (TETFund), Abuja
Mr. Taiye Williams, MD, LUBCON International Limited, Ilorin, Nigeria

KEYNOTE SPEAKER

Professor Martins Emeje
Director-General,
Nigeria Natural Medicine Development Agency (NNMDA), Lagos, Nigeria

Speakers at the Conference

Prof. Enock O. Dare, Department of Chemistry, Federal University of Agriculture, Abeokuta, Nigeria

Prof. Yogendra K. Mishra, University of Southern Denmark, SØnderborg, Denmark

Prof. Fabian. I. Ezema, Department of Physics, University of Nigeria, Nsukka, Nigeria

Associate Prof. Hassan Soleimani, Department of Fundamental and Applied Sciences, Universiti Teknologi PETRONAS 32610 Seri Iskandar Perak Malaysia

Prof. Ambali S. AbdulKareem, Department of Chemical Engineering, Federal University of Technology, Minna, Niger State, Nigeria

Prof. Sheriff Adewuyi, Department of Chemistry, Federal University of Agriculture, Abeokuta, Nigeria

Dr. Elias E. Elemike, Department of Chemistry, Federal University of Petroleum Resources, Effurun, Delta State, Nigeria

Prof. AbdulLateef Bakre, Department of Pharmaceutics and Pharmaceutical Technology, Olabisi Onabanjo University, Ago-Iwoye, Nigeria

Dr. Hammad Arshad, Department of Biology, Lahore Garrison University, Lahore, Pakistan

Dr. Okunola A. Alabi, Department of Biology, Federal University of Technology, Akure, Nigeria

SCHEDULE OF ACTIVITIES (TIME ZONE GMT +1)

DAY ONE (TUESDAY, NOVEMBER 19, 2024)
WORKSHOP ON THE SYNTHESIS, CHARACTERIZATION, AND APPLICATIONS OF NANOPARTICLES

S/N	TIME	ACTIVITIES	VENUE/ANCHOR
1.	8:00 – 9:30 am	Arrival and registration	Old Biology Laboratory
2.	9.30 – 10.00 am	Introduction of *NANO*⁺	Prof. A. Lateef/Prof. T.B. Asafa
3.	10:00 – 10:40 am	Overview of nanotechnology, biosynthesis of nanoparticles and applications	Prof. J.A. Badmus
4.	10:40 – 10:50 am	Questions and Answers	Prof. T.A. Yekeen
5.	10:50 – 11:10 am	**Tea Break**	
6.	11:20 am	Courtesy visit to Dean, FPAS, LAUTECH	Office of the Dean
7.	11:40 – 12:30 pm	Practical session on the green synthesis of nanoparticles-Prof. E.A. Adebayo, Prof. J.A. Badmus & Dr. O. Adedokun	Research Lab, Department of Pure and Applied Biology, LAUTECH
8.	12:30 – 1:00 pm	Basic characterization of nanoparticles I- UV-Vis and FTIR spectroscopy	Dr. O. Adedokun
9.	1:00 – 2:00 pm	**Lunch**	
10.	2:00 – 2:30 pm	Basic characterization of nanoparticles II- Electron microscopic analysis of nanoparticles	Prof. T.B. Asafa
11.	2:30 – 3:00 pm	Funding research in Africa: Opportunities for Nigerian scientists	Dr. O.A. Alabi, Federal University of Technology, Akure, Nigeria
12.	3:00-3.30 pm	African bioresources as substrates for sustainable nanotechnology	Dr. E.E. Elemike, Federal University of Petroleum Resources, Effurun, Nigeria
13.	3.30 – 4.00 pm	Basic characterization of nanoparticles III- XRD	Prof. M.O. Durowoju
14.	4.00 – 4.30 pm	Questions and interactive session	Prof. I.C. Oladipo

DAY TWO (WEDNESDAY, NOVEMBER 20, 2024): OPENING CEREMONY

Time	Activities	Anchor/Presenter
9:00 am	Arrival and registration of participants	**Prof. T.B. Asafa/Dr. M.K. Awodele**
9:30	Courtesy visit to the Vice Chancellor	**Public & Alumni Relations, LAUTECH**
9:45	Arrival of dignitaries and special guests	**Protocol**
10:00	Anthems	**Public & Alumni Relations, LAUTECH**
10:10	Introduction of guests	**Public & Alumni Relations, LAUTECH**
10:15	Host's speech	**Prof. A. Lateef** Head, Nanotechnology Research Group (*NANO*⁺), LAUTECH, Ogbomoso
10:20	Speech by Chairman, National steering committee on nanotechnology policy development	**Dr. M.E.J. Bassey** Director, Chemical Technology, FMIST, Abuja
10:30	10th year anniversary and documentary about *NANO*⁺	**Media team/Prof. M.A. Azeez**
	Goodwill messages	**Public & Alumni Relations, LAUTECH**
10:50	Vice Chancellor and Chairman's speech	**Prof. Razaq O. Rom Kalilu**

		Vice-Chancellor, LAUTECH, Ogbomoso
11:30	Minister's speech	**Chief Uche Geoffrey Nnaji,** Honourable Minister of Innovation, Science and Technology, Abuja
11:30	Citation of Keynote Speaker	**Prof. T.B. Asafa**
11:35-12-30	Keynote Speech	**Prof. Martins Emeje** DG/CEO, Nigeria Natural Medicine Development Agency (NNMDA), Lagos, Nigeria
12:30	Closing remark/Vote of thanks	**Prof. I.C. Oladipo** Secretary, *NANO*+, LAUTECH, Ogbomoso
12:40	Photograph session	**Protocols**
12:40	**Short break**	
1:00 pm	Citation of lead speaker	**Prof. M.A. Azeez**
1:00-2:00	**Lead paper:** Circularity and sustainable nanotechnology win-win strategies to Sustainability; hinging the duo with	**Prof. Enock O. Dare** Federal University of Agriculture, Abeokuta, Nigeria
2:00	**Lunch break**	
2:10-2:50		
DISCUSSION/INTERACTION		
3:00	**BREAK-OUT SESSIONS (NOVEMBER 20, 2024)** **SESSION A (PHYSICAL/ENGINEERING)**	
	Moderators	**Prof. M.O. Durowoju/Dr. M.K. Awodele**
	ABSTRACT NUMBER/TITLE	**AUTHORS/PRESENTERS**
3:00-3:40	**Invited Lecture 4**: TiO_2-based photoactive materials: synthesis, mechanism, and effectiveness for treating effluent from petroleum refineries	**Prof. Fabian I. Ezema** Department of Physics and Astronomy, University of Nigeria, Nsukka, Nigeria
3:40	**2024/P001:** Determination of elemental composition of bitter kola (*Garcinia kola*) using x-ray fluorescence (XRF) method	Garba, A.A.
3:50	**2024/P003:** The effect of Ce doping on the magnetic properties of $NdFe_{11}Ti$ alloys	Shehu, J., Shchetinin, I.V., and Habib, Z.G.
4:00	**2024/P007:** Development of nanocomposite for military body armour applications: potentials and challenges in Nigeria	Muhammad, I.D., Arudi I.S., and Haruna, A.S.
4:10	**2024/P009:** Application of nanotechnology in renewable energy	Lawal, M.
4:20	**2024/P010:** Highly efficient CsPbBr3 Perovskite solar cells with TiO_2 nanoparticles and quaternary chalcogenide Cu_2FeSnS_4 as charge transport channels	Danladi, E., and Yusuf, A.S.
4:30	**2024/P011:** Application and impact of nanotechnology in solar cells for human development	Garba, A.A.
4:40	**2024/P012:** Self-sustaining solution combustion synthesis of ZnO nanoparticles: effect of fuel on particle properties and antimicrobial activity	Masokano, D.S.A., Sadiq, I.A., and Sani, U.
4:50	**2024/P013:** Comparing the effects of nano and microparticles sizes on the properties of hybrid copper	Eze, A.A., Sadiku, E.R., Kupolati, W.K., Snyman, J., Ndambuki, J.M., and Ibrahim,

	alloys made via SPS technique	I.D.
5:00	**Participants are to move to the general room for closing**	
BREAK-OUT SESSIONS (NOVEMBER 20, 2024) SESSION B (BIOMEDICAL)		
	Moderators	**Prof. I.C. Oladipo/Prof. J.A. Badmus**
	ABSTRACT NUMBER/TITLE	**AUTHORS/PRESENTERS**
3:00-3:40	**Invited Lecture 4**: Nanoparticle-based drug delivery systems: challenges and opportunities	**Prof. Lateef G. Bakre** Department of Pharmaceutics and Pharmaceutical Technology, Olabisi Onabanjo University, Nigeria
3:40	**2024/B002:** Encapsulation of *Justicia carnea* leaf extract with different wall materials	Oladeji, O.A., Awolu, O.O., Falade, O.O., and Agbi, P.I.
3:50	**2024/B004:** Comparative study on the antimicrobial activity of polyvinyl pyrrolidone stabilized silver nanoparticles and lemongrass essential oil	Ibraheem, S.A., Balarabe, F.T., Adegbe, E.A., Musa, M.J., Balogun, E.O., and Barminas, J.T.
4:00	**2024/B005:** Innovations in nano-based sunscreens: advancing skin protection through nanotechnology	Salau, A.K., Shehu, M.S., Olarewaju, O.I, and Adisa, K.O.
4:10	**2024/B006:** Nanoemulsion-based drug delivery systems for dermatological disorders	Salau, A.K., Shehu, M.S., Sorunke, T.A., Adeyemo, A.A., Adeusi, H.A., Dada, S.O., and Amusan, K.A.
4:20	**2024/B008:** Bimetallic iron oxide nanoparticles for antimycobacterial applications	Badejo, M., Tapfuma, K., Mpundu, H., Baatjies, L., and Mavumengwana, V.
4:30	**2024/B016:** Biosynthesis of zinc oxide nanoparticles using *Colocasia esculenta* leaf extract and *in vitro* antimicrobial studies of white yam pathogens	Ugosor, P.T., Shausu, A.A., and Ornguga, T.T.
4:40	**2024/B020:** The role of nanomaterials in enhancing the industrial preservation of probiotics for safe and sustainable food production: a review	Ohijeagbon, O.R., Adegbola, G.M., Ajaiyeoba, T.A., Ajibade, O.A., Omotayo, J.A., Bolarinwa, I.F., and Oladipo, I.C
4:50	**2024/B021:** Synthesis of amodiaquine loaded chitosan-coated superparamagnetic iron oxide nanoparticles and in silico drug reprofiling of amodiaquine for anti-cancer drug delivery	Salako, K.S., Babamusa, N.O., and Adams, L.A.
5:00	**2024/B063:** Extraction and characterization of date seed oil and its application in oral drug delivery of Ibuprofen	Nkeiru. I.P., Agbo, P.C., Umar, S.O., Alfa, J., Abdulmumin, H., Ezeodimegwu, A., Nnamani, N.C., Nnabuike, D., Kenechukwu, C.F., and Momoh, A.M
5:10	**2024/B066:** Zinc oxide nanoparticles biosynthesized using aqueous aerial-leaf extract of *Vachellia sieberiana* mitigated hepatic and renal DMH/DSS-induced oxidative-stress in Wistar rats	Afolabi, O.D., Ajao, D.O., Yusuf, K.O., Akintola, A., Alabi, T.D., Oguntibeju, O.O., Yekeen, T.A., and Badmus, J.A.
5:20	**Participants are to move to the general room for closing**	
DAY THREE (THURSDAY, NOVEMBER 21, 2024): GENERAL		
9:00	**Invited Lecture 5**: **Advancements in chitosan-based nanoparticle technology: securing drug delivery systems through sustainable bio-nanohybrid approaches** **Prof. S. Adewuyi** Department of Chemistry, Federal University of Agriculture, Abeokuta, Nigeria	
9:30	**Invited Lecture 6: Tetrapods based Smart Materials for Advanced Technologies** **Prof. Yogendra K. Mishra** Mads Clausen Institute, NanoSYD, Smart Materials University of Southern Denmark, Alsion 2, 6400, Sønderborg, Denmark	

BREAK-OUT SESSIONS (DAY THREE – NOVEMBER 21, 2024) SESSION A (PHYSICAL/ENGINEERING)		
	Moderators	**Prof. T.B. Asafa/Dr. A.O. Adedokun**
	ABSTRACT NUMBER/TITLE	**AUTHORS/PRESENTERS**
10:00	**Invited Lecture 7: Electrochemical potentials of cobalt oxide nanofluid for improved oil recovery with the aid of electromagnetic filed** **Dr. H. Soleimani** Department of Geoscience, Universiti Teknologi Petronas 32610 Tronoh, Perak, Malaysia	
10:30	**2024/P014:** Development of stable Mg-Zr phases: a study on tribocorrosion and biocompatibility in biomaterials	Adegbola, T.A., Aramide, B.P., and Adeoti, M.O.
10:40	**2024/P015:** Green synthesis of zinc oxide nanoparticles: a trifecta of antioxidant, antifungal, and catalytic excellence	Danas, A.Y., Labulo, A.H., Usman, A., Hassan, I., Idzi, A.A., Owoseni, M.C., Oyinade, D.A., Isah, M., Ashonibare, R.A., Ojedoja, K.A., Tywabi-Ngeva, Z., Omotehinwa, F.H., Said, M.A., and Uyi, O.G.
10:50	**2024/P017:** Smart nanocomposite coatings for explosive devices: enhancing safety and performance	Haruna, A.S., and Unoneme, A.C
11:00	**2024/P018:** Chitosan, alginate and polyethylene glycol capped zinc oxide nanoparticles for hyperthermia applications	Nwabunwanne, C., Aisida, S.O., Alnasir, M.H., Botha, S., Awada, C., Alshoaibi, A., and Ezema, F.I.
11:10	**2024/P019:** The impact of thermophysical properties on the heat and flow characteristics of a nano-lubricant based on aluminum oxide (Al_2O_3) in a cylindrical channel	Itabiyi, O. E., Sangotayo, E.O., Olojede, M.A., and Akinrinade, N.A.
11:20	**2024/P022:** Fabrication and characterization of dye-sensitized solar cells using natural dye extracts of *Vernonia amygdalina* leaf as photosensitizers	Soge, A.O., Willoughby, A.A., Oshin, A.F., Ulbricht, C., Mayr, F., Olukanni, O.D., Sanyaolu, M.E., Dairo, O.F., Adeyemi, O.G., Tekoglu, S., Scharber, M.C and Sariciftci, N.S
11:30	**2024/P030:** Synergistic effects of gadolinium oxide into matrix of zeolitic imidazolate frameworks (ZIFs) for supercapacitor applications	Ikhioya, I.L., Alghamdi, N., Omeje, S.E., Ikeh, D.C., and Odoh, R.N.
11:40	**2024/P031:** Assessing air quality impacts of Gaari processing: a nanotechnology-based approach	Olatona, G.I., and Oyedokun, S.M.
11:50	**2024/P036:** A review on green synthesis of metal and metal oxide nanoparticles and their applications in environmental remediation	Amaunmwosa, E.C., Baba, I.A., Tijani, J.O., and Abdulkareem, A.S.
12:00	**2024/P039:** Durability of stabilized lateritic bricks modified with saw dust ash and terrasoil nanochemical	Tijani, I.O., Adegbola, A.A., and Olaniyan, O.S.
12:10	**2024/P042:** Removal efficiency of rhodamine-b dye from aqueous solution by chitosan-glutaraldehyde/rice husk composite	Adeoye, M.D., Lawal, A.T., Azeez, L.A., Adewuyi, S., Ajao, F.D., and Araoye, A.O.
12.20	**2024/P043:** Uptake performance of ibuprofen in aqueous solution by Jacob's leaves (*Acalypha wilkesiana*) mediated with titanium dioxide nanoparticles (JL-TDNPS)	Adeoye, M.D., Azeez, L.A., Lawal, A.T., Tewogbola, K.K., and Junaid, L.
12:30	**2024/P044:** Nanotechnology and wastewater treatment: a review of efficiency, safety and environmental implications	Owodunni, B.A., Aduloju, L.S., Ayinla, S.O., and Anidiobi, U.S.
12:40	**2024/P045:** Biosensors and nanosensors: a review on food analysis/safety	Ayinla, S.O., Adeleke, A., Ikhuoria, B., Aduloju, L.S., and Owodunni, B.A.
12:50	**2024/P047:** Synthesis of nano-biochar for industrial	Abubakar, A.I., Abdulfatai, J., Adefeso, I.B.,

	wastewater treatment	Ahmad, I.A., Mohammed, U., and Said, H.M
1:00	**2024/P052:** Nanotechnology safety in biomedical applications: a review of recent advances	Hamzat, A.K., and Asmatulu, R.
1:10	**Lunch Break**	
2:10	**2024/P053:** Potato peels-synthesized carbon nanotubes for crude oil spill clean up	Mansur, Y.I., and Afolabi, A.M.
2:20	**2024/P054:** Synthesis and characterization of iron tungstate nanoparticles	Ajala, O.J., Tijani, J.O., Salau, R.B., and Abdulkareem, A.S.
4:30	**Participants are to move to the general room for Polling and Closing of the conference**	
BREAK-OUT SESSIONS (DAY THREE – NOVEMBER 21, 2024) SESSION B (BIOMEDICAL)		
	Moderators	**Prof. M.A. Azeez/Prof. E.A. Adebayo/Prof. M.A. Olamoyegun**
	ABSTRACT NUMBER/TITLE	**AUTHORS/PRESENTERS**
10:10	**2024/B064:** Development and characterization of gelatinated-mucin based microparticles for oral delivery of insulin in diabetes treatment	Agbo, P.C., Ugwu, C.E., Amadi, B., Akpa, P., Umar, O., Abdulmumin, H., Alfa, J., Nnamani, N.D., Okereke, N., Darlington, Y., Kenechukwu, F.C., and Momoh, M.A.
10:20	**2024/B062:** Phytosynthesis, characterization and biological evaluation of silver nanoparticles from *Piper guineese* leaf and seed methanol extracts	Adebayo-Tayo, B.C., Folarin, V.A., Alao, S.O., Oduokpaha, G.E., and Ajani, T.F.
10:30	**2024/B023:** Probing the role of ginger starch on physicochemical and thermal properties of gum Arabic hybrid biocomposite for food packaging applications	Oluba, O.M, Owoso, T.O., Bayo-Olorunmeke, A.O., Erifeta, G.O., Josiah, S.J., Ojeaburu, S.I., Subbiah, N., and Palanisamy, T
10:40	**2024/B024:** Purification of different fractions of industrial wastewater using biosynthesized silver nanoparticles of Amaranthus hybridus and *Amaranthus viridis*	Egonu, S.N., and Edochie, W.C
10:50	**2024/B025:** Sorghum bicolor: a potential crop for nutrient-nanoparticles for agricultural bio-fortification	Adisa, K.O., Salau, A.K, and Shehu, M.S.
11:00	**2024/B026:** Essential oil- encapsulated nanochitosan for food safety and security: A review	Oyafajo, L.A., Shittu, T.A., Azeez, L., Busari, H.K., Yusuf-Omoloye, N.A., and Sanni, L.O.
11:10	**2024/B027:** *Nymphaea lotus*-synthesized gold nanoparticles attenuate cadmium-induced hepatotoxicity in rats	Adewale, O.B.
11:20	**2024/B028:** Anticancer potential of Ganoderma lucidum mediated selenium nanoparticles	Oke, M.A., and Adebayo, E.A.
11:30	**2024/B029:** Biosynthesis of silver nanoparticles mediated by bioflocculant derived from *Serratia nematodiphila* ETA1 PP413762 isolated from Asa river and its application in water treatment	Ejafu, M.I., and Adebayo, E.A.
11:40	**2024/B032:** Biogenic synthesis of silver and silver-gold alloy using *Ganoderma lucidum* (ON394695), their Phytochemical screening, and wound healing potentials	Kilani, T.A., Adebayo, E.A., Oyeleke, O.O., Lateef, A., Azeez, M.A., Yekeen, T.A., Matyumza, N., Beukes L.S., and Gueguim-Kana, E.B.
11:50	**2024/B033:** Nutraceutical properties enhancement using nanotechnology	Okunade, O.A., and Adebayo, E.A.
12:00	**2024/B034:** Chitosan nanoparticles as antibiofilm and antimicrobial agent: mechanisms of action against biofilm-embedded bacteria in drinking water treatment	Ahmed-Oke, M.O., and Adebayo, E.A.

	plant	
12:10	**2024/B035:** Nanotechnological approaches to antiviral therapy with their mechanism of actions	Ajisope, N.A., and Adebayo, E.A.
12:20	**2024/B037:** Nanotechnology in water treatment and remediation in the last three years: a systematic review	Ametefe, G.D., Oluyide, O.O., Itakorode, B.O., Muritala, I., Oyedara, O., and Ametefe, D.S.
12: 30	**2024/B051:** *Cinnamomum camphora* mediated synthesis and immobilization of silver nanoparticles onto textile materials for antimicrobial applications and their cytotoxic evaluation	Naveed, S., Arshad, H., Khan, M.N., Malkani, N., Khalid, A, Aslam, M.S., and Zafar, A.
12:30	**2024/B038:** Biomedical applications of selenium nanoparticles biosynthesized from *Pentaclethra macrophylla* seed extract as antimicrobial, antioxidant, anticoagulant and thrombolytic agents	Bamigboye, O.F., Adesuyi, T.A., Emmanuel, C.H., Oyeleye, O.B., and Yusuf, Y.A.
12:40	**2024/B040:** Antibacterial and *in vitro* antioxidant properties of silver nanoparticles biologically synthesized from aqueous extract of sweet potato leaf with preliminary qualitative phytochemical analysis	Fagbemi, K.O., Thonda, O.A., Oyewole, T., and Aina, D.A.
12:50	**2024/B041:** *In vitro* assessment of *Ganoderma lucidum* mediated silver and gold nanoparticles for their antimicrobial and antioxidants potential	Oyeleke, O.O., Kilani, T.A., Oke, M.A., Adebayo, E.A., Lateef, A., Azeez, M.A., Yekeen, T.A., Matyumza, N, Beukes, L.S., and Gueguim-Kana, E.B.
1:00	**2024/B046:** Assessment of tapioca-synthesized graphene-modified electrode with biopolymer-based membrane for enhancing biofilm efficiency in microbial fuel cell	Oluyide, O.O., Oloke, J.K., Adenigba, V.O., Elufisan, T.O., and Ametefe, G.D.
1:10	**Lunch Break**	
2:10	**2024/B048:** Selenium nanoparticles biosynthesized using *Sarcocephalus latifolius* stem-bark extract and their anti-microbial, antioxidant and thrombolytic activities	Raimi, O.R., and Lateef, A.
2:20	**2024/B049:** Antimicrobial activity of silver nanoparticles biosynthesized by metabolites of lactic acid bacteria isolated from fermented *Cyperus esculentus* milk	Mamora, O.T., Aina, D.A., Jonathan, S.G., Amodu, S., and Fagbemi, K.O.
2:30	**2024/B050:** The current status and prospect of silver nanoparticles as antimicrobial agent	Adeniran, J.A., Azeez, A.O., Oyelami, G.T., Alagbe, E.A., Omomowo, I.O., Adenigba, V.O., and Bamigboye, C.O.
2:40	**2024/B068:** *In vitro* antioxidant, anti-inflammatory, and antidiabetic of titanium dioxide nanoparticles synthesized using aqueous aerial parts extract of *Vachellia sieberiana*	Badmus, J.A., Azeez, M.A., Adedosu, O.T., Oladipo, I.C., Alabi, T.D., Abimbola, A., Asimolowo, F., and Abisona, A.
2:50	**2024/B055:** Green synthesis of titanium dioxide nanoparticles from *Tetrapleura tetraptera* seed extract and its antidiabetic activity	Oladipo, I.C., Ogunsona, S.B., Rabiu, O.F., and Ogunleke, O.B
3:00	**2024/B056:** Green synthesis of zinc oxide nanoparticles using *Tetrapleura tetraptera* husk aqueous extract and its biomedical applications	Ogunleke, O.B., Oladipo, I.C., and Ogunsona, S.B.
3:10	**2024/B057:** Characterization and antibacterial activity of silver-fabricated nanoparticles using stem bark extract of *Cassia sieberiana* against gastroenteritis-associated bacteria	Amodu, S., Fabiyi, E.D., Ezeamagu, C.O., Aina, D.A., Animashaun, R.O., Fagbemi, K.O., and Oyewole, T.E.
3:20	**2024/B058**: Influence of biosynthesized zinc oxide	Adebomojo, A.A., and AbdulRahaman, A.A.

	nanoparticle on pepper plant	
3:30	**2024/B059:** Biosynthesis and characterization of bismuth nanoparticle using *Bredelia ferruginea* bark extract and its antibacterial potential	Adebayo-Tayo, B.C., Alao, S.O., Folarin, V.A., Sanusi, J.F., Maloma, M., and Adebami, G.E.
3:40	**2024/B060:** Antibacterial and dye reduction potential of *Calotropis procera* bismuth nanoparticles	Adebayo-Tayo, B.C., Oduokpaha, G.E.., Folarin, V.A., Alao, S.O., Fashogbon, R.O., Ajani, T.F., and Ogunleye, G.E.
3:50	**2024/B061:** Biosynthesis and characterization of *Cactus* leaf methanol extract silver and magnetic nanoparticles	Adebayo-Tayo, B.C., Folarin, V.A., Dawodu, E.A., Durojaye, T.O., Ojo, J.S., Alao, S.O., and Sanusi, J.F.
4:00	**2024/B065:** Development and evaluation of Eudraginated-gelatin based microparticles: An application in oral insulin delivery for diabetes treatment	Akpa, P., Amadi, B., Ugwu, E.C., Agbo, P.C., Nnamani, N.D., Umar, O., Abdulmumin, H., Alfa, J., Okereke, N., Zakari, D., Darlington, Y., Kenechukwu, F.C., and Momoh, M.A.
4:10	**2024/B067:** Roles of zinc oxide nanoparticles synthesized from *Vachellia sieberiana* aqueous aerial part extract in DMH/DSS-induced colon cancer inflammation, apoptosis, and DNA damage	Afolabi, O.D., Babalola, O.M., Anthony, P.J., Odewale, M.J., Adebayo, E.A., Bolarinwa, I.F., Lateef. A., and Badmus, J.A.
4:20	**2024/B069:** Exploring the antioxidant, anti-inflammatory, and anti-diabetic potential of zinc oxide nanoparticles bio-fabricated using *Vachellia sieberiana* aqueous aerial parts extract	Abimbola, A., Ibidoja, E., Ojo, H., Adesokun, J., Yekeen, TA., Adebayo, E.A., Lateef, A., Olamoyegun, M.A., and Badmus, J.A.
4:30	**2024/B070:** Evaluation of the chicken feather-mediated zinc oxide nanoparticles fortified fish meal on the growth and haematological profile of juvenile *Clarias gariepinus*	Adetutu, F.A., Yekeen, T.A., Azeez, M.A., Lateef, A., Badmus, J.A., Oladipo, I.C., Adebayo, E.A, Olamoyegun M.A., Alaba, T.J., Oyewole, A.D., and Olusegun, R.T.
4:40	**2024/B071:** Development of green synthesized calcium nanoparticles coatings as preservative for tomatoes (*Solanum lycopersicum* L.), peppers (*Capsicum chinense*) and potatoes (*Solanum tuberosum*)	Olasupo, O.O., Bolarinwa I.F., and Azeez, M.A.
4:50	**2024/B072:** Development of nanotechnology-based sensors for monitoring environmental pollutants and their potential impact on biodiversity conservation	Akinsowon, A.J., and Ikokide, S.Y.
5:00	**Participants are to move to the general room for Polling and Closing of the conference**	

WELCOME ADDRESSES

Prof. A. Lateef
Head, Nanotechnology Research Group (NANO⁺), LAUTECH, Ogbomoso, Nigeria

It is with delight that I welcome you, on behalf of the LAUTECH Nanotechnology Research Group (*NANO⁺*), to the 8th International Conference on Nanotechnology (LAUTECH-NANO 2024). This year's conference is taking place on our campus, after holding the last two editions (2022 and 2023) in Abuja in partnership with the National Space Research and Development Agency (NASRDA) and the Federal Ministry of Innovation, Science and Technology (FMIST). It also coincides with the 10th year anniversary of the formation of our research group. Thus, it is a home-coming and a time to take the stock of our activities on nanotechnology in 10 years.

Our multidisciplinary research group was formed in 2014 to advance studies in nanotechnology, and our activities have blossomed over the years. We have published more than 170 articles on nanotechnology, developed some nano-based products, organized workshops and conferences, and carried out a series of advocacy projects that include web-based projection and press releases to deepen nanotechnology discourse. We also established a specialized journal on nanotechnology, '*Nano Plus: Science and Technology of Nanomaterials*', now indexed in African Journals Online (AJOL), South Africa. We have been able to establish partnerships with governmental agencies, and involved in the national implementation strategy on nanotechnology. Our members have won fellowships, awards and grants within 10 years, which our nanotechnology pursuits have contributed immensely to these exploits.

In furthering nanotechnology discourse in Nigeria, we have assembled seasoned scholars and scientists that will showcase their works at this conference with more than 80 presentations from different institutions around the world.

Nanotechnology, the science of fabrication, manipulation, characterization, and applications of materials at the nanoscale (10^{-9} m), is expanding at a great speed with its exponential impacts on various spheres of life. The application is cosmopolitan: engineering, industries, food and agriculture, built environment, healthcare, environment, energy, space exploration, water, sports, waste treatment, security and defence, and manufacturing of consumer products among others.

Our pursuit in nanotechnology is fueled by passion to put Nigeria on the global nanotechnology map, with the view of extracting benefits from its enterprise, thus the theme of the conference 'Nanotechnology Revolution for Sustainable Development:

Securing the Future for the Benefits of Humanity'. We must consciously pursue nanotechnology R&D for sustainable development, through its deployment to address myriads of problems that confront us as a nation.

While Nigeria started the nanotechnology journey in 2006, the national progress in this area has been plagued with a lot of challenges – lack of national policy, dearth of scholars, lack of scientific nanotechnology infrastructure to characterize nanomaterials, and non-existent budget headlines and agencies on nanotechnology. Though National Agency for Science and Engineering Infrastructure (NASENI) spearheaded nanotechnology discourse in the country in 2006 and also established a constituent laboratory, Engineering Materials Development Institute (EMDI, Akure), the efforts have not yielded the expected results. With the Department of Chemical Technology under the Federal Ministry of Innovation, Science and Technology now saddled with the responsibilities of providing a national roadmap on nanotechnology, we must work in unison to drive nanotechnology enterprise in the country.

We have good examples in developing countries like South Africa, India and Iran that have made giant strides in nanotechnology R&D, patenting and development of nano-based products, thereby contributing to their GDP. South Africa that we started the nanotechnology journey together has left Nigeria far behind: developed policies on nanotechnology, completed a 10-year nanotechnology development plan, established several centres of excellence in nanotechnology, developed curricula in nanotechnology and moved from basic research to translational research with products in the markets. This is a challenge to us as a nation. Nanotechnology itself is the new oil. For instance, Iran generated $551 million from nanotechnology products in 2020, with projection of generating $1 billion in 2025. Worldwide, nanotechnology was estimated to worth $3 trillion in 2021 and would account for 6 million jobs and 10% of global GDP in 2030.

For us to move forward, we must work together via healthy partnership – academia, government, private sector, and community. We have pursued this campaign as a research group at every opportunity. We need a national policy on nanotechnology. Research in this area should be prioritized and well-funded. Centres of excellence in nanotechnology should be established and this can be achieved by NASENI and TETFund in partnership with Universities with track records of research in nanotechnology. A dedicated agency, council, or department should be carved out to focus on nanotechnology R&D in Nigeria.

We appreciate the supports that have been received from different organizations and individuals in the last 10 years. Firstly, the successive authorities at LAUTECH, Ogbomoso, Nigeria since 2014 are appreciated for lending support for our activities. We appreciate the current administration under the able leadership of the Vice-Chancellor, Prof. R.O. Rom Kalilu *fnsa*. We are grateful for the positive consideration of our proposal, leading to the establishment of Centre for Nanoscience and Nanotechnology

Research (CEENANO) in the University. The Department of Chemical Technology under FMIST is also appreciated for its interest in what we have done in the last 6 years. We are grateful to the leadership at NASRDA, the immediate past DG/CEO, Dr. Halilu A. Shaba for partnering with us on the organization of the 6th and 7th international conference on nanotechnology. We appreciate our eminent invited lecturers over the years for enriching our activities with their wealth of knowledge. The participants at our workshops and conferences are valued for their belief in what we do. Our local and international collaborators, captains of industries, gentlemen of the press and our students are deeply appreciated for their support over the years.

On this note, I welcome you once again to the 8th International Conference on nanotechnology and wish you a fruitful experience.

Thank you and God bless.

WELCOME ADDREES BY THE VICE-CHANCELLOR, PROFESSOR RAZAQ OLATUNDE ROM KALILU AT THE 8th INTERNATIONAL CONFERENCE ON NANOTECHNOLOGY HELD ON NOVEMBER 19-21, 2024 AT LAUTECH, OGBOMOSO, NIGERIA

The Honorable Minister of Innovation, Science and Technology, Chief Uche Nnaji,
The Permanent Secretary, Federal Ministry of Innovation, Science and Technology,
The Deputy Vice-Chancellors,
All Principal Officers of the University,
The Lead Speaker,
Invited personalities,
Invited Lecturers and all other attendees from across the globe,
Ladies and gentlemen,

It is my pleasure to welcome all of you to the 8th International Conference/Workshop on Nanotechnology with the theme 'Nanotechnology revolution for sustainable development: securing the future for the benefits of humanity'. This year's conference is taken place in LAUTECH after two successful hosting at Abuja. The 6th and 7th editions of the conference were held at the National Space Research and Development Agency (NASRDA) Campus with many important dignitaries in attendance including the former Federal Minister of Science, Technology and Innovation, Dr. Olorunnimbe Adeleke Mamora, and the immediate past Director-General of NASRDA, Dr. Halilu A. Shaba.

Going down memory lane, *NANO*+ embarked on its nanotechnology advocacy journey in 2017, introducing scholars and students to the fundamentals of synthesizing nanoparticles and their applications. By 2018, the group's initiatives had garnered the attention of the Federal Ministry of Science, Technology, and Innovation, leading to their active participation in the last two conferences.

Ladoke Akintola University of Technology, Ogbomoso has come of age and now stands prominently among its peers. This year, the university achieved a notable ranking, securing the 16th position in Nigeria according to the Times Higher Education (*THE*). These accomplishments owe much to the outstanding research efforts and dedicated staff of the university. Recently, five of LAUTECH scholars, including the Chairman of Nanotechnology Research Group, Prof. A. Lateef, were listed among the top 2% of scholars across the globe as published by Stanford University/Elsevier B.V. The invaluable contributions of this research group contribute to the favourable ranking of the university.

LAUTECH has solidified its position as a frontrunner in the field of nanotechnology in Nigeria and deserves support for even greater achievements. Notably, five of our scholars rank among the top 20 in the country for nanotechnology research, based on papers indexed in Scopus over the past decade (2010-2020). I therefore implore the Federal Ministry of Science, Technology and Innovation to leverage on her esteemed position to garner backing for the establishment of a center of excellence in nanoscience and nanotechnology at LAUTECH, Ogbomoso. In our own little ways, through the consideration and pursuance of a memorandum that was submitted by *NANO*$^+$, the university established a centre for nanoscience and nanotechnology research (CEENANO). Our *NANO*$^+$ group has consistently demonstrated prowess in cutting-edge research, publications, training, and mentorship, culminating in the formation of the first journal of nanotechnology (*Nano Plus: Science and Technology of Nanomaterials*) in sub-Saharan Africa. As the research group celebrates its 10th anniversary, I am pleased to announce that this flagship journal is now hosted by the African Journals Online (AJOL), South Africa; a step that will further enhance its visibility and academic impact.

Nanotechnology stands as a formidable catalyst for national development, owing to its versatile applications. It holds the potential to address a multitude of challenges facing our nation - from environmental degradation and water scarcity to energy crises, food insecurity, security concerns, infrastructural gaps, and the burden of diseases, among others. Creatively harnessed, nanotechnology leads to innovation and the development of new processes and products, with profound impacts on job creation and economic stimulation. Therefore, Nigeria must act swiftly to embrace nanotechnology for sustainable growth and development.

I express my gratitude to our keynote speaker, guest speakers, and all other invited speakers, as well as our esteemed guests and participants, for gracing us with your presence. Additionally, I congratulate *NANO*$^+$ for achieving this significant milestone, emphasizing that the university takes great pride in your contributions to the field of nanotechnology. I encourage you not to relent in contributing to national development and global advancement of knowledge.

I warmly invite all participants to join me in extending our heartfelt congratulations to the *NANO*$^+$ research group on the occasion of the 10th anniversary. This milestone marks a decade of tireless dedication, groundbreaking research, and remarkable contributions to the field of nanotechnology, not just within Ladoke Akintola University of Technology (LAUTECH), but across Nigeria and beyond. This is worthy of emulation and celebration.

I thank you all for your attention as I declare this 8th international conference on nanotechnology open.

GOODWILL MESSAGES

Prof. D.O. Araromi
Deputy Vice-Chancellor (Academics and Innovation), LAUTECH, Ogbomoso, Nigeria

I extend warm greetings to the Nanotechnology Research Group (*NANO*⁺) on the occasion of your International Annual Conference.

Nanotechnology, the manipulation of matter at the nanometer scale, has transformed various industries and improved lives. Your Group's cutting-edge research in this field has significantly contributed to LAUTECH's excellence.

Established in 2014, the Nanotechnology Research Group has grown into a multidisciplinary team of renowned scholars, advancing knowledge in the synthesis, characterization, application, and ecotoxicological safety evaluation of nanoparticles. Your collaborations with local and international institutions have fostered innovation and capacity building.

Your contributions have been instrumental in our ranking as the 12th best university in Nigeria in World University 2025 and consistently maintaining the best state university in Nigeria. Your dedication has enhanced our national standing and contributed to the global knowledge base in nanotechnology, with potential applications in medicine, energy, and environmental sustainability.

As Deputy Vice-Chancellor for Academic and Innovation, I acknowledge the Group's outstanding contributions to LAUTECH's growth and excellence in research, significantly impacting our upward trajectory in research quality and international outlook. I am proud to recognize the Nanotechnology Research Group as a shining example of LAUTECH's commitment to academic excellence and innovative research.

I urge you to continue pushing the boundaries of knowledge, fostering collaborations, and inspiring the next generation of researchers. LAUTECH appreciates your hard work and remains committed to supporting your endeavors and providing an enabling environment for research excellence.

Please accept my warmest goodwill message and best wishes for a successful conference.

Thank you.

Prof. A.T.J. Ogunkunle
Deputy Vice-Chancellor (Strategy and Management), LAUTECH, Ogbomoso, Nigeria

On this auspicious occasion of the 8th international conference of Nanotechnology Research Group of Ladoke Akintola University of Technology, Ogbomoso, Nigeria (LAUTECH *NANO*$^+$), which coincides with the group's 10th anniversary, I offer fraternal greetings and a congratulatory message from the Office of the Deputy Vice Chancellor (Strategy and Development) of the University.

I am aware and exceedingly proud of the plethora of achievements that LAUTECH *NANO*$^+$, a multidisciplinary research group has recorded within the past ten years of its birth. We are particularly pleased by your leadership role in advancing the knowledge of nanotechnology, being the most prolific outfit in nanotechnology research and development in Nigeria with a turnout of nearly 200 published articles within a short period of 2014 till date. Your exemplary role in promoting multi-sectoral application of nanotechnology is also applauded with an array of nano-based products that have been developed by members of your group. These include but not limited to nanopaints, nanotextiles, nanopesticides, nanobiocides, nanofertilizers, nanoadsorbents, and nanofilters.

The laudable achievements enumerated above, coupled with your mentoring of students and academics in over twenty universities and other institutions within and outside Nigeria, as well as your 'catch them young' approach of expanding the outreach of nanotechnology discourse to students of primary and secondary schools are sure steps to ingrain nanoscience in Nigeria sustainable development efforts.

Added to our satisfaction with your attainments thus far, is the gratification that this year's edition of the conference themed "Nanotechnology Revolution for Sustainable Development: Securing the Future for the Benefits of Humanity" is part of the continued effort of your group aimed at nanotechnology discourse for national development.

I hereby congratulate the Head and members of LAUTECH *NANO*$^+$ on this unique and solemn occasion. I urge you to keep the flag flying in order to ensure further growth and development of your group; then, the sky will not be the limit.

I thank you very profoundly for your patience and wish you happy and fruitful deliberations.

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Goodwill Message

I warmly congratulate the Nanotechnology Research Group of Ladoke Akintola University of Technology (LAUTECH) on your 10th anniversary—a decade of remarkable achievements and progress. Your contributions, from publishing over 170 research papers to launching *Nano Plus Journal*, have positioned LAUTECH as a leader in nanotechnology research within Nigeria and beyond.

Your development of nano-based products, international collaborations, and commitment to training students and researchers reflect your vital role in advancing knowledge and innovation. The "Catch Them Young" initiative further exemplifies your dedication to nurturing future scientists from an early stage.

It is gratifying to see how your efforts have enhanced the university's reputation and strengthened its standing through research excellence. As you continue this journey, I trust that your passion for discovery will open new frontiers and lead to even greater success.

I celebrate your accomplishments and wish you many more milestones in the years ahead.

Dr. Adefunke S. Ebijuwa,
University Librarian,
LAUTECH

Prof. M.O. Alade
Dean, Faculty of Pure and Applied Sciences, LAUTECH, Ogbomoso, Nigeria

On behalf of the board members of Faculty of Pure and Applied Sciences, Ladoke Akintola University of Technology, Ogbomoso, it is a great pleasure and honor to extend a warm welcome to all esteemed participants, scholars, researchers, and industry partners gathered for the 8th International Conference on Nanotechnology (Hybrid): LAUTECH-NANO 2024 2024. Over the past decade, LAUTECH *NANO*$^{+}$ has not only showcased the groundbreaking strides in nanotechnology, but has also contributed immensely to advancing knowledge, and fostering innovations.

As Dean of the Faculty of Pure and Applied Sciences, LAUTECH, I am incredibly proud of the contributions this conference has made to the scientific community, both locally and globally. The theme of this year's conference: Nanotechnology Revolution for Sustainable Development: Securing the Future for the Benefits of Humanity, highlights the transformative role that nanotechnology plays in addressing today's critical challenges in areas such as medicine, electronics, energy, agriculture, and environmental sustainability. The work presented here reflects the unwavering dedication of our researchers and the robust support of our partners, who are deeply committed to leveraging nanotechnology for societal good.

This 10th anniversary celebration is also a testament to the collaborative spirit that defines our faculty and our university. We have witnessed remarkable growth in research quality, the breadth of topics explored, and the significant impact of our findings in real-world applications. Our university, students, and research partners have demonstrated resilience, curiosity, and a commitment to excellence, making LAUTECH a beacon of innovation and progress.

I commend all those who have worked tirelessly to make LAUTECH NANO 2024 a success. May this conference inspire new ideas, spark meaningful collaborations, and further our shared vision for a future shaped by innovation. Congratulations on this milestone, and may we continue to advance together in the years to come.

Thank you.

Prof. O.S. Oladejo
Dean, faculty of Engineering and Technology, LAUTECH, Ogbomoso

I am honored to be invited to deliver a goodwill message at the 10th anniversary and LAUTECH NANO 2024 Conference. I commend Prof. Agbaje Lateef, the Head of the *NANO+* Research Group, for his outstanding leadership in assembling experts from both industry and academia. This conference is a crucial platform for sharing innovative ideas, and I look forward to the impactful discussions that will emerge.

Dear members of the LAUTECH Nanotechnology Research Group, Congratulations on reaching this significant milestone as you celebrate the 10th anniversary of the group and the successful hosting of your latest conference. This moment marks a decade of groundbreaking research, innovation, and unwavering commitment to advancing nanotechnology and its applications. Your accomplishments over the past ten years have established LAUTECH as a leader in scientific exploration, both in Nigeria and on the global stage, and it has hitherto earned you a Centre of Excellence, to which early this year, your proposal to the University for the establishment of a Centre of Excellence on Nanoscience and Nanotechnology Research (CEENANO) was approved by the University Senate and the Governing Council.

Your relentless pursuit of knowledge in nanotechnology is commendable. Through dedicated efforts and strong collaboration, you have built a dynamic community that drives innovation in critical areas such as materials science, medicine, and environmental sustainability. As the world increasingly turns to nanotechnology for solutions to its most pressing challenges, the contributions of the LAUTECH Nanotechnology Research Group are essential and impactful. As you step into this next chapter, continue to embody the spirit of dedication and innovation that defines your group. Let your research leads to groundbreaking discoveries, and ensure that your strong unity propels you forward. Here's to wish you many more years of success, growth, and significant breakthroughs.

Once again, congratulations, and let this conference be a powerful testament to everything you have achieved and the promising future ahead. Wishing you a successful and impactful event!

Prof. B.A. Akinwande
Director of Academic Planning, LAUTECH, Ogbomoso, Nigeria

It is with great pride and admiration that I celebrate with LAUTECH Nanotechnology Research Group on the 10th year anniversary. Over the past decade, from 2014 to 2024, this exceptional team has solidified its position as a leader in nanotechnology research in Nigeria and beyond. One of the most commendable milestones of the group is the substantial contribution to global knowledge, with over 170 high-impact research publications in reputable journals and books. This prolific output underscores the commitment of the members to advancing the frontiers of science. Furthermore, their collaborative spirit is evident in the partnerships in more than 30 Nigerian institutions and international collaborations with scholars from Africa, Asia, and Europe.

The 'Operation Catch Them Young' initiative of the group indicates the forward-thinking approach by nurturing interest in nanotechnology among primary and secondary school students. Also, the training of numerous university students at all levels ensures a legacy of skilled professionals that are equipped to drive future innovations. All this signifies the dedication of the group to human capital development.

The establishment of '*Nano Plus: Science and Technology of Nanomaterials*,' which is the first specialized nanotechnology journal in sub-Saharan Africa, represents a landmark achievement. Now in its eighth volume and indexed in CrossRef, AJOL, and Google Scholar, this journal amplifies the visibility and impact of the research findings of the group within and beyond the continent.

Also, as recognized by LAUTECH for the invaluable contribution to research and development, the group has secured three prestigious TETFund National Research Fund grants. These accomplishments reflect an unwavering dedication to excellence and a profound impact on both academia and industry.
Congratulations to the LAUTECH Nanotechnology Research Group at this 10th anniversary for the outstanding achievements. Your work inspires and paves the way for future scientific endeavours. I join others to celebrate you.

Thank you.

Prof. O.S. Bello
Director, Centre for Research and Development, LAUTECH, Ogbomoso, Nigeria

Nanotechnology has emerged as a powerful tool in addressing global challenges and advancing sustainable development. By manipulating materials at the nanoscale, researchers have unlocked new possibilities in various fields, including energy, healthcare, agriculture, construction, transportation, and environmental conservation thereby improving energy efficiency and energy conversion, leading to a more sustainable and clean energy future, improving water purification processes, enabling access to clean drinking water for communities, enabling targeted drug delivery systems, early disease detection, and personalized medicine. This 2024 NANO conference that is focused on securing the future for the benefits of humanity will be addressing these possibilities. I wish all participants fruitful deliberations and recommendations that will propel and reposition our society in the global community as we progress in the various sessions of this conference.

PLENARY LECTURES

Tetrapods based Smart Materials for Advanced Technologies

Yogendra Kumar Mishra
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Considering the size dependent utilization complexities of nanoscopic dimensions tin real technologies, the focus of nanomaterials community is converging to three-dimensional (3D) nanomaterials which are built out of interconnected nanostructures building blocks. This talk will briefly introduce the importance of tetrapod nanostructures towards smart 3D nanostructuring via a simple and single step flame-based approach for synthesis of zinc oxide tetrapods. These tetrapods have already demonstrated their potential roles in many different technologies. These zinc oxide tetrapods can be used as solid backbone or sacrificial templates to design hybrid or new tetrapods as smart materials. These smart 3D nanomaterials offer many applications in engineering and advanced technologies. Application examples of 3D tetrapods in nanosensing, composite engineering, antiviral candidates, water purification, piezotronics, and in several other applications will be demonstrated [1-10]. The integration of tetrapods in composites, electrospun fibers offer many advantages in biomedical engineering and few examples about nano-engineered electrospun fibers will be presented as recent developments.

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Circularity and sustainable nanotechnology win-win strategies to Sustainability; hinging the duo with!

Dare, E.O
Department of Chemistry, Federal University of Agriculture, Abeokuta, Nigeria

Nigeria is endowed with abundant biodiversity which, however, remain under-utilized. Unfortunately, however, its poor waste management system led us to an unprogressive linear economy (LE). In the circular economy, materials exist in biological or technical cycles. The biological cycle is composed of materials from renewable resources that, at the end of its useful lifetime, nourish and perpetuate as natural, biochemical feedstocks. Materials in the technical cycle are sourced from finite resources that have no conventional end-of-life; they are reused in the same or another product in their current or in a transformed form. Sustainable nanotechnology research to date illuminates immense synergies with the circular economy in several key areas, providing opportunities to accelerate its successful roadmap to sustainability [Fig 1]. Sustainable nanotechnology is the development of science and technology within the 1 – 100 nanometer scale, with considerations to the long-term economic viability and a sensible use of natural resources, while minimizing negative effects to human health and the environment. Engineered nanomaterials (ENMs) are incorporated in products across all major markets. Thus, there is an opportunity to accelerate the circularity by establishing connections between the past, present, and future of sustainable nanotechnology concepts. The duo has win-win strategies to transform the technology into sustainable, green, and clean alternatives to deal with global warming, climate change consequences and functional devices. The question is what are/is the hinging tool(s) for effective functioning of the duo in the realization of sustainability? Through this presentation, I shall uncover the hinging tool(s) and how ENMs properties, behaviours, and functions as well as the products they enable, are modified in natural and engineered systems. While much of this work was initially pursued and discovered through the lens of risk assessment and safety, the findings from our historic and continued efforts [1-3], will ensure that the future of "the very small" fosters the circular economy rather than becoming obsolete or forgotten in its wake. Therefore, striving "win-win" for waste-to-wealth in sustainable nanotechnology cascade and a green capital lens for sustainability remain the "master narrative" of this presentation.

Figure 1: Strategic roadmap from the pivoted duo to sustainability

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Advancements in chitosan-based nanoparticle technology: securing drug delivery systems through sustainable bio-nanohybrid approaches

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Chitosan, a biopolymer derived from chitin, has emerged as a versatile entrant for drug delivery systems due to its biocompatibility, biodegradability, and ability to form nanoparticles. Recent advancements in chitosan-based nanoparticle technology are poised to revolutionize pharmaceutical applications, particularly in enhancing the efficacy and targeting of therapeutic agents. This presentation explores innovative bio-nanohybrid approaches that integrate chitosan with various nanomaterials, including metal nanoparticles and polymeric carriers, to create multifunctional delivery systems. By leveraging the inherent properties of chitosan, such as its mucoadhesive nature and ability to encapsulate a wide range of drugs, chitosan nanoparticles (NPs) as a matrix in drug-release systems are basically in two forms as beads and granules. However, the release rate of chitosan NPs bead loaded drug has been found to be slower than its counterpart granular form. Significantly, the emergence of chitosan-MNPs has resolved the draw backs of conventional chemotherapeutic agents, especially non-specificity and selectivity. The major parameters in the behavior of chitosan-MNPs are related to surface chemistry, size (magnetic core, hydrodynamic volume and size distribution) and magnetic properties. In typical studies using metal-magnetite nanohybrid as the magnetic core in drug delivery system (DDS), chitosan-metal nanoparticles previously synthesized were loaded with test drugs. This DDS showed faster and higher drug release as a result of the porosity of the nanohybrid. The synergistic effects of these chitosan-based nanoparticles not only offer exciting possibilities for targeted therapy and controlled release but also highlight their potential to contribute to a more sustainable future in drug delivery systems.

TiO_2-based photoactive materials: synthesis, mechanism, and effectiveness for treating effluent from petroleum refineries

Ezema, F.I
Nano Research Group, Department of Physics and Astronomy, University of Nigeria, Nsukka, Nigeria

These days, treating effluent from petroleum refineries is a big concern. Stricter rules are being put in place, which emphasize the necessity of creating and utilizing cutting-edge treatment technologies that can handle the dangerous organic contaminants found in waste streams. Because of their high toxicity, poor biodegradability, and ecological concerns, persistent organic compounds found in wastewater from petroleum refineries constitute a severe discharge hazard. In the meantime, the solution lies in the sensible application of photoactive nanoparticles based on TiO_2 in photocatalytic wastewater treatment. Because of its superior chemical stability and high redox potential over other semiconductor photocatalysts, titanium dioxide has drawn the interest of photocatalysis researchers. Although TiO_2 has several advantages over other semiconductor photocatalysts, its 3.2 eV band gap limits its use in the ultraviolet ($\lambda < 387.5$ nm) area of the electromagnetic spectrum. Thus, one of the main obstacles in the field of photocatalysis is the creation of visible-light active titanium dioxide. One of the main issues facing the research community is increasing the visible-light spectrum sensitivity of TiO_2. Advances in the methods for activating visible light, the source of visible light activity, and the electrical structure of different visible-light active TiO_2 photocatalysts are explored in this context. A number of strategies to find suitable bimetallic dopants for better visible-light absorption and electron-hole separation to increase the photocatalytic activity of the TiO_2 are discussed, and potential recommendations are also presented, based on recent advancements in the theory and experiments in visible-light induced degradation of persistent organic pollutants. A rigorous evaluation is conducted on the impact of several visible-light activation procedures on the electronic structure and photocatalytic activity of TiO_2. Photoactive nanoparticles based on TiO_2 have the ability to break down persistent organic contaminants found in wastewater from petroleum refineries. Several parameters, including pH, temperature, and catalyst concentration, can be used to study the removal of such contaminants. we highlight here the use of a cheap and recoverable photocatalyst based on TiO_2 for treating wastewater from petroleum refineries.

Electrochemical potentials of cobalt oxide nanofluid for improved oil recovery with the aid of electromagnetic filed

H. Soleimani
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32610 Tronoh, Perak, Malaysia

Oil reservoir formation damage is a significant issue in secondary and tertiary oil recovery operations. Enhanced oil recovery (EOR) approaches can address these issues while increasing production rates and resource recovery. However, challenges include chemical degradation, high chemical volumes, and high costs. Nanotechnologies can improve oil recovery by improving subsurface porous media and pore fluids, separating fluid phases, and introducing influencing coatings. Cobalt oxide-based materials have been extensively evaluated for their amphiphilic properties, thermal stability, and high reactivity, which can modify physicochemical properties and improve crude oil recovery. Coo nanoparticles were characterized using various techniques, including FTIR, Raman spectroscopy, X-ray photoelectronic spectrometry, and FSEM. Results showed that Coo nanofluid positively affects reservoir mineral with electromagnetic fields, improving oil recovery. It also improves thermal stability and promotes stable emulsion formation and decreases the IFT up to a 45% for the light-crude-oil/water system at low concentrations of nanofluid and can improve the thermal stability with respect to Coo in a wide range of temperatures, favoring the formation of stable emulsions.

Funding research in Africa: Opportunities for Nigerian scientists

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Research is the systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions. Research funding on the other hand is a term generally covering any funding for research activities irrespective of the field of study. There are four main types of funding and these include: scholarships and fellowships which are usually given to individuals; seed funding which is usually intended to get the researcher started on a project; project funding which is the main funding which the majority also referred to as research funding; and prizes and awards which usually entails giving plaques, certificates, and money. Local and international research funding are available to Nigeria researchers, although, there are more international funding opportunities and very limited local funding opportunities. Due to Nigeria's lack of participation, some international funding bodies have started removing Nigeria's name from the list of eligible nations. Available research funding for Nigerian researchers includes short term (3-6 months) visit to other laboratories, split-program research funding (up to 1 year), and long term (1-5 years) research funding. More funding opportunities are available for women than men and for early career researchers than for senior researchers. One of the major ways a Nigerian scientist can successfully carry out good quality research despite the paucity of local funds is by having research collaborations, locally and internationally. Such collaborations will not only provide an opportunity for reduced financial burden but also enhance an improved research atmosphere through the sharing of ideas and resources to achieve a conclusion which is not only locally acceptable but of international dimension or application. The presentation will share information on some of the available funding for Nigerian researchers and discuss ways of establishing quality collaborations both locally and internationally.

Nanoparticle-based drug delivery systems: challenges and opportunities

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Nanoparticles as drug delivery structures are being increasingly used to improve therapeutic efficacy and patient response to medication. A drug that cannot be delivered to its site of action is essentially useless. In drug delivery applications, nanotechnology typically involves the creation of nanoparticles (5 ~ 800 nm) that are then used to package drug molecules and genes. A number of diverse nano-sized structures have been investigated for drug formulation and delivery, including small molecule and polymeric micelles, solid lipid nanoparticles, nano-sized crystalline drug and drug-antibody conjugates, dendrimers, liposomes, lipid emulsions, and solid drug-polymer nanoparticle dispersions. Engineering of these particles has produced nanomedicines that target drugs and genes to tumors and improve the brain delivery of peptides and other molecules. These particles are also capable of promoting oral drug absorption and drug transport across other biological barriers such as the cornea and the skin. These nanomaterials provide a high degree of biocompatibility before and after conjugation to biomolecules for specific function so as to translate into nanomedicines and clinical practice. Nanomaterials provide for a favorable blood half-life and physiologic behavior with minimal off-target effects, effective clearance from the human organism, and minimal or no toxicity to healthy tissues in living organisms. Nanomaterials have been used for strategic development of new drug delivery systems and reformulation of existing drugs to enhance the effectiveness, patent protection, patient-compliance, safety of drugs and decreasing the cost of health care. Recent advances in nanodrug delivery suggest that the forthcoming generations of nano products will have target specificity, may carry multiple drugs and could potentially serve as carriers for the treatment and management of chronic diseases such as cancer, asthma, hypertension, HIV and diabetes. Currently, only a few of these nanodrugs are commercially available such as liposomes, low molecular weight micelles and polymer–drug conjugates; but the therapeutic benefits being observed in both preclinical studies and early clinical testing suggest that more of these technologies will emerge into the patient arena in the future. As nanodrug delivery continues to evolve, it stands poised to reshape the landscape of pharmaceuticals, offering the promise of more effective and patient-centered therapies for a wide range of medical conditions.

African bioresources as substrates for sustainable nanotechnology

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Africa has a lot of bioresources, even when these resources are presumed as wastes, they still serve ultimately as substrates for production of nanomaterials. There are a lot of bioresources which have been used for the synthesis of nanomaterials including the organic, inorganic, carbon based and nanocomposites materials. The biocomponents of different medicinal plants have been utilized to synthesize many inorganic or metal-based nanoparticles that offer applications as anticancer, antimicrobials, wound healing, antioxidants and so on. Nanocellulose from agricultural wastes have also been applied in drug delivery system and tissue engineering due to their endearing properties. Snail shells are good source of chitosan, a versatile bio-based material for sustainable production and economic development. Nanochitosan is applied over a wide range of fields like biomedical and pharmaceutical, water engineering, and sustainable agricultural production and management. Chitosan is used as smart material in drug formulation and drug delivery system due to its pH and temperature sensitivities. Its potentiality in filtration membrane system for wastewater treatment as adsorbent is well known, though with some limitations. A nonmetal- based semiconductor material called graphitic carbon nitride (g-C_3N_4 or g-CN) is currently gaining tractions and a hot research topic in the energy and environment sectors because of its exceptional and interesting characteristics such as increased stability (chemical and thermal), unique bandgap energy and valence band, effective conductivity, and cost-effectiveness. This g-C_3N_4 can be obtained using different plant extracts and biological agents. Green plants are highly rich in natural carbon and nitrogen compounds, such as glucose, aloin, protein, etc. However, g-CN research is making more ways than other carbon-based materials due to the presence of elements such as C, N, O, and H, thus making it more electron-rich and having multifunctional properties. Some other biomaterials such as water hyacinth can be utilized as nanobiochar (or nano-enabled biochar) for green fertilizer production offers a promising strategy for waste management, environmental remediation, improvement of waterway transportation infrastructure, and agricultural sustainability. Hydrothermal treatment can convert corn cobs into carbon dots which can be used for wastewater treatment, energy storage, environmental remediation and also nanomedicine. There are more to the potentials of the available bioresources in the African continent towards the development of nanotechnology, hence concerted efforts are required to extend the frontiers.

ABSTRACTS OF ORAL PRESENTATIONS

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Determination of elemental composition of bitter kola (*Garcinia kola*) using x-ray fluorescence (XRF) method

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Abstract

Keywords
Garcinia kola
EDXRF
Elemental composition
Bioactive compounds

Garcinia kola, commonly known as bitter kola, is a widely consumed plant species in many parts of the world, particularly in Africa, where it holds cultural, social, and economic significance. Understanding the elemental composition of bitter kola is crucial for assessing its nutritional value and potential health benefits. The aim of this work is to determine the elemental composition of bitter kola and the level of their biological effects by determining the nutritional values of bitter kola. The samples were analyzed at the National Geoscience Research Laboratory (NGRL) Kaduna, using high-resolution Energy Destructive X-ray Fluorescence (EDXRF) technique. A minimal 425kv, Dy No. 1055 XRF machine was utilized, with each sample subjected to analysis for a period of 200 seconds to emit or fluoresce their characteristic elements. Fourteen different elements were detected namely Ni, As, Cr, Co, Mn, Cu, Zn, Cd, Pb, Fe, V, Na, K, and Ca. The analysis revealed significant variations in the elemental composition of the samples. Potassium oxide (K_2O) exhibited the highest oxide composition at 33.80%, while Arsenic trioxide (As_2O_3) showed the lowest at 0.10%. Potassium (K) had the highest percentage concentration overall, with 28.06% in the elemental composition. The crushed coated sample of bitter kola displayed the lowest concentration of Arsenic (0.064%) and Potassium (0.024%) among all samples. The findings indicate that the presence and concentration of certain elements, such as Potassium, Sodium, Calcium, and Copper, vary significantly across different samples of *Garcinia kola*. These elements play vital roles in human physiological functions, including blood pressure regulation, heart health, metabolism, nerve transmission, and bone strength. Additionally, some elements are particularly important for pregnant women, contributing to fetal development and maternal health. This study

provides valuable insights into the elemental composition of various bitter kola, highlighting their nutritional significance and potential health benefits. Further research is warranted to explore the correlation between elemental content and specific health outcomes associated with bitter kola consumption, paving the way for informed dietary recommendations and potential therapeutic applications. We propose that nanotechnology can also enhance the potencies of bitter kola as alternative medicine.

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Encapsulation of *Justicia carnea* leaf extract with different wall materials

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Keywords
Justicia carnea
Encapsulation
Wall materials
Nutritional values
Food fortification

Abstract

The study evaluates the influence of different wall matrix on the bioactive substances in encapsulated *Justicia carnea* leaf extract for use in food fortification. The leaf of *J. carnea* is commonly used for the treatment of nutritional anaemia which affect over 2 million people around the world. Encapsulation involves formulation of thin layer protection around bioactive components of food matrix to prevent environmental and enzymatic degradation and preserve bioactivity and control release of the substance at the active site. Encapsulation may be achieved either on nano scale (1-100 nm) or micro scale (1-1000 µm). The thin layer formed is referred to as wall matrix or nano/micro carrier, while the bioactive substance entrapped is the core matrix. Wall materials commonly used are chitosan, starches, alginates, proteins, lipids etc. In this study, gelatin, maltodextrin, gum Arabic and starch were used in two combinations (1:3) to obtain four types of wall matrix (Gum arabic:Maltodextrin, Gelatin:Maltodextrin, Gum arabic:Starch, and Gelatin:Starch) which were dissolved with water to obtain 20% w/v *J. carnea* leaf was extracted with water and concentrated using rotary evaporator and the resulting extract was added in ratio 1:2 to the wall material and homogenized. Encapsulation was achieved by homogenization at 240 rev/50 cycles for 30 min, followed by freeze drying. The samples obtained are AGM (core + Gum Arabic: maltodextrin); BGM (core + Gelatin:Maltodextrin); CGS (core +Gum arabic:Starch) and DGS (core + Gelatin:Starch). Carotenoids, chlorophyl, and anthocyanin were significantly higher ($p \leq 0.05$) in the sample containing starch and gum arabic (CGS) as the wall matrix than other samples, while betalain was higher in sample BGM. vitamins E and D, Ca and Mn in sample CGS (0.44 and 0.36 µg/100g; 51.65 and 1.55 mg/100g) and DGS (0.45 and 0.37 µg/100g; 51.96 and 1.67 mg/100g) were not significantly different from each other but significantly higher than those present in

sample AGM (0.31 and 0.34; 1.16 and 35.55) and BGM (0.34 and 0.25; 31.50 and 1.15) while vitamins B1, B3 and C were higher in sample DGS (1.94, 0.20 and 2.71) than others (0.87-1.36, 0.09-0.15 and 1.44-2.64). Sample DGS has significantly lower (6.19%) solubility than others (6.48-7.86%). Samples moisture content falls within 4.56 to 7.89%. Characterization of the particles with scanning electron microscope (SEM) revealed irregular shaped particles mostly polyhedral with size range of 10.53-14.16 µm for all the samples. Formation of clusters (agglomeration) is observed mostly in particles of sample AGM and CGM. Differential Scanning Calorimetry (DSC) revealed onset transition temperature range of 76.1 to 87.3 ^{o}C for all the samples. The particles are endothermic and amorphous in nature except for sample CGS which became semi-crystalline at about 203.2 ^{o}C. Sample DGS has the highest (76%) encapsulation efficiency and sample BGM (59%) having the least. The study showed either gelatin or gum arabic with starch as wall material encapsulates bioactive substances in *J. carnea* leaf better, while composite wall containing starch and gelatine is more efficient. The study output may be applied in food fortification and pharmaceuticals.

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The effect of Ce doping on the magnetic properties of $NdFe_{11}Ti$ alloys

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Keywords
Magnetic properties
$(Nd_{1-x}Ce_x)$ $Fe_{11}Ti$ alloys
$ThMn_{12}$-type structures (I4/mmm)
Hysteresis properties
Arc-melting

Abstract

The studied alloys exhibit good magnetic properties, that attracts the interest of future research, which could lead to its commercial and industrial applications. The investigation of the structure and magnetic properties of (Nd1-xCex) $Fe_{11}Ti$ alloys, revealed that, Ce doping has effect on the structure and magnetic properties of the alloys after arc-melting process. The main phase of the processed alloys are compounds with $ThMn_{12}$-type structures (I4/mmm). After smelting (as cast), the main phases resulted to have volume fractions of 74 - 80 vol.% and an average grain size of 100 - 150 nm. The volume of the unit cell is nearly the same by a unit difference with impurities as the remaining phase, where the values that does not exceed 10 - 15 vol.% of the alloys composition. The phase structure inhomogeneity (crystalline multiphase state and dendritic segregation) of the alloys in the cast state explained as the result of change in hysteresis properties.

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Comparative study on the antimicrobial activity of polyvinyl pyrrolidone stabilized silver nanoparticles and lemongrass essential oil

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Keywords
Silver nanoparticles
Antimicrobial
Essential oil
Polyvinyl pyrrolidone
Lemongrass

Abstract

The increasing prevalence of antimicrobial-resistant pathogens and the emergence of new infectious diseases underscore the urgent need for novel and potent antimicrobial agents. Nanotechnology is an emerging area with promising potential for biomedical sciences. In this study, we sought to compare the antimicrobial properties of silver nanoparticles stabilized with polyvinyl pyrrolidone (PVP) and essential oils derived from Lemongrass leaf cultivated in Nigeria. The synthesized nanoparticles were characterized using Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), UV-visible spectrophotometer, Fourier Transform Infra-Red (FTIR) and X-ray Diffraction (XRD). The lemongrass oil was extracted via hydro-distillation of the leaf and subjected to Gas Chromatography and Mass Spectrometer (GCMS) analysis to reveal the bioactive constituents. The antimicrobial activities of the silver nanoparticles and the essential oil were evaluated against select bacterial pathogens (both gram-negative and gram-positive). In addition, Minimum Inhibitory Concentration (MIC) and Minimum Bactericidal Concentration (MBC) were determined by the microdilution method. All the microscopic and spectrometric analyses confirmed the successful formation of the silver nanoparticles. Both the PVP stabilized silver nanoparticles and the essential oils from the lemongrass leaf exhibited strong antimicrobial effect against tested bacteria. The findings from this study suggest that both the PVP stabilized silver nanoparticles and bioactive compounds found in essential oils from Lemongrass exhibited antimicrobial activities and may have useful applications

in development of plant based nanodrugs as antibacterial alternatives.

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Innovations in nano-based sunscreens: advancing skin protection through nanotechnology

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Keywords
Nano-based sunscreens
Nanocarriers
Nanoemulsions
Zirconia nanoparticles
Sun protection factor (SPF)

Abstract

Recent advancements in nanotechnology are revolutionizing the development of next-generation sunscreens. This review examines how integrating nanoparticles into sunscreen formulations can significantly enhance their efficacy, stability, and safety. Specifically, we explore the application of lipid-based nanocarriers, including nanostructured lipid carriers (NLCs) and nanoemulsions, which facilitate controlled delivery and bolster the sun protection factor (SPF) of sunscreens. Additionally, we investigated natural alternatives, such as botanical nanoemulsions and zirconia nanoparticles, which offer UV protection with reduced cytotoxicity. The synergistic effects of innovative nanocomposites are also explored; these include the combination of inorganic UV filters like titanium dioxide with clays such as montmorillonite to achieve superior photoprotection and potential antimutagenic benefits. By this review, we highlight the promise of nanotechnology in creating sunscreens with enhanced photoprotective properties and minimal side effects, and we consider their potential applications in treating photosensitive skin conditions.

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Nanoemulsion-based drug delivery systems for dermatological disorders

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Keywords
Skin delivery
Drug penetration
Topical treatment
Azelaic acid
Skin conditions

Abstract

Can nanoemulsion-based drug delivery systems revolutionize the treatment of dermatological disorders? This review examines recent research on the use of nanoemulsions in dermatology, emphasizing their potential for both dermal and transdermal applications. Nanoemulsions enhance drug permeation through the skin by fluidizing stratum corneum lipid bilayers, offering improved drug solubility, stability, and bioavailability. The effectiveness of nanoemulsions hinges on their composition and characteristics, particularly droplet size and zeta potential, which dictate their stability and penetration ability. These systems have demonstrated success in treating various skin conditions, particularly in delivering anti-inflammatory agents with reduced systemic side effects. Advantages over conventional methods include bypassing first-pass metabolism and providing controlled drug release. While generally considered non-toxic and non-irritant, further human studies are needed to fully evaluate their safety for long-term use. This review further explores nanoemulsions loaded with active pharmaceutical ingredients for skin applications, focusing on their design, synthesis, and characterization. Enhanced drug penetration through skin layers and interaction with hair follicles are particularly highlighted. Key active ingredients like azelaic acid, niacinamide, ascorbic acid, and salicylic acid are evaluated for their efficacy when delivered via nanoemulsions. We also compared these formulations with traditional topical treatments, showcasing improved bioavailability and therapeutic outcomes. Case studies of nanoemulsion-based treatments for conditions such as psoriasis, eczema, alopecia, melanoma, and acne demonstrate the versatility of this approach. Overall, this review provides insights into the current state and potential of nanoemulsion technology in dermatology, emphasizing the need for continued research and development in this field.

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Development of nanocomposite for military body armour applications: potentials and challenges in Nigeria

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Keywords
Ballistics impact
Body armour
Fibres
Nanocomposites

Abstract

During numerous military combat operations, ammunitions or bullets are exchanged at various velocities between troops. To stop or reduce the speed of bullets, ballistic impact-resistant body armour (BIR) items such as vests, helmets, and plates are manufactured and used globally. With a force of more than 230,000 active personnel, the Nigerian military is one of the largest in Africa and thus has also participated in the production of bulletproof wares such as vests, helmets, and plates. This was attained through collaboration between the Defence Industries Corporation of Nigeria (DICON) and two (2) private companies with the establishment of manufacturing plants in Kaduna and Lagos. However, most bulletproof wares made from conventional materials affect the target or person to suffer from blunt force trauma, severe bruising, or damage to vital organs. There are also environmental challenges in getting and disposing of materials used for making existing bulletproof materials. As a way out, nanocomposite materials are currently being developed for bulletproof products due to their unique properties such as high strength-to-weight ratios, excellent energy absorption capability, high stiffness, and elevated strength for various ballistic and anti-impact applications. If adopted in Nigeria, the nanocomposite technology could lead to the creation of home-grown, high-performance bulletproof materials, reducing reliance on imported products, and stimulating local economic growth. As a way out, this paper reviews the potential and challenges of developing Nano-based composites locally for applications in making bulletproof wares.

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Bimetallic iron oxide nanoparticles for antimycobacterial applications

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Keywords
Iron oxide
Metals
Mycobacterium smegmatis
Nanoparticles

Abstract

Metallic nanomaterials are flexible nanostructures and can be used as nano-vehicles for therapeutic agents. The aim of the study was to investigate the antimicrobial effect of iron oxide nanoparticles (IONS) stabilized with one or more metals against *Mycobacterium smegmatis* mc2155. IONS were synthesized via the chemical co-precipitation of $FeSO_4.7H_2O$ and $FeCl.6H_2O$. The resulting IONS were surface-coated with Ag, Au, Cu, and Ni to produce bimetallic nanoparticles: Ag@NION, Au@ION, Cu@ION, and Ni@ION, respectively and characterized using various spectroscopy and microscopy techniques including Scanning Electron Microscopy (SEM), Energy Dispersive X-ray Spectroscopy (EDX), UV-Vis spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR), Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS) and dynamic light scattering (DLS). Time-kill antimycobacterial activity assays were performed to investigate the synergistic effects of the bimetallic nanoparticles. Afterwards, ternary nanoparticles (Ag/Cu@ION and Ag/Ni@ION) were synthesized from active synergistic combinations, and antimycobacterial activity was evaluated. The uptake of nanoparticles by *M. smegmatis* was quantified through ICP-MS, and their cytotoxicity was assessed on murine RAW 264.7 macrophage cells. The synthesized nanoparticles had an average diameter size ranging from 16.86 nm to 33.5 nm. SEM/EDX further confirmed the synthesis of the bimetallic and trimetallic nanoparticles. Among the bimetallic nanoparticles, Ag@ION and Cu@ION demonstrated antimicrobial potential, with minimum inhibitory concentrations (MIC) of 3.9 µg/mL and 62.5 µg/mL, respectively, unlike Au@ION and NiION (MIC > 250.0 µg/mL). Synergized bimetallic nanoparticles exhibited antimycobacterial activity in the following order: Ag@ION+Cu@ION (0.5 µg/mL + 1 µg/mL) > Ag@ION+Ni@ION (1.0 µg/mL + 7.8 µg/mL) > Ag@ION+Au@ION (4 µg/mL + 31.25 µg/mL). Similarly, ternary

nanoparticles followed the trend of Ag/Cu@ION > Ag/Ni@ION, with MIC of 1.95 µg/mL and 3.9 µg/mL, respectively. The nanoparticles induced morphological changes in treated M.smeg cells, and an ICP-MS study revealed the uptake of Ag, Cu, and Fe into the cells. Additionally, the nanoparticles were found to be non-toxic to RAW 264.7 macrophage cells at the MIC concentrations. Ag@ION, Cu@ION, Ag/Cu@ION demonstrated potent antimycobacterial effect against *M. smegmatis*. The antimicrobial effect of synergized Ag@ION + Cu@ION, and Ag@ION + Ag@NiION was higher than their respective individual effects. The nanoparticles also induced morphological changes in treated cells. Future studies will explore the impact of these nanoparticles at the genomic level.

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Application of nanotechnology in renewable energy

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Keywords
Nanotechnology
Renewable energy
Solar
Hydro
Wind
Biomass
Geothermal

Abstract

The great technological challenges in 21st century is the development of renewable energy technologies due to serious problems related with the generation and use of energy. Nanotechnologies area of research considered nowadays as one of the most recommended choices to solve this problem. The aim of this review is to introduce several significant applications of nanotechnology in renewable energy systems. Papers reviewed were Desk (theoretical) research works only related with nanotechnology applications in solar, hydro, wind, biomass, and geothermal. A lot of literatures were reviewed and summarized carefully to give an overview about the role of nanotechnology in improving the various sources of renewable energies. This paper can be considered as an important bridge between nanotechnology and all available kinds of renewable energies. From the other side, these researches study the effect of nanotechnology to enhance the renewable energy industry especially in solar, hydro, wind, biomass, and geothermal.

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Highly efficient $CsPbBr_3$ Perovskite solar cells with TiO_2 nanoparticles and quaternary chalcogenide Cu_2FeSnS_4 as charge transport channels

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Keywords
Perovskite solar cells
SCAPS-1D
Charge transport channels
TiO_2 NPs
Cu_2FeSnS_4
$CsPbBr_3$

Abstract

Cesium-based perovskite solar cells have received tremendous research interest in the domain of photovoltaic due their high stability and low cost, but their performances are challenged with low output when compared to their organic-inorganic halide counterpart. In this research work, the one-dimensional solar cell capacitance simulation (SCAPS-1D) tool was used to investigate the photovoltaic (PV) performance of $CsPbBr_3$-based PSC with different hole transport layers (HTLs) which include copper thiocyanate (CuSCN), copper iodide (CuI), magnesium doped copper delafossite (Mg-$CuCrO_2$), copper oxide (CuO), copper antimony sulphide ($CuSbS_2$), quaternary copper-iron-tin sulfide (CFTS) and copper barium thiostannate (CBTS). The best device configuration was ITO/TiO_2/$CsPbBr_3$/CFTS/Au which gave a power conversion efficiency (PCE) of 12.665%. Further study was carried out on the optimized configuration by varying the thickness of electron transport layer (ETL), doping concentration of ETL and absorber, defect density of the absorber, thickness of absorber and thickness of HTL to obtain 0.01 µm, 1020 cm^{-3}, 1012 cm^{-3}, 1014 cm^{-2}, 0.5 µm and 1.2 µm as optimized values. After proper simulation with the optimized data, a PCE of 26.032% was obtained with TiO_2 and CFTS as charge transport channels. This shows an enhancement of ~2.06 times in PCE over the unoptimized device. Additionally, the influence of temperature, metal work function, series resistance and shunt resistance were also studied and found to affect the performance of the optimized device. This simulation alongside the validated results shows the real potential of $CsPbBr_3$ absorber, creating a major research pathway for the PV industry to develop less expensive and high-performing devices.

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Application and impact of nanotechnology in solar cells for human development

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Keywords
Nanotechnology
Solar cell
Thermo-photoelectric
Environment
Nanoparticles
Humankind

Abstract

Energy is a fundamental demand for humankind. With increases in technological advances, the demand for energy is rapidly increasing, new renewable energy technologies in a variety of shapes and forms are developing daily. Nanotechnology has the potential to significantly extend the lifespan and capacity of sunlight-based energy sources while also helping to address current efficiency challenges. A variety of real cycles that can be applied to the management and transfer of solar energy have been mapped out at the nanoscale. A further era of better execution items has been made possible by the application of nanotechnology in sun-oriented cells. In light of the intensifying competition for sustainable energy options, a range of different approaches have been investigated in order to expand the options. In the areas of sun-oriented cell age, multi-age, range adjustment, thermo-photoelectric cells, hot transporter, centre band, and many other techniques, new standards have been researched. It has been demonstrated that nanoparticles and nanostructures can improve. For the purpose of producing significant amounts of power on a wide scale, today's solar cells are just too expensive to manufacture and too inefficient. On the other hand, possible developments in nanotechnology might make it possible to produce solar cells that are somehow more efficient and less expensive. In the solar industry, nanotechnology has already demonstrated enormous advancements. They are an entirely different kind of solar cell from anything you could have imagined. While solar cell performance may be improved via nanotechnology, which can be the most promising use to the environment.

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Self-sustaining solution combustion synthesis of ZnO nanoparticles: effect of fuel on particle properties and antimicrobial activity

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Keywords
Nanoparticles
Zinc oxide
Solution combustion synthesis
Antimicrobial activities

Abstract

Solution combustion synthesis (SCS) involves self-sustained exothermic reactions between a metal nitrate (oxidizer) and an organic fuel (reducer) along an aqueous or sol-gel medium. Here-in we report SCS of two ZnO nanopartices synthesised using urea and citric acid as fuels (ZnO-U and ZnO-C.A, respectively). These samples were characterized by XRD, FTIR, SEM, BET and TGA techniques. The properties of these samples were compared with that of a reference sample (ZnO-P) synthesized via a simple precipitation method. The ZnO-U sample is more amorphous based on the broader XRD, showing smaller particle sizes and higher BET surface area. The ZnO-C.A was more crystalline with bigger particles sizes and smaller surface area. The properties of the reference sample (ZnO-P) in terms of particle sizes and surface area were in between the two SCS samples. The SEM images of the SCS samples showed particles with irregular morphology. While the ZnO-U sample appeared as sponge-like particles, the ZnO-C.A showed gravel-like particles of bigger sizes at the same magnification. The particles of the reference sample (ZnO-P) also showed irregular morphology but the particle sizes were comparably more uniformly distributed. The TGA results of the samples showed that the order of decreasing thermal stability of the samples is as follows: ZnO-C.A > ZnO-U > ZnO-P. The antimicrobial activities of the samples were evaluated based on two bacterial isolates: *Staphylococcus aureus* and *Eschericia coli*, and two fungal isolates: *Candida albicans* and *Aspergillus fumigatus* using the disc diffusion method (DDM). The ZnO-C.A showed the least antimicrobial activity, while higher zones of inhibition were observed for the ZnO-U sample at all concentrations, which also showed lowest minimum inhibitory concentrations (MICs) of 1.80-2.40 µg/ml against all the test organisms.

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Comparing the effects of nano and microparticles sizes on the properties of hybrid copper alloys made via SPS technique

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Keywords
Nanoparticles
Cu-based alloys
Microparticle
Nb
SPS

Abstract

A CuNb(TiB2)C multi-principal element alloy was created with a composition of 40 wt.% Cu, 30 wt.% Nb, 20 wt.% (TiB2), and 10 wt.% C. The alloy was designed to have both 14 nm and -44 µm particle sizes of Nb. The spark plasma sintering (SPS) technique was used to produce the alloy at two different sintered temperatures of 650 ◦C and 700 ◦C while keeping other SPS parameters constant. An investigation was conducted to analyze and choose the most suitable alloy for aerospace applications by analyzing and comparing the sintering mode, microstructures, microhardness, density, relative density, wear behaviour, and corrosion properties of the alloys. The study found that alloys containing nanoparticles of Nb had faster sintering, lower wear rates, and a microstructure characterized by a dendritic configuration. These alloys also exhibited graphite-rich and niobium-rich nano-segregations in the inter-dendritic areas, resulting in the lowest coefficient of friction. Among the tested alloys, CuNbTiB2C with nanoparticles of Nb sintered at 650 ◦C showed the highest microhardness value (786.04 HV0.3). On the other hand, CuNbTiB2C with micro-particles of Nb sintered at 700 ◦C demonstrated superior anti-corrosion properties in a sulphuric acid environment. The findings of this study meet the criteria for high-performance engineering materials, making innovative materials significant in the aerospace sector.

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Development of stable Mg-Zr phases: a study on tribocorrosion and biocompatibility in biomaterials

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Keywords
Implant
Magnesium
Tribocorrosion
High entropy alloy

Abstract

Magnesium is widely studied for its electrochemical corrosion behavior across various applications, particularly in the biomaterials industry, where it ranks just below titanium. However, magnesium's relatively low elastic modulus and susceptibility to corrosion pose challenges when used as an implant material. Despite extensive research on magnesium corrosion, there is a noticeable gap in studies addressing the combined effects of mechanical and electrochemical processes (tribocorrosion), especially in environments that mimic implant replacement or oral conditions. Understanding the material degradation in biological environments, where tribocorrosion is influenced by biological species, remains complex. This paper aims to develop and evaluate allergen-free magnesium-based composites reinforced with zirconium (Zr) for biomedical applications, focusing on improving corrosion resistance and mechanical properties. The study employs high entropy alloy predicting software to predict the behavior of Mg-Zr/Mo/Ni/Cr phases at different compositional levels, optimizing the alloy's mechanical and corrosion resistance properties. The inclusion of Zr in magnesium-based composites demonstrates a potential to lower the elastic modulus and enhance biocompatibility. The alloy composition was optimized to achieve stable and functional phases suitable for biomedical implants. Therefore, magnesium-based composites reinforced with Zr can overcome the limitations of pure magnesium, offering improved mechanical properties and corrosion resistance, making them promising candidates for biomedical implants.

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Green synthesis of zinc oxide nanoparticles: a trifecta of antioxidant, antifungal, and catalytic excellence

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Keywords
Green synthesis
ZnONPs
Newbouldia laevis
Antifungal
Antioxidant
Catalysis

Abstract

In this study, green synthesis methods were employed to fabricate zinc oxide nanoparticles (ZnONPs) using *Newbouldia laevis* leaf extract. The synthesized ZnONPs were characterized by utilizing different analytical techniques, including UV-Vis spectrophotometer, Fourier-Transform Infrared Spectroscopy (FTIR), Transmission Electron Microscopy (TEM) and Thermogravimetric Analysis (TGA). The synthesis of ZnONPs with well-defined characteristics was shown through the structural and morphological analyses. The presence of functional groups involved in the reduction and stabilization of the nanoparticles were verified using the Fourier-transform infrared spectroscopy (FTIR). Transmission electron microscopy (TEM) gave insights into the size and structure of the nanoparticles. A crystalline structure with a hexagonal shape morphology, non-spherical particles with a well-defined size spread with average nanoparticle size of 34.8 nm. The green-synthesized ZnONPs exhibited distinct antioxidant properties. The results indicated a concentration-dependent rise in radical scavenging activity of the ZnONPs. In addition, the green-synthesized ZnONPs displayed a significant activity against the three fungal strains; *Candida albicans*, *Aspergillus fumigatus* and *Trichophyton rubrum*, displaying their potentials as environmental-friendly antifungal agents. Additionally, ZnONPs was found to be an effective catalyst in the reduction of 4-nitophenol to aminophenol, when its catalytic activities were explored in model reaction.

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Biosynthesis of zinc oxide nanoparticles using *Colocasia esculenta* leaf extract and *in vitro* antimicrobial studies of white yam pathogens

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Keywords
Biosynthesis
ZnONPs
Colocasia esculenta
Antimicrobial
Yam pathogens

Abstract

Zinc oxide nanoparticles (ZnONPs) were synthesized by green method using methanolic leaf extract of *Colocasia esculenta* L. (Cocoyam) and characterized by UV-Visible, XRD, SEM, EDX and FTIR. The study revealed that maximum rate of synthesis could be achieved with 0.50 moldm^{-3} ZnO solution at 90 ^{o}C in 5 h. Again, clearly segregated wurtzite hexagonal crystalline ZnONPs with average crystallite size of 10 nm with a range of 9.85-10.12 nm were obtained. FTIR spectra of the extract and the synthesized ZnONPs revealed reducing agents such as phenolic groups as well as capping and stabilizing agents such as amines, peptides and amides groups. The data obtained from the zone of inhibition (mm) was analyzed using statistical package for social science, SPSS Version 20. The biosynthesized ZnONPs exhibited antimicrobial action in a dose-dependent manner against five white yam pathogenic fungi: *Aspergillus niger, Aspergillus flavus, Botryodioplodia theobromae, Rhizopus stolonifer* and *Fusarium oxysporum* as well as three bacteria: *Klebsiella oxytoca*, *Serratia marcescens* and *Pseudomonas aeruginosa*. The biosynthesized ZnONPs exhibited effective to moderately effective inhibition ranging from 94.55% to 32.08% on the test organisms when compared with standard antifungal (Teraconazole) and antibacterial (Ciprofloxacin) agents. The ZnONPs holds great potential in reducing postharvest white yam tuber rot and many other related agricultural products losses.

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Smart nanocomposite coatings for explosive devices: enhancing safety and performance

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Keywords
Explosive devices
Safety
Smart nanocomposite coatings
Military applications
Nanotechnology

Abstract

The advancement of nanotechnology has opened new frontiers in enhancing the safety and performance of explosive devices through the development of smart nanocomposite coatings. This review explores the innovative application of nanocomposite materials in explosive device technology, focusing on how these coatings can significantly improve stability, durability, and functionality. Smart nanocomposite coatings incorporate nanoscale materials such as carbon nanotubes, graphene, and metallic nanoparticles, which impart unique properties like enhanced mechanical strength, thermal stability, and real-time monitoring capabilities. These coatings can effectively shield explosive materials from environmental factors, reducing the risk of accidental detonations and extending the operational lifespan of the devices. Additionally, smart features integrated into these coatings, such as embedded sensors for condition monitoring, allow for real-time data collection and early detection of potential failures, thereby enhancing operational safety. This paper reviews the latest advancements in nanocomposite coatings, their mechanisms of action, and their practical applications in military and industrial settings. By examining case studies and recent research findings, the paper highlights the transformative potential of nanocomposite technologies in creating safer, more reliable explosive devices. Future research directions are also discussed, emphasizing the need for further development in scalability, cost-effectiveness, and integration with existing systems to fully realize the benefits of smart nanocomposite coatings in explosive technology.

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Chitosan, alginate and polyethylene glycol capped zinc oxide nanoparticles for hyperthermia applications

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Keywords
Nanoparticles
Zinc oxide
Polymers
Sol-gel
Hyperthermia

Abstract

Functional oxides have been very ingenious for diverse applications, recently in biomedical applications. Among the functional oxides, zinc oxide nanoparticles (ZnONPs) have proven to be exceptional for biomedical applications. Chitosan (CS), alginate (Alg) and polyethylene glycol (PEG) has been explored in the synthesis of ZnONPs as a potential capping agent for hyperthermia applications. The X-ray diffractometer (XRD), UV-visible spectroscopy, scanning electron microscopy (SEM), Fourier transform infrared spectroscopy (FTIR) and Vibrating sample magnetometry (VSM) techniques were used to analyze the crystallinity, absorbance, morphology and the magnetic properties of the samples, respectively. The hyperthermia analyses of ZnONPs and PEG, CS and Alg capped ZnONPs were conducted under an applied field of 180 Oe. The results indicated that the samples reached elevated temperatures that fall within the therapeutic range. A high specific absorbance rate (SAR) was obtained for the capped samples when compared with the pristine sample, making it more suitable for hyperthermia applications.

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The impact of thermophysical properties on the heat and flow characteristics of a nano-lubricant based on aluminum oxide (Al_2O_3) in a cylindrical channel

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Keywords
Nanolubricants
Aluminum oxide (Al_2O_3)
Thermophysical properties
Heat transfer
Flow dynamics
Cylindrical channel

Abstract

The potential of nano-lubricants to improve heat transfer and flow characteristics in a variety of engineering applications has motivated a significant amount of interest in the study of their thermophysical properties in recent years. This paper examined the influence of thermophysical properties, including thermal conductivity, viscosity, density, and specific heat capacity, on the heat and flow behavior of aluminum oxide (Al_2O_3)-based nano-lubricants that are flowing through a cylindrical channel. The governing equations for momentum and energy were converted to non-dimensional form and solved using a finite difference scheme that was implemented in C++. The analysis examined the impact of thermal conductivity ($0.3<\kappa<1.5$), viscosity ($0.001<\mu<0.3$), density ($998< \rho <3592$), and heat capacity ($1100 < Cp < 4200$) on the heat and flow characteristics of the alumina nanolubricant while maintaining the Eckert number (Ec = 1.0) and a Reynolds number of 100. The findings revealed that the modified nanofluid exhibits improved thermal conductivity as a result of the integration of Al_2O_3 nanoparticles into a base lubricant. This results in improved heat dissipation and temperature distribution along the channel walls. The flow dynamics are also influenced by the altered viscosity of the nanolubricant, which affects the coefficient of drag friction, stream function, and circulation. The results demonstrated that the heat transfer effectiveness is significantly improved by the inclusion of Al_2O_3 nanoparticles, while the flow characteristics are simultaneously altered. Consequently, the Al_2O_3-based nanolubricant is an attractive option for use in thermal management systems, heat exchangers, and automotive systems.

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The role of nanomaterials in enhancing the industrial preservation of probiotics for safe and sustainable food production: a review

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Keywords
Nanomaterials
Probiotics
Preservation
Food safety

Abstract

The integration of nanomaterials in the industrial preservation of probiotics represents a significant advancement in food technology, aimed at enhancing the stability, viability, and efficacy of probiotic strains during processing, storage, and consumption. This review explores the current state of nanotechnology applications in probiotic preservation, highlighting the mechanisms by which nanomaterials improve the encapsulation, protection, and controlled release of probiotics. Key nanomaterials, including nanoparticles, nanofibers, and nanocomposites, were explored for their roles in maintaining probiotic viability under adverse conditions such as temperature fluctuations, oxidative stress, and gastrointestinal transit. The review also addresses the safety, regulatory, and sustainability aspects of using nanomaterials in food systems, emphasizing their potential to contribute to safer and more sustainable food production. By synthesizing recent research findings, this paper aims to provide a comprehensive overview of the benefits and challenges associated with nanomaterial-enhanced probiotic preservation, offering insights into future directions for research and application in the food industry.

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Synthesis of amodiaquine loaded chitosan-coated superparamagnetic iron oxide nanoparticles and in silico drug reprofiling of amodiaquine for anti-cancer drug delivery

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Keywords
Cancer
Reprofiling Amodiaquine
Superparamagnetic iron oxide nanoparticles
Chitosan

Abstract

Nanotechnology has emerged as a powerful tool in the field of medicine offering innovative solutions for drug delivery and cancer management. Amodiaquine, an antimalarial drug, has shown potential in cancer therapy due to its intrinsic autophagic inhibitory activity. Clinical application has been limited by off-target effects. A key challenge in cancer treatment is the destruction of cancer cells alongside healthy cells. The aim of this research was to synthesize amodiaquine loaded chitosan-coated superparamagnetic iron oxide nanoparticles (SPIONs) and evaluated the *in silico* reprofiling of amodiaquine for cancer drug delivery. SPIONs were synthesized via co-precipitation method and were characterized using magnetization test and Fourier-transform infrared spectroscopy (FTIR). Subsequently, the SPIONs were surface coated with chitosan and also characterized using FTIR. Amodiaquine was finally then loaded on the chitosan-coated SPIONs and they were characterized using FTIR Amodiaquine loading capacity, encapsulation efficiency and release studies were carried out using UV-spectrophotometry. Chitosan-coated amodiaquine was evaluated through molecular docking studies using PyRx AutoDock Vina Wizard and visualized with BIOVIA Discovery Studio. Results from the FTIR analysis showed the Fe-O characteristic peak vibrations at 500-700 cm^{-1}, chitosan C=O stretching vibration at 1650 cm^{-1}, amodiaquine aromatic C-H bending at 1490 cm^{-1} and C-O stretching at 1060 cm^{-1}. The loading capacity of the drug was 5.1%, with an encapsulation efficiency of 98.8%. The release profile indicated that 0.16% and 0.024% of amodiaquine was released from the nanoparticles at pH 7.3 and pH 5.4. *In silico* molecular docking of amodiaquine molecule showed hydrophobic interaction with breast, colon and ovarian

breast cancer proteins while chitosan-coated amodiaquine showed hydrophobic interaction with breast, colon, lung and colorectal cancer proteins. These findings suggest that chitosan-coated SPIONs can serve as an effective nanocarrier for amodiaquine, enhancing its delivery and anticancer activity while minimizing side effects.

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Fabrication and characterization of dye-sensitized solar cells using natural dye extracts of *Vernonia amygdalina* leaf as photosensitizers

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Keywords
Iron oxide
Metals
Mycobacterium smegmatis
Nanoparticles

Abstract

The power conversion efficiency of a dye-sensitized solar cell (DSSC) depends largely on the photochemical performance of the dye utilized as the photosensitizer to harvest the solar energy for electricity generation. Several natural dyes from plants have been studied as photosensitizers for low-cost and environmentally friendly DSSCs but the fabricated cells usually suffer from low efficiency. Therefore, tremendous research efforts are being focussed on the search for natural dyes with enhanced photochemical performance as photosensitizers in DSSCs. This study investigates the suitability of natural dye extract of bitter leaf (*Vernonia amygdalina*), as a photosensitizer in DSSCs. The natural dye was extracted using acetone and ethanol solvents and characterized by FTIR, UV–Vis, and photoluminescence (PL) spectroscopy. The FTIR spectrometry results demonstrated the presence of three functional groups: the hydroxyl, amine, and carbonyl groups, a strong indication of good adsorption by the semiconductor metal oxides in DSSCs. The UV-Vis and PL spectra showed that the natural dye of *V. amygdalina* extracted with acetone and ethanol displayed stable and strong optical absorption in the visible region of the electromagnetic spectrum. Therefore, the natural dye extract of *V. amygdalina* is a potential candidate for photosensitizers in DSSCs. The DSSC fabricated with *V. amygdalina* dye extracted using acetone delivered higher solar efficiency than ethanol with performance parameters (short-circuit

current density Jsc, open-circuit voltage Voc, fill-factor FF, and power conversion efficiency η) as 330.51 μA/cm², 522 mV, 0.68 and 0.12%, respectively.

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Probing the role of ginger starch on physicochemical and thermal properties of gum Arabic hybrid biocomposite for food packaging applications

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Keywords
Polymer blending
Gum Arabic
Ginger starch
Biocomposite
Packaging materials

Abstract

This study assessed the effect of ginger starch (S) on the physicochemical and thermal attributes of gum arabic (GA) hybrid biocomposites for postharvest storage. Two composite blends of GA and S at [GA-S 96.7:3.3% (v/v)] and [GA-S 93.3:6.7% (v/v)] concentrations were developed and examined. Standard techniques were used to analyze moisture content, thickness, transparency, water solubility (WS), water vapor permeability (WVP), tensile strength, elongation at break (E@B), surface microstructure, functional groups, and thermal stability of the biocomposite films. The results showed that, with 6.7% starch, the film's moisture content, thickness, transparency, tensile strength, and E@B increased by 33.4%, 47.1%, 22.6%, 18.8%, and 26.6%, respectively, compared to the 3.3% starch blend. Conversely, WS and WVP decreased by 13.0% and 28.6%, respectively, in the 6.7% starch film. The biocomposite films' morphology became less smooth with higher starch content. FTIR indicated intermolecular interactions between GA and S, while SEM and thermal analyses (TGA and DSC) confirmed good compatibility and thermal stability. When coated on tomatoes, the GA-S biocomposites improved storage stability for 20 days at 25±2 ^{o}C due to reduced lycopene content and low cell wall softening enzyme activity. These results highlight ginger starch's potential to enhance GA films for postharvest tomato storage.

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Purification of different fractions of industrial wastewater using biosynthesized silver nanoparticles of *Amaranthus hybridus* and *Amaranthus viridis*

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Keywords
Industrial wastewater
Amaranthus species
Silver nanoparticles
Phytochemicals

Abstract

The growing demand for readily available water as well as the problem of pollution of water bodies caused by various byproducts of production processes, poses a critical challenge for proper and sustainable use of water, hence the need for remediation. The research work examined the potential of biosynthesized silver nanoparticles from *Amaranthus viridis* and *Amaranthus hybridus* in purification of different fractions of industrial wastewater. After synthesis of the silver nanoparticles, standard methods for characterization were used for UV-visible Spectroscopy, X- ray Diffraction, Scanning Electron Microscopy, Fourier Transform Infrared Spectroscopy, Energy Dispersive X-ray and Dynamic Light Scattering, while Harbone methods was used for phytochemical screening. For the wastewater treatment analysis. The UV-vis spectroscopy result showed that *A. viridis* and *A. hybridus* AgNPs had 430 nm and 400 nm absorption peaks respectively. XRD results of synthesized *A. viridis* and *A. hybridus* AgNPs showed that the highest peak was observed at the plane with miller index of (111), indicating their crystalline nature and an average crystalline size of 2.95 nm. SEM results of *A. viridis* and *A. hybridus* AgNPs showed that the AgNPs were agglomerated and flake-like in shape. The FTIR spectra of *A. viridis* AgNPs and *A. viridis* leaf extracts revealed that the peak shifts were consistent with hydroxyl groups, amines, carboxylic acids, alkanes, alkynes, alkenes, phenols and chlorides, indicating presence of phytochemicals. EDX result of *A. viridis* and *A. hybridus* AgNPs showed the presence of silver and some other elements, with silver having the highest percentages of 65.60% in *A. viridis* and 64.50% in *A. hybridus*. DLS result of *A. viridis* and *A. hybridus* AgNPs showed that both AgNPs had similar Z average size (12.5 nm) of

nanoparticles. The qualitative and quantitative phytochemical result of *A. viridis* revealed the presence of alkaloids (1.3%), flavonoids (5.8%), terpenoids (1.2%), phenolics (0.0014 %), tanins (0.9%) and hydrogen cyanide (0.0004%). The qualitative and quantitative phytochemical result of *A. hybridus* revealed the presence of alkaloids (1.6%), flavonoids (7.2%), terpenoids (1.8%), phenolics (0.0018%), tanins (1.1%) and hydrogen cyanide (0.0006%). Antimicrobial activity of *A. viridis* nanoparticle revealed that the nanoparticle had varying levels of activity against *Staphylococcus aureus* and *Escherichia coli*, however, the effect was more pronounced on the gram-positive *S. aureus* strain. The wastewater was analyzed for water quality parameters such as pH, COD, BOD, presence of heavy metals and results showed that apart from pH, all physicochemical and water quality parameters were reduced by *A. viridis* AgNPs and *A. hybridus* AgNPs. From this study, it can be implied that *A. viridis* and *A. hybridus* AgNPs can be applied in wastewater treatment for the removal of contaminants due to their antimicrobial and adsorption properties.

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Sorghum bicolor: a potential crop for nutrient-nanoparticles for agricultural bio-fortification

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Keywords
Nanoparticles
Micronutrients
Sorghum bicolor
Biofortification

Abstract

Sorghum (*Sorghum bicolor* (L.) Moench) is an important food crop in Africa and is the 5th most important cereal crop grown in the world as well as the most important cereal food in the Northern states of Nigeria. Nigeria is the 2nd largest producer of sorghum, grown on about 5.9 million ha with current annual production estimated to be about 6.7 million tonnes. *Sorghum bicolor* is a major staple crop grown in semiarid regions due to its drought tolerance, which makes it a good candidate for biofortification. This narrative review suggests a novel approach to sorghum into micronutrient nanoparticles (FeNPs, CuNPs, and ZnNPs) through green synthesis methods. The unique properties of nanoparticles, including enhanced nutrient absorption and growth modulation in plants, offer promising avenues for addressing nutrient deficiencies affecting millions globally. This work is aimed at increasing crop yield and food security and promoting environmental sustainability with the aid of biogenic nanoparticles from *Sorghum* in order to bio-fortify commonly consumed vegetables. In addition, the narrative investigates the application of these nanoparticles in promoting vegetable growth in addition to enhancing their micronutrient contents, especially iron. This review helps to affirm the transformative potential of agricultural by-products in addressing nutritional deficiencies and at the same time enhance the sustainable production of food from plants.

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Essential oil- encapsulated nanochitosan for food safety and security: A review

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Keywords
Nanochitosan
Essential oil
Food Safety
Food Security
Food Sustainability

Abstract

The growing global population and agricultural constraints have driven creative ways to food preservation in response to growing concerns about food safety and security. The review investigates the possibility of nano-encapsulated essential oils in chitosan-based systems as a novel approach to enhance food safety and security. This review explores the potential of essential oil-encapsulated nano chitosan in developing next-generation food preservation technologies, ensuring food safety and security in the modern world. Essential oils, known for their antibacterial, antioxidant, and preservative capabilities, are becoming increasingly popular as natural alternatives to synthetic chemicals. However, their instability, volatility, and pungent fragrance frequently limit their use in food systems. Chitosan, a biopolymer produced from chitin, offers a promising approach for nano-encapsulation to address these difficulties. Chitosan nanoparticles can improve the stability, controlled release, and bioactivity of essential oils while simultaneously increasing solubility and lowering sensory effects.

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Nymphaea lotus-synthesized gold nanoparticles attenuate cadmium-induced hepatotoxicity in rats

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Keywords
Cadmium
Gold nanoparticles
Hepatic
Nymphaea lotus
Toxicity

Abstract

Cadmium (Cd) toxicity is one of the several health problems that disrupt the normal physiological activities of most organs. The use of gold nanoparticles for drug delivery and targeted therapy against tissue damage is a considerable option. This study investigated the effect of *N. lotus*-synthesized AuNPs (NL-AuNPs) against cadmium (Cd)-induced liver damage in rats. Thirty rats were grouped into six of five each. Group 1 served as control, while groups 2 to 5 were orally administered with 10 mg/kg $CdCl_2$ daily for 5 days, to induce hepatic damage. Groups 3 to 5 were also treated with silymarin (75 mg/kg), 5 and 10 mg/kg NL-AuNPs, respectively. Group 6 rats received 10 mg/kg NL-AuNPs only. Biochemical parameters including liver damage and function markers (alanine transaminase (ALT), aspartate transaminase (AST), alkaline phosphatase (ALP) and albumin), oxidative stress (malondialdehyde (MDA)) and inflammation markers (Interleukin-6 (IL-6) and Nuclear Factor-κB (NF-κB)), and liver histopathology were assessed. It was revealed that cadmium caused a significant ($p < 0.05$) liver damage in rats, based on significant ($p < 0.05$) increase in serum ALT and ALP, tissue MDA, IL-6 and NF-κB, and significant ($p < 0.05$) decrease in albumin, when compared with the control. These changes were significantly attenuated by both doses of spherically-shaped NL-AuNPs (size range of 25–30 nm with wavelength 541 nm), although trace of toxicity was noted with 10 mg/kg dose. It can therefore be concluded that NL-AuNPs could reverse liver damage induced by cadmium and can, therefore, be considered a potential agent against liver diseases.

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Anticancer potential of *Ganoderma lucidum* mediated selenium nanoparticles

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Keywords
Biosynthesis
Selenium nanoparticles
Ganoderma lucidum
Anticancer

Abstract

Selenium nanoparticles (SeNPs) hold promise for developing novel cancer prevention and treatment approaches due to their significant biomedical potential including their antiproliferative and anticancer properties. Their implementations into clinical practice have recently increased vastly owing to their inimitable physicochemical characteristics, encompassing their high biocompatibility, high stability, high bioavailability, and low toxicity. Green synthesis of diverse nanoparticles, using different biological biomolecules is a cheaper, simpler, and environmentally friendly alternative. They serve as a useful mediator that prevents aggregation, enhances stability, and leads to a more bioavailable and less toxic profile. SeNPs have the potential to destroy cancer cells via apoptosis induction, internalization of the nanoparticles, regulation of reactive oxygen species production, induction of autophagy, and activation of the intrinsic apoptotic machinery while protecting normal healthy cells from damage. SeNPs can induce cytotoxic effects and exert an immunostimulatory on tumour cells. Exploration of *Ganoderma lucidum* had established the presence of countless bioactive compounds, majorly triterpenoids and polysaccharides. These bioactive compounds confirmed *G. lucidum* broad pharmacological and therapeutical potential. The potential of *G. lucidum* in the prevention and treatment of various kinds of tumours, including breast, prostate, colon, lung, and cervical cancer, has been established. This review will unfold the biogenic synthesis of selenium-based nanoparticles using different extraction mediums from *Ganoderma lucidum* and its characterizations. It will explore their potential as anticancer therapies.

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Biosynthesis of silver nanoparticles mediated by bioflocculant derived from *Serratia nematodiphila* ETA1 PP413762 isolated from Asa river and its application in water treatment

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Keywords
Water treatment
Bacteria
Bioflocculants
Silver nanoparticles

Abstract

The drawbacks in water treatment include increased presence of carcinogenic, recalcitrant and toxicogenic substances in water bodies. The growing burden of waterborne diseases has compelled researchers to identify more efficient ecofriendly ways for treating water for drinking and other anthropogenic purposes. Studies have revealed that bioflocculants and silver nanoparticles (AgNPs) show prospects as viable alternatives. The research aimed at isolating a bioflocculant-producing bacteria isolated from Asa river for the biosynthesis of AgNPs for water treatment. A bacterium that was identified molecularly as *Serratia nematodiphila* ETA1 PP413762 (SN) with flocculating activity of 88% was used to prepare cell-free bioflocculants that were used for SN–AgNPs biosynthesis. The SN–AgNPs were first characterized using Ultraviolet-visible spectrophotometry and Fourier transform infrared (FTIR) spectroscopy. The antimicrobial properties and removal efficiency (R.E) for biological oxygen demand (BOD), chemical oxygen demand (COD), phosphorus removal (P), nitrogen removal and optical density were evaluated. The bioflocculant bio-reduced $AgNO_3$ to SN–AgNPs. The SN–AgNPs showed surface plasmon resonance absorption peak for UV was at 416 nm at an absorbance value of 1.55 and FTIR showed prominent peaks at 1634.8, 2165.8 and 3335.4 cm^{-1}. It also showed a 98.5% reduction in microbial load and R.E of 47.16% (BOD), 39.49% (COD), 36.49% (P), 64.45% (N) and 35.94% (OD). The SN-AgNPs can be utilized as potential flocculating agent and antimicrobial agents in water purification and treatment.

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Synergistic effects of gadolinium oxide into matrix of zeolitic imidazolate frameworks (ZIFs) for supercapacitor applications

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Abstract

Keywords
Direct combination
ZIF-8
ZIF-67
GCD
Absorbance

In this study, we synthesized ZIF-8, ZIF-67, $Gd_{0.01}$/ZIF-8, and $Gd_{0.01}$/ZIF-67 electrodes using the direct combination technique. Both electrodes are being used for energy storage devices. We extensively evaluated these nanocomposites using a variety of electrochemical methods, including stability tests, galvanostatic charge-discharge (GCD), cyclic voltammetry (CV), and electrochemical impedance spectroscopy (EIS). ZIF-8 exhibits a wide band gap of approximately 3.0 eV, suggesting its main absorption is of UV light. The peaks in the absorbance spectrum vary slightly in wavelength due to the presence of different metal centers. Peaks between 1400-1600 cm^{-1} indicate C–N stretching vibrations from the imidazolate linkers. Peaks between 1600-1700 cm^{-1} are associated with C=C stretching vibrations. ZIF-8 exhibits well-defined peaks in its XRD pattern, indicating a high level of crystallinity. Peaks can be observed at specific 2θ values, typically at 22.09°, 26.62°, 38.49°, and 47.27°, which correspond to the (110), (200), (211), and (220) planes. The calculated specific capacitances for ZIF-8 and ZIF-67 are 223.95 and 255.20 F/g. For $Gd_{0.01}$/ZIF-8, and $Gd_{0.01}$/ZIF-67 specific capacitances are 575.00 and 587.50 F/g. The ZIF-8, ZIF-67, $Gd_{0.01}$/ZIF-8, and $Gd_{0.01}$/ZIF-67 electrode exhibited specific capacitances of (78.30, 192.59, 342.57, and 1164) F/g at current densities of 1 A/g from the GCD calculation. The retention plot of ZIF-8, ZIF-67, $Gd_{0.01}$/ZIF-8, and $Gd_{0.01}$/ZIF-67 electrode shows efficiency of 71%, 71%, 105% and 75%, respectively, indicating their suitability for supercapacitor applications.

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Assessing air quality impacts of Gaari processing: a nanotechnology-based approach

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Keywords
Air quality
Nanotechnology
CO_2 emissions
Temperature
Relative humidity
Air pollution control,
Food processing facilities
PCE-AQD 50

Abstract

Air quality in food processing facilities, including gaari processing, is a growing concern due to potential health risks associated with exposure to pollutants. Nanotechnology offers promising solutions for air quality monitoring and remediation. This study investigated the air quality at a gaari processing factory in Ejigbo local government area, Osun State, Nigeria. Daily atmospheric data of CO_2, temperature, relative humidity, and pressure were collected using a PCE-AQD 50 device over a 42-day period. Statistical and data visualization techniques were employed to analyze the data and assess air quality trends, correlations between variables, and potential health implications. The study found the maximum, minimum and mean values of the atmospheric data of CO_2, temperature, relative humidity, and pressure to be 1934.28, 466.29 and 1012.40, 39.16, 26.67 and 32.60, 75.06, 45.15 and 58.41, and 898.00, 898.00 and 898.00 accordingly, where elevated CO_2 levels at the factory, has a positive correlation between CO_2, and temperature. The measured CO_2 levels may pose health risks to workers and the surrounding community. The findings highlight the need for effective air pollution control measures in gaari processing facilities. Nanotechnology-based solutions, such as advanced sensors and air purification technologies, can be implemented to improve air quality and protect human health. Further research is recommended to investigate the long-term health impacts of exposure to elevated CO_2 levels in this setting.

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Biogenic synthesis of silver and silver-gold alloy using *Ganoderma lucidum* (ON394695), their Phytochemical screening, and wound healing potentials

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Keywords
Ganoderma lucidum
Wounds
Phytochemical
Nanoparticles
Wound healing

Abstract

Wound is a silent epidemic that can pose a risk to a patient's health. The use of enhanced treatment strategies by a nanotechnology-based approach is necessary to potentiate wound healing activity. Phytochemical screening was done to reveal the bioactive constituents of *G. lucidum*. The aqueous extract of the harvested fruiting body was used to synthesize silver nanoparticles (GL-AgNPs) and silver-gold bimetallic nanoparticles (GL-Ag-AuNPs) and characterized. *In-vivo* wound healing assay of GL-AgNPs and GL-Ag–AuNPs was carried out using animal experiments. Phytochemical analysis showed the presence of several bioactive components (%) with tannin, saponin, alkaloids, anthroquinones, flavonoids, steroids, phlobatannin, and phenols. The UV–vis spectroscopy showed 430 and 540 nm for GL-AgNPs and GL-Ag–AuNPs respectively. The significant Fourier transform infrared (FTIR) peaks: GL-AgNPs (3227 and 1633 cm^{-1}) and GL-Ag–AuNPs (3257 and 1633 cm^{-1}) which implied that protein acted as a capping and stabilizing agent. Transmission electron microscopy (TEM) confirms the nanoparticles to be poly-dispersal in nature while Selected area electron diffraction (SAED) revealed the crystalline nature of the nanoparticles. GL-AgNPs and GL-Ag-AuNPs demonstrated 100 and 99.25 percentage of wound healing by Day 18 respectively, while positive control (Gentamycin) gave 100%. GL-Ag-AuNPs obtained complete wound closure by Day 21 (100%). The results affirmed the efficacy of synthesized silver nanoparticles (GL-AgNPs) and silver-gold bimetallic nanoparticles (GL-Ag-AuNPs) as prospective wound-healing agents that can be

exploited to enhance faster wound closure.

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Nutraceutical properties enhancement using nanotechnology

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Keywords
Nanotechnology
Nutraceuticals
Nanoparticles
Bioavailability
therapeutic.

Abstract

Nanotechnology plays a major role in human nutrition, providing numerous opportunities to improve food quality and safety. This work investigates the enhancement potential of nanoparticles (NPs) in enhancing the potency of nutraceuticals. Nutraceuticals are food products with both nutritional and therapeutic potential. However, despite their demand and popularity, their nutritional and therapeutic effects are inhibited by their low bioavailability. This is due to various physiological and physiochemical factors, and quality control, which is an important step to determine the safety and authenticity of the nutraceuticals on the global supply level. In recent years, nutraceuticals have come to the limelight because of people's recent way of living which leads to improper nutrition creating a need for food supplements. Nanotechnology can enhance the nutrition and the delivery of nutraceuticals to the body via the vitamins, minerals, and antioxidants within nanoparticles (NPs) which introduces a new approach to counteract nutritional instabilities and low solubility in food. NPs possess exceptional solubility, a significant surface-to-volume ratio, and diameters ranging from 1 to 100 nm, which makes them very valuable for applications, such as tissue engineering, drug delivery, and nutraceutical properties enhancement. This study will focus on iron oxide, calcium oxide, and selenium nanoparticles to be used in the enhancement of nutraceuticals.

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Chitosan nanoparticles as antibiofilm and antimicrobial agent: mechanisms of action against biofilm-embedded bacteria in drinking water treatment plant

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Keywords
Chitosan
Nanoparticles
Antibiofilm
Antimicrobial
Drinking water

Abstract

Biofilms, complex communities of microorganisms that adhere to surfaces, present a significant challenge in drinking water treatment plants, acting as reservoirs for multidrug-resistant bacteria. Conventional disinfection methods often fail to effectively remove biofilms, allowing pathogenic bacteria to persist and compromise water quality. In recent years, chitosan nanoparticles (CSNPs) have emerged as a promising alternative with potent antibiofilm and antimicrobial properties. This study evaluates the mechanisms of action of CSNPs against biofilm-embedded bacteria in drinking water treatment plants. A comprehensive review of existing literature is conducted to elucidate the antimicrobial efficacy of CSNPs, focusing on their ability to disrupt biofilm structure, inhibit bacterial adhesion, and prevent biofilm formation. Key mechanisms include electrostatic interactions, membrane disruption, and oxidative stress induction. Furthermore, this review explores the synergistic effects of CSNPs when combined with conventional antimicrobial agents, offering a dual approach to combating biofilm-related issues in water treatment facilities. The implications of CSNP application in reducing biofilm-associated health risks and improving overall water quality in water systems, thereby contributing to the development of sustainable water treatment strategies. This review aims to provide a critical understanding of chitosan nanoparticles as an innovative and effective solution for managing biofilm-embedded bacteria in drinking water plant.

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Nanotechnological approaches to antiviral therapy with their mechanism of actions

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Keywords
Nanotechnology
Antiviral
Therapy
Therapeutics

Abstract

Viral diseases constitute a prominent problem globally, being the leading cause of many pandemics and epidemics with a severe mortality rate. In recent years, the COVID-19 pandemic, Lassa fever, and Ebola epidemics have constituted global panic with significant effects on the economy. Nanotechnology has fostered new techniques and approaches to therapies and disease treatment in recent years, playing important roles in overcoming impediments to conventional therapeutic methods. The nature and size of nanoparticles and nanomaterials promote the development of novel therapeutics, which have reported tremendous results. Nanoparticles have been used as vehicles to convey drugs to target sites, bypassing biological transport mechanisms. The antiviral potency of various nanoparticles has also been widely reported. This review aims to discuss current and novel nanotechnology-based approaches to combat various viral infections and the design strategies which could impact further nanotechnological techniques for addressing viral infection.

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A review on green synthesis of metal and metal oxide nanoparticles and their applications in environmental remediation

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Keywords
Green synthesis
Metal oxide nanoparticles
Environmental remediation
Biological agents
Catalytic degradation

Abstract

The green or biological synthesis of metal and metal oxide nanoparticles has attracted significant attention as a sustainable and eco-friendly alternative to conventional chemical methods, giving numerous advantages in environmental applications. This approach utilizes biological resources such as bacteria, fungi, plant extracts, and algae as reducing, capping, and stabilizing agents, thereby effectively minimizing the use of hazardous chemicals and reducing the environmental footprint connected with nanoparticle production. This green process is not only energy-efficient but also leverages renewable and abundant resources, aligning with the SDG's goals for environmental sustainability. This review paper provides an in-depth examination of the various steps and operational parameters employed in the green synthesis of metal and metal oxide nanoparticles, highlighting the role of different biological agents in influencing the shape, size, and functional properties of the resulting nanoparticles analyzed using several analytical techniques. The paper explored the extensive applications of these nanoparticles in environmental remediation, including the removal of heavy metals from contaminated water, degradation of persistent organic pollutants, treatment of industrial wastewater, and air purification. Various treatment techniques, such as adsorption, catalytic degradation, and photocatalysis, were studied in this review, also with the comparative effectiveness of different nanoparticles in specific environmental scenarios. Moreover, this review paper considered the limitations associated with the green synthesis of nanoparticles, particularly in terms of stability, reproducibility, scalability, and potential environmental risks. Recent advancements in the field were considered for better application in different aspects of environmental remediation. This review

bridges the gap between nanotechnology and environmental remediation to improve sustainability.

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Nanotechnology in water treatment and remediation in the last three years: a systematic review

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Keywords
Nanotechnology
Nanoparticles
Water treatment
Remediation
Metal analysis

Abstract

Nanotechnology is an interdisciplinary field focused on manipulating and engineering materials at the nanoscale. Innovative water treatment and remediation approaches are necessary due to the growing world population and worldwide need for clean water. Nanotechnology offers promising solutions for these problems. Applications of nanotechnology, using nanoparticles from magnetic materials, copper oxide (CuO) synthesised from natural products, maghemite, and metals, in water treatment and remediation have been reviewed in this study. The most recent developments in nanotechnology for water treatment and remediation from 2021 to 2023 on the ScienceDirect database were systematically studied adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria. Nanotechnology offers a range of benefits, such as reduced energy consumption, improved precision, and increased efficiency, all of which were explored. The study also underscored the challenges of nanotechnology for water treatment and remediation and briefly highlighted the regulation of this technology. Future water security may be possible using nanotechnology, which has potential of transforming remediation and water treatment methods.

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Biomedical applications of selenium nanoparticles biosynthesized from *Pentaclethra macrophylla* seed extract as antimicrobial, antioxidant, anticoagulant and thrombolytic agents

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NANO2024/B038

Keywords
Pentaclethra macrophylla
SeNPs
Antimicrobial
Antioxidant
Anticoagulant
Thrombolytic

Abstract

Selenium nanoparticles (SeNPs) is known to have a good advantage over other nanomaterials due to its promising role in stabilizing the immune system and as a defense mechanism, it also helps in boosting the immune system and help the body to fight against the pathogens. *Pentaclethra macrophylla* (African oil bean), an indigenous tropical plant majorly found in the Eastern part of Nigeria and the seed is used as a nutritious food condiment. It is a tropical crop belonging to the family Leguminosae. This study focuses on the synthesis of SeNPs using seed extract, examine the antimicrobial, anticoagulant and thrombolytic activity of selenium nanoparticles synthesis from *Pentaclethra macrophylla* (Ugba) seed extract. The SeNPs was characterized using UV-visible spectroscopy, Scanning Electron Microscope (SEM), EDS, and the Fourier Transform Infrared Spectroscopy (FTIR). Antibacterial, antifungal, antioxidant, anticoagulant and thrombolytic activities of the biosynthesized nanoparticles were carried out. The results of the FTIR spectroscopy shows that there were seven (7) components in the extract that responsible for the activities with the highest peak at 3928.00 and the lowest peak at 784.00 cm^{-1}. The maximum absorbance was obtained at 456 nm with a strong silver peak observed around 2.0 KeV with the EDS. The SEM showed a large number of interconnected lobes with particle diameter ranging from 20 to 100 µm. The PM-SeNPs was effective against *Salmonella typhii* at concentration 10 and 80 µg/ml with 15 mm and 20 mm, *Klebsiella pneumoniae* at 10 µg/ml and concentrations, while little or no inhibition was observed with *Pseudomonas aeruginosa* and *Staphylococcus aureus*. The PM-AgNPs completely inhibited the growth of *Candida albicans, Aspergillus flavus, Aspergillus fumigatus* and *Aspergillus niger*. The synthesized

nanoparticles showed scavenging activity of DPPH at all concentrations, high anticoagulant efficacy was displayed, while 70% blood clot lysis was observed for thrombolytic activity. This study therefore demonstrated the effectiveness of biosynthesized *Pentaclethra macrophylla* seed extract of SeNPs as antimicrobial, antioxidant, anticoagulant and thrombolytic agents.

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Durability of stabilized lateritic bricks modified with saw dust ash and terrasoil nanochemical

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NANO2024/P039

Keywords
Saw Dust Ash (SDA)
Terrasoil
Nanochemical
Laterite
Earth bricks

Abstract

Earth bricks are considered an environmentally friendly choice due to their low carbon emissions, thermal conductivity, and good hygroscopic properties. However, earth bricks lack of strength, limited durability, and vulnerable to erosion by rain. The aim of this study is to assess the durability of stabilized earth brick modified with Saw Dust Ash (SDA) and Terrasoil nanochemicals (TNC). Laterite was collected from Igboora and its geotechnical properties of laterites, including Particle Size Distribution (PSD), Liquid Limit (LL), Plastic Limit (PL), Plasticity Index (PI), Shrinkage Limit (SL), Optimum Moisture Content (OMC), Bulk Density (BD) and Dry Density (DD) were determined in line with standard. Chemical composition, such as Iron oxides (Fe_2O_3), Aluminium oxide ($Al(OH)_3$), Kaolinite ($Al_2Si_2O_5(OH)_4$), Quartz (SiO_2), Organic Content (OC) and pH of the laterite were determined. Physical properties of the SDA including, Particle Size Distribution (PSD), Bulk Density (BD), Moisture Content (MC), Porosity, Maximum Dry Density (MDD) Optimum Moisture Content (OMC) and Flow Ability (FA) were determined. The Compressive Strength (CS), Splitting Tensile Strength (STS) and Water Absorption (WA) of modified earth bricks with varying proportions of SDA (0, 2, 4, 6, 8, and 10%) and concentrations of TNC (0-5%) were determined at 58 days. The optimal mix of SDA and TNC was analysed at 5% significant level using Two-way Analysis of Variance. The laterite PSD shows a Cu and Cc value of 3.20 and 0.01. The LL, PL, PI, SL, OMC, BD and DD values ranged 28.75-31.56%, 17.89-19.23%, 10.86-12.33%, 6.95-7.45%, 13.89-15.12%, 1.82-1.88 g/cm³ and 1.47-1.52 g/cm³, respectively. The laterite chemical composition which include Fe_2O_3, $Al(OH)_3$, $Al_2Si_2O_5(OH)_4$, SiO_2, OC, and pH values ranged 9.5-13.87%, 11.85-16.92%, 23.27-37.49%, 46.72-49.2%, 2.58-3.33%, and 5.17-7.63, respectively. Also, the PSD of SDA shows a Cu and Cc of 4.533

and 0.019. The, BD, MC, Porosity, MDD, OMC and FA of SDA varied from 0.45–0.55 g/cm³, 10.21–12.50%, 65.12–70.18%, 0.58-0.62 g/cm³, 14.10–16.30%, 55.20–65.55 g/100g, respectively. The CS, STS, and WA of modified earth bricks ranged 1.12–2.32 MPa, 0.22–0.62 MPa, and 19.5–14.4%, respectively. The optimal mix for both CS, STS and WA is 8% SDA and 5% TNC at 58 days for all the tests with p value of 0.0001. The stabilized earth bricks modified with 8% SDA and 5% TNC exhibited improved performance and met building requirement. It is recommended to utilize these modified bricks for construction to ensure improved durability, strength, and overall effectiveness.

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Antibacterial and *in vitro* antioxidant properties of silver nanoparticles biologically synthesized from aqueous extract of sweet potato leaf with preliminary qualitative phytochemical analysis

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Keywords
Sweet potato
Biosynthesis
Silver nanoparticles
Antibacterial
Antioxidant
Phytochemicals

Abstract

Sweet potato (*Ipomoea batatas*) is a significant global food crop; its leaf offers nutrients and numerous bioactive substances. It contains complex carbohydrates and health-enhancing secondary metabolites. This study aimed to investigate the phytochemical compounds, phenolic and flavonoid content of the leaf before silver nanoparticle synthesis. Qualitative and GC-MS methods were used to evaluate the phytochemical compound. The synthesized silver nanoparticles were characterized using analytical techniques. The antioxidant and antibacterial activities were assessed and compared with the aqueous extract. Qualitatively screening shows positive results for saponin, anthraquinone and flavonoids while tannin, terpenoids, phlobactanins, alkaloids, and cardiac glycoside gave negative results. In the GC-MS analysis, 9 bioactive compounds were identified in the aqueous extract; Hexadecanoic acid and Methyl stearate were the most abundant with 47.7% and 42.48%, respectively. The total phenolic and flavonoid content were quantified as 67 mg/ GAE/g and 56 mg/ QE/g, respectively. These results suggested that sweet potato leaf contains diverse bioactive compounds with potential therapeutic benefits. The UV-Vis spectroscopy of the synthesized silver nanoparticles indicated a surface plasmon resonance peak around 519 nm, confirming the formation of nanoparticles. Fourier transform infrared (FTIR) spectroscopy revealed the presence of various functional groups in the nanoparticles, including carboxylic acids (COOH), carbonyls (C=O), alcohols (OH) and amide groups, suggesting that these moieties were involved in the reduction and stabilization of the silver ions during nanoparticle synthesis. Scanning electron microscopy (SEM) images showed that the nanoparticles were fairly spherical, with an average size of approximately 10 nm. The

antioxidant activities of both the crude extract and the synthesized silver nanoparticles were assessed using DPPH (2,2-diphenyl-1-picrylhydrazyl), FRAP (ferric reducing antioxidant power), and TAC (total antioxidant capacity) assays. The results indicated that the silver nanoparticles exhibited about 44% inhibition, while the crude extract had an inhibition of 31%. The antibacterial efficacy of the aqueous extract and the synthesized nanoparticles was evaluated against a range of bacterial strains, including *Escherichia coli, Listeria monocytogenes, Klebsiella pneumoniae, Staphylococcus aureus,* and *Pseudomonas* spp. The results showed that the silver nanoparticles demonstrated superior antibacterial activity with MIC of 0.08 mg/ml, while the crude extract had 0.1 mg/ml across all tested bacterial strains. In conclusion, the biosynthesis of silver nanoparticles from sweet potato leaf extract enhances its antioxidant capacity and significantly improves its antibacterial potential. These findings highlight the potential of silver nanoparticles as a promising tool in developing novel antimicrobial agents, especially in the context of the growing threat of antimicrobial resistance.

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In vitro assessment of *Ganoderma lucidum* mediated silver and gold nanoparticles for their antimicrobial and antioxidants potential

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Keywords
Myco-nanobiotechology
Nanoparticles *Ganoderma lucidum*
Antimicrobial
Antioxidant

Abstract

Nanoparticles are structures of sizes ranging from 1 to 100 nm which are responsible for their several unique physicochemical and biological properties. Myco-nanotechnology is the functional application of fungal species in nanotechnology to synthesize nanoparticles. The medicinal fungus, *Ganoderma lucidum* (GL), is a mushroom with numerous biological activities. In this stud, silver (AgNPs) and gold nanoparticles (AuNPs) were biosynthesized using aqueous extracts from *Ganoderma lucidum* (GL). The biosynthesized silver (GL-AgNPs) and gold (GL-AuNPs) nanoparticles were characterized using UV-vis spectroscopy, Fourier-transform infrared spectroscopy (FTIR), transmission electron microscopy (TEM), selected area electron diffraction (SEAD), Energy Dispersive X-ray spectroscopy (EDX) and X-ray diffraction (XRD) among others. They were assessed for their antibacterial, and antioxidant properties. The UV-visible spectroscopy shows peaks at 430 nm and 550 nm for GL-AgNPs and GL-AuNPs respectively. FTIR analysis showed possible biomolecules with prominent peaks at 3227 cm^{-1} and 1633 cm^{-1} for GL-AgNPs, 3238 cm^{-1}, and 1635 cm^{-1} for GL-AuNPs. TEM results indicated spherical, anisotropic, rod, and hexagon particles with a size range of 18-80 nm for AgNPs and 16-71 nm for AuNPs. SEAD showed ring-shaped nanoparticles and crystalline form. The biosynthesized nanoparticles efficiently inhibited the growth of tested bacteria with the highest mean value of 19.33±0.3 mm for GL-AgNPs against *Pseudomonas aeruginosa* (ATCC 27853) at 100

µg/ml. Furthermore, GL extract also exhibited a good zone of inhibition compared with positive and negative control. The antifungal activity test shows the highest inhibition percentage of 83.8% for GL-AuNPs. GL-AgNPs demonstrated excellent antioxidant properties with a percentage mean value of 75.4±0.13. The biosynthesized coupled with the GL extracts were effective against pathogens with superb antioxidant potential, thus indicating the efficacy of myco-nanoparticles in healthcare delivery.

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Removal efficiency of rhodamine-b dye from aqueous solution by chitosan-glutaraldehyde/rice husk composite

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Keywords
Composite
Physio-sorption
Monolayer
Adsorption capacity
Sequestration
Isotherms

Abstract

The efficiency and adsorption characteristics of the synthesized chitosan-rice husk/glutaraldehyde composite (CRHGC) for Rhodamine B dye (RHDB) from aqueous solution was conducted in this research. CRHGC was synthesized and characterized by Scanning Electron Microscopy (SEM), Fourier Transform Infrared Spectrum (FTIR) and Energy Dispersive X-ray (EDX). The effects of various operational parameters such as; pH, initial concentration, dosage, temperatures and contact time were investigated on CRHGC adsorption capacity. The data obtained were fitted to kinetic, thermodynamics and adsorption (Langmuir, Freundlich, Temkin and Dubinin-Radushkevich) isotherms models. The FTIR spectral peaks at 3324 cm^{-1}, 2174 cm^{-1} and 1558 cm^{-1} may be attributed to N–H, thiocyanate (-SCN) and C-H of methyl and methylene frequencies respectively, and the peaks at 2513 cm^{-1}, 1626 cm^{-1} and 576 cm^{-1} can be assigned to S-H stretch of thiols, C=C and C-S stretch of the disulfides. The SEM and EDX showed a well-enlarge pores, which enhanced its surface efficiency, with prominence of Na (1.3%) and Si (2.0%). The pH point of zero charges (pH_{pzc}) being 9, with maximum adsorption occurring at pH 5 is an indication of negative surface charge of CRHGC and cationic nature of RHDB. An increase in adsorption capacity of CRHGC with increase in its dosage form, and reductions in RHDB percentage adsorptions with increasing RHDB concentrations and temperatures were observed. The investigated operational parameters effects were all significant, with Freundlich isotherm best describing the adsorption processes. Monolayer adsorption capacity of 9.4 mg g^{-1} with

correlation coefficient (R^2) value of 0.98 at 313K was recorded. The R_L (0.093-0.205) and n (>1) values for RHDB indicate the favorability and cooperative nature of these processes as temperature increased. The adsorption energy, E (0.614, 0.8963 and 0.9003KJ/mol), calculated from the Dubnin-Radushkevich plots at diverse temperatures suggested physio-sorption, and pseudo-second-order kinetic model (R^2 = 0.989) favourably described the uptake performance of the studied adsorbent, with closer agreement between experimental and calculated adsorption capacities (q_t). The negative values obtained for both ΔG (-20.293 to -19.968KJ/mol) and ΔH (-25.286 KJ/mol), indicate that the adsorption of RHDB on the prepared CRHGC was spontaneous and CRHGC is a good adsorbent for sequestration of dyes from waste water.

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Uptake performance of ibuprofen in aqueous solution by Jacob's leaves (*Acalypha wilkesiana*) mediated with titanium dioxide nanoparticles (JL-TDNPS)

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Keywords
Ibuprofen
Adsorption
Nanoparticles
Monolayer
Free energy

Abstract

This study investigated the efficiency of the synthesized Jacob's leaf extract-mediated titanium dioxide nanoparticles (JL-MTNPs) for removing the drug in ibuprofen (IBP) drug-simulated aqueous solution. The prepared JL-MTNPs were characterized using Scanning Electron Microscopy (SEM), Fourier transform infrared spectrum (FTIR), and Energy dispersive X-ray (EDX). The effects of pH, initial concentration, IBP dosage, temperatures, and contact time on the adsorption capacity of JL-MTNPs were also investigated. The adsorption data were fitted to different adsorption models and kinetic and thermodynamic studies. The UV/Vis spectra of JL- MTNPs showed characteristic bands at 365nm, while the observed FTIR spectral peaks at 3458 and 1626 cm^{-1} can be attributed to O-H and C=C stretching frequencies, respectively. The SEM analysis showed well-developed images of JL-MTNPs, with EDX showing prominence of Ti in JL-MTNPs. A pH point of zero charges (pH_{pzc}) occurred at 7.4, while the maximum adsorption occurred at pH 2. An increase in the percentage of IBP adsorbed with increasing dosage form of JL-MTNPs, its decrease with increasing concentrations of JL-MTNPs, and temperature was observed. The effect of operational parameters investigated were all significant on the adsorption models; Langmuir isotherm describes the adsorption characteristics of JL- MTNPs, with monolayer adsorption capacity of 5.16mg g^{-1} and the highest correlation coefficient (R^2) value of 0.98 at 313K. However, the Freundlich isotherm model was the most fitted, with an adsorption capacity of IBP on JL-MTNPs and an R^2 value of 0.9214 at 308K for IBP. The values of RL ranged from 0.031 to 0.55, and for IBP, they ranged from 0.55. The

adsorption energy (E) calculated from the Dubinin–Radushkevich plot at different temperatures for IBP are 0.001, 0.01 and 0.001 kJ/mol suggesting that physio-sorption was involved in the uptake of IBP, Pseudo-second-order best-described kinetics of IBP uptake on JL-MTNPs with (R^2 = 0.9975 and 0.9999) and closer agreement between experimental and calculated adsorption capacity (q_t) at time t. The thermodynamic parameters indicated that the adsorption was spontaneous, with -ΔG value ranging from -1.5998 to -8.0381. Conclusively, this investigation shows that JL-MTNPs is an alternative promising adsorbent for the recovery of dyes, and most likely heavy metal from aqueous solutions.

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Nanotechnology and wastewater treatment: a review of efficiency, safety and environmental implications

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Keywords
Nanotechnology
Wastewater
Water treatment
Nanomaterials safety
Waste management
Environment

Abstract

The management of wastewater poses a significant environmental concern, particularly in light of the growing urbanization, industrial activities, and agricultural runoff, which are all major factors in water contamination. To overcome the difficulties that traditional approaches have in eliminating a wide range of contaminants, nanotechnology has emerged as a viable solution for improving wastewater treatment procedures. The purpose of this review is to understand the significance, effectiveness, and applications of nanotechnology in wastewater treatment. It also aims to identify the difficulties associated with applying nanotechnology in wastewater treatment, summarize the studied materials, and maybe offer solutions. Numerous nanomaterials have proven to be remarkably effective at eliminating heavy metals, organic pollutants, and pathogens from wastewater. These materials include carbon-based nanomaterials, metal and metal oxide nanoparticles, and polymeric nanocomposites. Concerns over these materials' widespread use are raised by their possible harm to the environment and human health. Even with the encouraging outcomes, there are questions about the safety of nanomaterials. The potential toxicity of nanoparticles to humans and the environment is a concern due to their small size and strong reactivity. Peer-reviewed journal papers, reports, and reviews from databases like Google Scholar, Scopus, and PubMed were all part of the approach used in this review. According to the results of the literature research, nanotechnology has proven useful in wastewater treatment because it can use precise sensors to detect pollutants at the molecular level. Nevertheless, little is known about the environmental dangers connected to the dispersal of nanoparticles into the soil, water bodies, and the atmosphere. This evaluation suggests that the Department of

Water Resources Planning and Management works with nearby nanotechnology facilities to enhance the industry's use of this technology for efficient wastewater treatment. On the other hand, this assessment emphasizes the necessity of a well-rounded strategy that optimizes the advantages of nanotechnology while minimizing any possible threats to the health of people and the environment. Lastly, the wastewater treatment industry can benefit from creative solutions to tackle the urgent problems of water pollution and scarcity, promoting a cleaner, healthier, and more sustainable environment for future generations, by utilizing the transformative potential of nanomaterials and interdisciplinary collaboration.

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Biosensors and nanosensors: a review on food analysis/safety

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Keywords
Biosensors
Nanosensors
Food safety
Nanoparticles
Food analysis

Abstract

Nanosensors and biosensors have become essential tools for assessing food safety, particularly in detecting contaminants, pathogens, allergens, and chemical residues. These devices, including electronic tongues and noses, provide rapid, accurate, and real-time analysis, driven by increasing regulations and the complexities of a global food supply chain. Biosensors utilize bioreceptors such as enzymes, antibodies, and nucleic acids, while nanosensors leverage the unique properties of nanomaterials like carbon nanotubes, quantum dots, and gold nanoparticles to enhance sensitivity and performance. Recent advancements in microfabrication have enabled the development of portable, user-friendly devices for on-site testing. However, challenges remain regarding sensor stability, repeatability, and regulatory approval. Further research is needed to enhance multiplexing capabilities, allowing for simultaneous detection of multiple analytes in complex food matrices. Integrating these sensors into larger food monitoring systems promises to improve food quality and safety from production to consumption.

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Assessment of tapioca-synthesized graphene-modified electrode with biopolymer-based membrane for enhancing biofilm efficiency in microbial fuel cell

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Keywords
Tapioca
Cellulose acetate
Microbial Fuel Cell
Graphene
Electrode
Membrane

Abstract

Microbial fuel cells offer enormous potential for waste management, energy production, and biomass valorization. However, technical challenges exist, including low power generation efficiency and operational stability. Graphene is an innovative material with remarkable physical and chemical properties that can enhance the advancement of microbial fuel cells (MFC) in various ways. This study utilized tapioca (cassava starch) as a novel precursor for graphene synthesis via a chemical exfoliation method. It was characterized using an XRD and FTIR spectroscopy. The anode electrodes were coated with graphene and integrated into the MFC system, combining cellulose acetate films as proton exchange membranes to allow the movement of ions. Their effect on bioelectricity generation was explored using a two- chambered microbial fuel cell reactor and their biofilm efficiency was determined. A mixed culture of three active bacteria (*Pseudomonas taiwanensis, Myroids odoratimimus,* and *Spingobacterium mizutai*) was used as biocatalyst. Membrane efficacy was assessed using SEM and EDX analysis. The graphene-coated copper electrode demonstrated a biofilm efficiency of 5.10%, resulting in higher energy output with a peak voltage generation of 2.5V presenting a potential material over non-coated ones. Comparative SEM images showed thicknesses of the support layers of cellulose acetate membranes before the experiment and the thickness and porosity sizes reduce over time. The study revealed tapioca-synthesized graphene-modified electrodes and cellulose acetate membranes can significantly improve Microbial

fuel cl performance. The modification enhances electrode conductivity and biofilm growth, while the cellulose acetate membrane supports proton conductivity, indicating potential for scaling up MFC technology.

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Synthesis of nano-biochar for industrial wastewater treatment

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Keywords
Biochar
Nano-biochar
Heavy metals
Wastewater
Industry

Abstract

In developing nations like Nigeria, industrial wastewater, notably untreated or inadequately treated, is often released directly into the surrounding environment, predominantly affecting water bodies. This concerning practice significantly impacts environmental health and safety, posing a worrisome issue due to its implications. Across the globe, various conventional methods are employed to eliminate wastewater pollutants. Thus, these techniques suffer from multiple drawbacks ranging from inefficiency in removing pollutants. However, recent study shows, that nano-biochar is a relatively new material, and research on its long-term result and potential in water and wastewater treatment is still limited. This study focuses on the synthesis and characterization of nano-biochar from rice husk for the treatment of industrial wastewater. The collected rice husk was washed dried in an oven at 60 °C for 30 min, subjected to pyrolysis at 450 °C for 1 h in muffle furnace, and then sieved through a 2 mm sieve. The finely ground 20 g of biochar was added to 600 ml of distilled water and solution was stirred for 2 min on a magnetic stirrer at 980 rpm. The solution was sonicated at 60 °C for 30 min and stirred again for 5 min. The nano-biochar was weighed to calculate the yield. The analysis reveals that Fourier Transform Infrared Spectroscopy (FTIR) indicates several functional groups on the surface of the rice husk, biochar and nano-biochar of C-X stretching at 1033 cm^{-1}, alkane C-H bonds at 1458 cm^{-1}, alkane C-C stretching at 2921 cm^{-1}, and hydroxyl groups at 3294 cm^{-1}. The nano-biochar demonstrates a high BET specific surface area of 323.22 m^2/g and a nanoscale of 2.38 nm, enhancing its effectiveness in adsorbing heavy metals. The wastewater was characterization includes, the initial levels of BOD of 452.8 mg/L,

a DO of 9.4 mg/L and a COD of 709.1 mg/L, indicating high pollution levels. The research also evaluates the adsorption capacity of nano-biochar for removing lead (Pb), arsenic (As), and iron (Fe) from rice mill wastewater. The findings reveal substantial reductions in lead concentrations from 5.4 mg/L to 2.76 mg/L, and iron from 20.6 mg/L to 12.6 mg/L, showcasing the nano-biochar's high efficiency in addressing heavy metal pollution, which is vital for protecting human health and the environment. Results demonstrate a correlation between the percentage removal of these metals and the adsorption capacity of nano-biochar. The isotherm model effectively represents the adsorption processes for Pb, As, and Fe. SEM images at various magnifications reveal a densely packed porous surface, crucial for adsorption capabilities. Comparative analysis with existing literature shows that nano-biochar obtained from this research outperforms. Future research is recommended to investigate the long-term effects and broader environmental applications of using nano-biochar in wastewater treatment.

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Selenium nanoparticles biosynthesized using *Sarcocephalus latifolius* stem-bark extract and their anti-microbial, antioxidant and thrombolytic activities

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Keywords
Sarcocephalous latifolius
Green synthesis
Selenium nanoparticles
Antimicrobial
Antioxidant
Anticoagulant
Thrombolytic

Abstract

Studies from literature review have confirmed *Sarcocephalus latifolius* to possess alkaloids, tannins, flavonoids, glycosides, and steroids with antibacterial, antimalaria, and anti-diabetic potential. However, there is lack of scientific evidence on the green synthesis of selenium nanoparticle from the stem of *S. latifolius* and its biological activities. This study is intended to determine the chemical composition of *S. latifolius* using Gas Chromatography Mass Spectrometry (GC-MS) and synthesize selenium nanoparticle using *S. latifolius* stem-bark extract, characterize them, determine their antibacterial activity, evaluate the *in-vitro* antioxidant, anti-coagulant and thrombolytic activities. The *S. latifolius* selenium nanoparticles (SL-SeNPs) were synthesized by reducing selenium dioxide with *S. latifolius* stem-bark extract. SL-SeNPs were characterized by UV-Vis, FTIR, SEM, and EDX. The anti-microbial activity of Methicillin resistant *Staphylococcus aureus*, *Escherichia coli* and *Candida albicans* was determined by agar disc diffusion method, *in-vitro* antioxidant activity was evaluated by DPPH, hydrogen peroxide and ferric iron scavenging. The GC-MS analysis of *S. latifolius* extract revealed sulfurous acid, phosphonoacetic acid, and hexadecanoic acid. The UV-spectroscopy of SL-SeNPs showed maximum absorbance at 281 nm, which is the characteristic feature of SeNPs. According to SEM images, the size of SL-SeNPs was 100 nm. Selenium in SL-SeNPs 67.06% weight at 1.7 keV. FTIR spectrum shows strong peaks at 3128.64, 2360.95, 1400.37 and 825.56 cm^{-1}. The synthesized nanoparticles showed inhibition against Methicillin Resistant *Staphylococcus aureus*, Multi-Drug Resistant *Escherichia coli* and Multi-Drug Resistant *Candida albicans* in the range of 10-22 mm respectively. Also, the nanoparticles have shown to possess

antioxidant, anticoagulant and thrombolytic activities. This study has shown that the green synthesized SL-SeNPs has a strong antimicrobial activity and potential biomedical applications.

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Antimicrobial activity of silver nanoparticles biosynthesized by metabolites of lactic acid bacteria isolated from fermented *Cyperus esculentus* milk

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Keywords
Antimicrobial resistance
Cyperus esculentus
Food safety
Lactic acid bacteria
Silver nanoparticles

Abstract

Antimicrobial resistance is a growing global public health threat, with the rapid rise of multidrug-resistant microbes becoming alarming. The quest for natural antimicrobials has increased as consumers seek safer alternatives for ensuring food safety, nutrition, and sensory quality. This current study investigates the antimicrobial activities of biosynthesized silver nanoparticles (AgNPs) from metabolites of lactic acid bacteria (LAB) isolated from *Cyperus esculentus* milk. LAB were isolated and characterized using conventional and molecular methods. Metabolites from the LAB strains were used to synthesize AgNPs. The AgNPs were characterized using UV-Visible Spectroscopy (UV-Vis), Transmission Electron Microscopy (TEM), and Energy Dispersive X-ray (EDX). Antimicrobial assay was done using agar well diffusion method. Results from the study showed that *Lactobacillus plantarum* has the highest occurrence (37.5%) and *Lactococcus acidophilus* (4.2%) occurred least. UV-Vis confirmed the formation of LAB metabolite-synthesized AgNPs with absorbance peaks at 450 and 500 nm. Transmission electron microscopy revealed spherical AgNPs ranging from 1.32 to 23.22 nm, with size variations attributed to different LAB strains. Energy Dispersive X-ray spectroscopy results indicated a significant presence of AgNPs, with weak signals of other elements. The biosynthesized AgNPs possess antibacterial and antifungal activities against selected food pathogens. *Lactobacillus plantarum* strain 218 had the strongest antibacterial activities (22±2.00 mm) against *Staphylococcus aureus*. *L. plantarum* strain a27 had the strongest antifungal activities (11.5±0.71 mm) against *Aspergillus flavus*. Silver nanoparticles synthesized from the metabolites of LAB isolated from *C. esculentus* milk therefore show great potential as

natural antimicrobials offering an alternative to combat antimicrobial resistance and improve microbial food safety.

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The current status and prospect of silver nanoparticles as antimicrobial agent

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Keywords
Nanotechnology
Wastewater
Water treatment
Nanomaterials safety
Waste management
Environment

Abstract

Novel applications of nanoparticles (NPs) are growing rapidly on various fronts due to their characteristic physicochemical properties, as well as antimicrobial, anti-cancer, catalyzing, optical, electronic and magnetic properties. These particles range from 1–100 nm, exhibits unique chemical, biological, and physical properties. This makes NPs widely applicable in medicine, biotechnology, agriculture, and environmental sectors. These particles exhibit strong antimicrobial properties against bacteria, fungi, and viruses due to their small size and large surface area. With the need for novel and effective antimicrobial agents, this review focuses on the antimicrobial impacts of AgNPs, as well as to describe the benefits of employing AgNPs as new antimicrobial agent in different life science applications. Relevant literatures were sourced from Springer and Elsevier website for analysis. From the literature reviewed, a variety of materials were explored for the green synthesis of NPs with potential antimicrobial activity. The enhanced antimicrobial activity of some metals at nanoscale has been most valuable in medical, environmental and healthcare areas, where the incorporation of AgNPs into different products has been studied, including surgical and food handling tools, clothing, cosmetics, dental products, water treatments, catheters, as well as wound dressings. Coating medical sutures with AgNPs enabled the inhibition of *E. coli, S. aureus* and *Candida albicans* (Baygar et al., 2019). The use of AgNPs as an antimicrobial agent in textile, food industry, agriculture, water treatment, and most importantly in health care sector was demonstrated in most studies. Fewer studies demonstrated the mechanisms by which the antimicrobial activity was implemented. There is a need to

conduct a holistic study of the long-term toxicity of NPs to living organisms and the environment at large.

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Cinnamomum camphora mediated synthesis and immobilization of silver nanoparticles onto textile materials for antimicrobial applications and their cytotoxic evaluation

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Keywords
Cinnamomum camphora
AgNPs
Nanotextiles
Antibacterial
Toxicity

Abstract

Silver nanoparticles (AgNPs) are powerful antimicrobials and are formulated using conventional toxic chemical processes, traditionally. In this study, an aqueous leaf extract of the *Cinnamomum camphora* (CE) plant was employed as a reducing and capping agent to synthesize and immobilize AgNPs onto cotton materials. UV-vis spectroscopy, Dynamic Light Scattering (DLS), Zeta potential, Fourier transform infrared spectroscopy (FTIR), Scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDX), and X-ray crystallography (XRD) were used for the characterization. *Escherichia coli* and *Staphylococcus aureus* were used for antimicrobial studies using Kirby Bauer method whereas erythrocytes and Vero cells were used for cytotoxicity studies. The synthesis and immobilization of *C. camphora*-conjugated AgNPs (C-AgNPs) was achieved in 15 min under sunlight irradiation. Synthesis and immobilization of C-AgNPs on cotton fabric (C-Cot) and cotton fiber (C-CotF) was confirmed by SEM-EDX analysis. FTIR analysis showed the involvement of phenolics and amines among others in formation of AgNPs. XRD analysis showed the semi crystalline behavior of C-AgNPs. Microbial growth was significantly inhibited by C-AgNPs, C-Cot, and C-CotF. MIC and MBC were between 50 to 200 µg/mL for both pathogens. C-AgNPs displayed low toxicity on human erythrocytes whereas dose dependent toxicity was noted on Vero cells. Our effective method and materials are promising for use in socks, bandages among other antimicrobial products.

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Nanotechnology safety in biomedical applications: a review of recent advances

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Keywords
Nanotechnology
Biomedicine
Toxicity
Biocompatibility
Nanosafety

Abstract

Nanotechnology has transformed biomedical applications, providing unparalleled prospects in drug delivery, diagnostics, imaging, and regenerative medicine, the unique properties of nanomaterials that make them valuable also raise significant safety concerns. This review examines recent advances in nanotechnology safety within the context of biomedical applications. We examined the present understanding of nanoparticle toxicity, biodistribution, and environmental effects, emphasizing the intricacies of nano-bio interactions. Recent advancements in safety evaluation are critically overviewed, encompassing enhanced characterization techniques, sophisticated *in vitro* and *in vivo* models, and novel strategies for nanoparticle design, including surface modifications and biodegradable materials. The evolving regulatory landscape is analyzed, emphasizing the challenges in developing comprehensive guidelines for nanomedicine. We anticipate upcoming trends in nanosafety research, such as high-throughput screening, in silico modeling, and the principle of "safety-by-design." The discussion also encompasses the potential for individualized safety profiles and the ethical ramifications of nanomedicine. This review emphasizes the essential need to balance innovation with safety considerations to fully harness the potential of nanotechnology in healthcare. Ongoing research, global collaboration, and flexible regulatory frameworks will be crucial for the responsible advancement and application of nanomedicine.

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Potato peels-synthesized carbon nanotubes for crude oil spill clean up

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Keywords
Nanotechnology
Potato peels
Carbon nanotubes
Crude oil
Remediation
Adsorption

Abstract

The increasing environmental concerns regarding crude oil spills have highlighted the need for sustainable and efficient remediation methods. Carbon nanotubes (CNTs), due to their high surface area and adsorption capacity, have emerged as a promising solution. This study investigates the synthesis of CNTs from potato peels, to offer an eco-friendly alternative for oil spill cleanup. Utilising waste materials like potato peels not only addresses environmental contamination but also contributes to waste valorisation and sustainability efforts. Potato peels were collected, washed, dried, and carbonised at 300 °C for 2 h. The carbonised material was then processed to synthesise CNTs. The CNTs were characterised using FTIR to identify the key functional groups (hydroxyl (O-H) and carbonyl (C=O) groups), which are crucial for adsorption. UV-Vis studies have revealed the absence of strong absorption in the visible region, suggesting the formation of well-structured CNTs, which are crucial for oil spill remediation. SEM analysis revealed a highly porous and rough surface ideal for crude oil adsorption. XRD studies confirmed the presence of graphitic carbon structures in the synthesised CNTs. The absorption dosage results indicated that the CNTs demonstrated a high adsorption capacity for crude oil, with a removal efficiency of up to 99.996% at an adsorbent dosage of 2 g and a contact time of 30 min. The maximum adsorption capacity reached 2500 mg/g at lower adsorbent dosages, suggesting efficient utilisation of the material. The results further show that keeping an acidic environment improves adsorption effectiveness, whereas increasing pH may inhibit interactions due to electrostatic repulsion. At increasing temperatures, the adsorption process becomes more thermodynamically favourable. As kinetic energy increases, crude oil molecules are more likely to overcome energy barriers and connect to the CNTs' active sites. The proportion of removal increases as the contact time decreases. This behaviour

shows the efficiency of the synthesised CNTs, demonstrating that lesser quantities of CNTs can adsorb larger volumes of crude oil in a shorter time frame. The CNTs synthesised present a sustainable and cost-effective solution for crude oil spill remediation. Their high adsorption efficiency makes them an ideal candidate for large-scale environmental applications.

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Synthesis and characterization of iron tungstate nanoparticles

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Keywords
$FeWO_4$ nanoparticles
Sol-gel synthesis
Nanotechnology
HRTEM
BET
XRD

Abstract

Iron tungstate ($FeWO_4$) nanoparticles were synthesized using a simple sol-gel method, employing sodium tungstate dihydrate and iron (II) sulfate as precursors, with distilled water as the solvent. The synthesized nanoparticles were characterized using various techniques, including Fourier-transform infrared (FTIR) spectroscopy, high-resolution scanning electron microscopy (HRSEM), high-resolution transmission electron microscopy (HRTEM), energy-dispersive X-ray spectroscopy (EDX), X-ray diffraction (XRD), and Brunauer-Emmett-Teller (BET) nitrogen adsorption-desorption analysis. FTIR spectroscopy revealed key vibrational modes: peaks at 771 cm^{-1} and 948 cm^{-1} were attributed to O–W–O vibrations and W–O bond stretching, respectively. Additionally, a peak at 567 cm^{-1} corresponded to Fe–O bending vibrations, while peaks at 3423 cm^{-1} and 1620 cm^{-1} were assigned to H–O–H stretching modes and bending vibrations, indicating the presence of free or adsorbed water. HRSEM and HRTEM analyses confirmed formation of aggregated and heterogeneous spherical shaped particles. XRD analysis demonstrated the formation of a highly crystalline monoclinic phase of $FeWO_4$ under optimal synthesis conditions: a solution pH of 7, a reaction temperature of 30 °C, and a stirring speed of 500 rpm. This comprehensive characterization underscores the successful synthesis of $FeWO_4$ nanoparticles using hydrogen chloride as the chelating agent.

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Green synthesis of titanium dioxide nanoparticles from *Tetrapleura tetraptera* seed extract and its antidiabetic activity

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Keywords
Tetrapleura tetraptera
Green synthesis
TiO_2NPs
Anti-diabetic activity

Abstract

Tetrapleura tetraptera seed extract was used to synthesize titanium dioxide nanoparticles. The nanoparticles were characterized using ultraviolet-visible spectroscopy, transmission electron microscopy (TEM), the energy dispersive X-ray (EDX), and selected area electron diffraction (SAED). The cloudy white color solution of titanium dioxide nanoparticles absorbed maximally at 226 nm. The biosynthesized titanium dioxide nanoparticles produced agglomerated and rhomboid particles in the size ranges of 28.34-79.69 nm. SAED showed that the particles were crystalline in nature as depicted by the ring patterns of diffraction. The titanium dioxide nanoparticles synthesized from *Tetrapleura tetraptera* seed extract was investigated for its antidiabetic properties in the present study. A total number of 35 healthy male albino rats with body weight ranges of 130-170 g were purchased and acclimatized for 14 days after which they were randomly divided into 6 groups (A-F) of 5 animals each. Group F, the control was not induced while the other 5 groups (A-E) were induced with 55 mg/kg/bw of Stretozotocin by intraperitoneal administration. After 48 h, measurement of the tail vein blood glucose was done to confirm hyperglycemia. Experimental rats with fasting glucose levels greater than 160 g/dl were considered diabetic. Group A and B received treatment with 100 and 200 mg of biosynthesized titanium nanoparticles respectively. Group C received treatment with 200 mg plant extract. Group D received treatment with 200 mg metformin, and Group E received distilled water (1 ml). Group F (non-diabetic) orally received 1 ml distilled water. This treatment was administered every day for 14 days. The result shows that the weight of the rats reduced after diabetes induction but after 14 days of treatment, the weight of treated groups increased when compared to the untreated group. Furthermore, it was observed

that after the treatment with the extract and metformin, the blood sugar was down regulated unlike the untreated groups. Due to the diabetic induction, there were increases in aspartate amino transferase (AST), alanine amino transferase (ALT), gamma glutamyl transferase (GGT) which was reduced after treatment with extract, titanium dioxide nanoparticles and metformin. Urea and creatinine levels in the serum of experimental rats were significantly reduced after the treatment. This research confirmed that titanium dioxide nanoparticles could be embedded in drugs or traditional medicine aimed at treating diabetes and related complications.

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Green synthesis of zinc oxide nanoparticles using *Tetrapleura tetraptera* husk aqueous extract and its biomedical applications

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Keywords
Tetrapleura tetraptera
Green synthesis
ZnONPs
Biomedical applications

Abstract

This study investigates the green synthesis of zinc oxide nanoparticles (ZnONPs) using an aqueous extract from *Tetrapleura tetraptera* husk, leveraging its eco-friendly and cost-effective properties. The synthesis process involves reacting zinc sulfate with the plant extract, resulting in the formation of ZnONPs under mild, ambient conditions. Characterization of the nanoparticles was performed using UV-Vis spectroscopy, X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDX), confirming the successful creation of ZnONPs with a crystalline structure and particle sizes ranging from 20 to 50 nm. The antimicrobial efficacy of the ZnONPs was assessed against various bacterial and fungal strains, showing substantial inhibitory effects. This research underscores the potential of using plant-based extracts for environmentally benign synthesis of ZnONPs, highlighting their promising applications in biomedical fields. The ultra-violet-visible spectrum of the nanoparticles displayed maximum absorbance at the wavelength of 222.0 nm. The FTIR absorption spectrum showed strong peak at 367, 3410, 3071, 2927, 2572, 1937 and 1601 cm^{-1} indicating that proteins acted as the capping and stabilization molecules in biosynthesized nanoparticles. The *in-vitro* antidiabetic properties of the synthesized zinc oxide nanoparticles were evaluated: the estimation of α-glucosidase inhibition was done by measuring the 4-nitrophenol released from p-nitrophenyl, α-D glucopyranoside at different concentration of (50-400 µg/ml) of the extract, nanoparticles, acarbose and zinc oxide. The α-amylase inhibition properties of the zinc oxide nanoparticles were discovered at the same concentration. The zinc oxide nanoparticles showed antidiabetic properties through the inhibition of α-glucosidase and α-amylase. The mycelial inhibitory properties of

the synthesized zinc oxide nanoparticles against toxigenic fungi such as *Aspergillus niger, Fusarium solani, Aspergillus flavus*, and *Aspergillus fumigatus* showed the potency of the nanoparticles. The biosynthesized zinc oxide nanoparticles showed significant free radical scavenging properties against 1,1-Diphenyl-2-Picryl-Hydrazyl (DPPH) by 46.14-74.58% at 25-200 µl/ml. Furthermore, the zinc oxide nanoparticles displayed anticoagulant and thrombolytic activities using human blood indicating the biomedical potential of zinc oxide nanoparticles in the management of blood coagulation disorders. This study has presented excellent antimicrobial and antioxidant potentials of eco-friendly zinc oxide nanoparticles from *Tetrapleura tetraptera* husk aqueous extract which can be exploited in therapeutic approach in treating infections and oxidative stress.

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Characterization and antibacterial activity of silver-fabricated nanoparticles using stem bark extract of *Cassia sieberiana* against gastroenteritis-associated bacteria

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Abstract

The quest for alternative therapy to combat the menace of infectious diseases caused by pathogenic bacteria is a serious public health concern worldwide. This study utilized *Cassia sieberiana* stem bark extract to synthesize silver nanoparticles (AgNPs) with antibacterial activity. The nanoparticles were characterized using UV-Visible Spectroscopy (UV-Vis), Fourier Transform Infrared Spectroscopy (FTIR), X-ray Diffraction (XRD), Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM). Antibacterial activity was examined using agar well diffusion method. The UV-Vis confirmed the presence of peaks at 420 nm for spherical AgNPs. The FTIR spectrum showed sharp peaks at 3785, 3406, 2919, 2855, and 1372 cm^{-1}, indicating the presence of hydroxyl, methyl, methylene, alkenyl, and alkyl groups in the AgNPs. The XRD indicated clear and distinct peaks confirming high purity and crystalline nature of phyto-synthesized AgNPs. The SEM and TEM showed the synthesized AgNPs were spherical in shape with average sizes ≥50 nm. The AgNPs synthesized showed zone of inhibition ranging between 6.00 mm and 14.00 mm against *Escherichia coli, Morganella morganii, Enterobacter hormaechei* and *Shigella flexneri*. The study concluded that *C. sieberiana* stem bark AgNPs displayed remarkable antibacterial activity against gastroenteritis-associated bacteria and could be used in therapeutic applications.

Keywords
AgNPs
Antibacterial activity
Cassia sieberiana
Gastroenteritis
Silver nanoparticles

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Influence of biosynthesized zinc oxide nanoparticle on pepper plant

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Keywords
Capsicum annuum
Green synthesis
ZnONPs
Plant growth
Elemental composition

Abstract

Pepper (*Capsicum annuum* L.) is ranked third in Nigeria among the cultivated vegetable crops, behind onions and tomatoes. It is vital to the nutritional stability of both rural and urban dwellers, providing vitamins and minerals in their diets. Due to the world's population growth and the limited amount of land available for cultivation, new agro-technologies need to be developed to support agricultural production and protection globally. In addition to greater food production, eating foods high in nutrients is essential for preventing malnutrition. An important micronutrient for humans, animals, and plants is zinc (Zn). The use of biosynthesized Zinc oxide (ZnO) nanoparticles through foliar fertilization can reduce this problem. The current study mainly focuses on the biosynthesis of ZnO nanoparticles using moringa leaf extract and their effects on Pepper plant. The formation of ZnO nanoparticles was confirmed by UV-Vis spectroscopy, Fourier Transform Infrared spectroscopy, Scanning Electron Microscopy, and particle size analysis. The effect of concentration of biosynthesized ZnO nanoparticles (10-100 mg) and distilled water as the control, was studied on morphology and reproductive parameters and elemental composition of pepper plant using pot experiment. Results indicated that spherical-shaped zinc oxide nanoparticles with sizes less than 100 nm were obtained, where phenolics were the main chemicals present at the surface of NPs. Zinc oxide nanoparticles improved the morphological and reproductive parameters as compared to the control treatment. Elemental analysis also showed that the zinc content was significantly increased with increasing concentration of ZnO nanoparticle as compared to the control. Hence our results indicated that zinc oxide nanoparticles can be utilized as nano fertilizers to improve morphological and reproductive parameters and zinc content in plants.

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Biosynthesis and characterization of bismuth nanoparticle using *Bredelia ferruginea* bark extract and its antibacterial potential

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Keywords
Bredelia ferruginea
Green synthesis
BiNPs
Antibacterial applications
Dye degradation

Abstract

The synthesis and application of bismuth nanoparticles (BiNPs) have garnered significant attention due to their unique properties and potential for diverse applications. This study aimed to synthesize and characterize BiNPs using aqueous extract of *Bredelia ferruginea* bark and evaluate their antibacterial efficacy and dye reduction potential. The BiNPs were synthesized using the bark extract and characterized using standard methods. A color change from red to dark brown indicated the reduction of bismuth nitrate. UV-Vis spectroscopy confirmed BiNP formation, showing absorption peaks at 350 nm with maximum absorbance around 1.0, indicative of surface plasmon resonance. FTIR analysis revealed 20 absorption peaks, highlighting functional groups responsible for nanoparticle reduction and stabilization, with prominent peaks at 1729.52 cm^{-1} (C=O stretch) and 525.18 cm^{-1} (C-S stretch). SEM and TEM images showed spherical BiNPs with non-uniform distribution and agglomeration, averaging 15.47 nm in size. XRD confirmed the crystalline nature of the BiNPs, corresponding to the face-centered cubic structure of bismuth, while EDX revealed bismuth as the predominant element (68.64%). The synthesized BiNPs exhibited significant antibacterial activity against the test pathogens. The zones of inhibition ranged from 2.0 - 8.0 mm and 8.0 – 14.0 mm for the aqueous *Bredelia ferruginea* bark extract and BiNPs. The minimum inhibitory concentration (MIC) values for the BiNPs were 5 µg/mL for most of the test pathogens. In dye reduction tests, BiNPs facilitated rapid and efficient degradation of dyes under ambient conditions, with the color of the solutions gradually changing to off-yellow and light blackish-brown.

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Antibacterial and dye reduction potential of *Calotropis procera* bismuth nanoparticles

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Keywords
Calotropis procera
Green synthesis
BiNPs
Antibacterial applications
Dye degradation

Abstract

The development of (BiNPs) using plant extracts has emerged as a sustainable and eco-friendly approach, leveraging the unique properties of BiNPs for various applications, including environmental remediation and antimicrobial activity. This study aimed to synthesize and characterize BiNPs using aqueous extracts of *Calotropis procera* leaves and evaluate their antibacterial efficacy and dye reduction potential. Aqueous extract of Calotropis procera leaves was used to synthesize BiNPs which was characterized using standard procedures. The green synthesis of BiNPs was indicated by a color change from a clear white colour to milky colour, indicating the reduction of bismuth nitrate. The UV-Vis spectroscopy confirmed the formation of BiNPs, with absorption peaks at the wavelength of 350 nm and a maximum absorbance of approximately 1.0, indicative of surface plasmon resonance. FTIR analysis revealed the presence of 26 absorption peaks indicating the different functional groups responsible for the reduction and stabilization of the nanoparticles, showing prominent peaks at 1729.52 cm^{-1} (C=O stretch) and 664.56 cm^{-1} (fingerprint region) for BiNPs. SEM and TEM showed the biosynthesized BiNPs had spherical morphologies, non-uniform distribution, and agglomeration with an average size of 2.90 nm. XRD analysis confirmed the crystalline nature of the BiNPs with distinct peaks corresponding to the face-centered cubic of bismuth, while EDX spectroscopy revealed bismuth as the predominant element for BiNPs (79.52%). The biosynthesized BiNPs exhibited significant antibacterial activity (2.0 – 8.0 mm) against tested. The BiNPs demonstrated a significant reduction in dye concentration.

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Biosynthesis and characterization of *Cactus* leaf methanol extract silver and magnetic nanoparticles

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Keywords
Cactus
Green synthesis
AgNPs

Abstract

Biosynthesis and characterization of silver and magnetic nanoparticles from cactus leaf methanolic extract and its application in wastewater treatment was investigated. The biosynthesized nanoparticles were characterized using SEM, TEM, UV-VIS, FTIR, EDX, XRD and TGA and its bioremediation potential in wastewater treatment was evaluated. Visible color change from silver-white to brick red and iron-amber to dark blue indicated the production of the nanoparticles under sunlight radiation. Surface plasmon resonance peak of cactus leaves extracts silver and magnet nanoparticles were 500 nm and 400 nm. The X-ray diffraction and SEM micrograph shows the crystalline nature, spherical aggregates and big pockets amorphous particles for CESNPs and CEMNPs. EDX analyses of CESNPs and CEMNPs shows silver and ferrous as the most prominent element. The TGA showed that CESNPs and CEMNPs were thermally stable up till 600°C and 400°C. CESNPs and CEMNPs contain hydroxyl, carbonyl, ketones and aldehyde, amides and aromatic groups. Cactus cladodes extracts were able to bio-reduce silver ions to silver nanoparticles and bio-oxidize ferrous ions to magnetic nanoparticles. Further research however needs to be carried to determine the extent of its application in various sectors.

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Phytosynthesis, characterization and biological evaluation of silver nanoparticles from *Piper guineese* leaf and seed methanol extracts

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Keywords
Piper guineese
Green synthesis
AgNPs
Antibacterial activities

Abstract

The study investigates the *in-vitro* antibacterial activities of greenly synthesized silver nanoparticles from *Piper guineese* leaf (PgMLE) and seed (PgMSE) methanol extracts. The synthesized silver nanoparticles from leave (PgMLEAgNPs) and seed (PgMSEAgNPs) extracts were characterized using UV-visible spectroscopy, FTIR, SEM, TEM, XRD, EDX, and TGA, and the in-vitro antibacterial activity of the extracts and nanoparticles against test pathogens from gastrointestinal tracts was evaluated. The PgMLE and PgMSE bio-reduced silver nitrate solution for the biosynthesis of PgMLEAgNPs and PgMSEAgNPs. The nanoparticles had the highest Surface plasmon resonance peaks at 500 nm. Functional groups such as alcohols, phenols, alkenes or alkynes, nitriles, ketones, aldehydes, or esters were identified as indicative of biomolecules present within PgMLEAgNPs, and PgMSEAgNPs. PgMLEAgNPs and PgMSEAgNPs were spherical flakelike and aggregated particles respectively with 15 nm in size, TEM shows the spherical shape nanoparticles. The nanoparticles were crystalline in nature and silver had the highest intensity as shown by XRD and EDX analysis. PgMLEAgNPs and PgMSEAgNPs exhibited varied antibacterial activity against the test pathogens. The antibacterial activity ranged from 2.00 to 18.00 mm in which *E. coli* had the highest susceptibility to PgMSEAgNPs compared to PgMLEAgNPs. The nanoparticles had better antibacterial efficacy against the test pathogens compared to the Piper guineense leaves and seed extracts. In conclusion, *Piper guineense* leaf and seed extract nanoparticles had profound antibacterial activity against bacteria from GIT which makes them a candidate for biomedical application.

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Extraction and characterization of date seed oil and its application in oral drug delivery of Ibuprofen

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Keywords
Dates seed oil
Microparticles
Homolipid
Ibuprofen
Drug delivery

Abstract

In this study, ibuprofen loaded solid lipid microparticles (SLM) were prepared and characterized. The solid lipid microparticles were prepared from lipid matrix of the binary fusion of goat fat and bees wax in the ratio 1:3 using the hot homogenization method. The SLMs which were prepared in four batches (A1, A2, A3 and ABo) contained 5% w/w of the lipid matrix (solid lipid), 2% of date seed oil (liquid lipid), 5% w/v of PVA, 2% w/v sorbitol, 3% of Tween 80, and distilled water to make up to 100% v/v with A1, A2 and A3 containing 100, 200 and 500 mg of ibuprofen respectively and AB0 had no drug. Parameters such as particle morphology, differential scanning calorimetry (DSC), encapsulation efficiency (EE) and Fourier transform-infrared (FT-IR) were evaluated. The encapsulation efficiency showed that the formulation had an entrapment efficiency of 75, 91 and 96% for A1, A2 and A3 respectively. The differential scanning calorimetry showed that A1, A2 and A3 were more amorphous than PA (pure ibuprofen sample). The result of the DSC showed that ibuprofen was properly solubilized in the microparticles as they had lower melting points compared to the pure ibuprofen sample (PA). The release study shows that A1 had the highest release with a release of 77.42%, A3 had a release of 20.81% and A2 has a release of 29.94%. The standard ibuprofen suspension had the lowest release with a release of 4.93%. Thus, this study has shown that ibuprofen loaded SLMs can be used as an alternative to the conventional ibuprofen suspension.

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Development and characterization of gelatinated-mucin based microparticles for oral delivery of insulin in diabetes treatment

Agbo, P.C[1]., Ugwu, C.E[2]., Amadi, B[2]., Akpa, P[1]., Umar, O[3]., Abdulmumin, H[4]., Alfa, J[5]., Nnamani, N.D[6]., Okereke, N[5]., Darlington, Y[1]., Kenechukwu, F.C[1]., and Momoh, M.A[1]

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Keywords
Mucin
Microparticles
Gelatin
Insulin
Diabetes
Biopolymer

Abstract

Development of an effective oral insulin delivery is still a challenge facing research for effective control of Type 1 diabetes. Double emulsion technique was adopted to prepare oral insulin microparticles (MPs) using gelatin and mucin (MG) at different ratios 0:1, 1:0, 1:1, 1:3, and 3:1 denoted as X1 – X5, respectively. The MG-MPs were evaluated and characterized by encapsulation efficacy (EE%), particle sizes and morphology, crystallinity, sedimentation and re-dispersity of microparticles. *In vitro* drug release and *in vivo* antidiabetic activity were also conducted. Results showed that EE ranged within 76.46 ± 0.86 to 89.10 ± 0.96%. SEM indicated aggregated and pitted particles with particle sizes that ranged within 13.47 ± 67.04 to 37.66 ± 0.01 µm. X4 had the highest sedimentation rate and lowest re-dispersibility. DSC produced X3 as the best copolymer complex that generated the highest amorphous state. *In vitro* study showed a gradual prolonged insulin release. *In vivo* oral antidiabetic activity of MG-MPs was significantly ($p < 0.05$) more effective than the control. Hence, mucin-gelatinized insulin-loaded microparticles could be a potential alternative to conventional insulin therapy.

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Development and evaluation of Eudraginated-gelatin based microparticles: An application in oral insulin delivery for diabetes treatment

Akpa, P[1]., Amadi, B[2]., Ugwu, E.C[2]., Agbo, P.C[1]., Nnamani, N.D[3]., Umar, O[4]., Abdulmumin, H[5]., Alfa, J[6]., Okereke, N[6]., Zakari, D[7]., Darlington, Y[1]., Kenechukwu, F.C[1]., and Momoh, M.A[1]

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Keywords
Eudragit S 100
Insulin
Gelatin
Antidiabetic activity
Microparticles

Abstract

Oral application of insulin remains problematic in pharmaceutical research. In this work, Eudragit and gelatin were employed in the formulation of insulin microparticles (EGel-MPs) for oral delivery at different ratios Y1= 0:1; Y2 = 1:0; Y3 = 1:1; Y4 = 1:3; and Y5 = 3:1; using double emulsion technique. EGel-MPs were evaluated and characterized by encapsulation efficacy (EE), scanning electron microscopy (SEM), and differential scanning calorimetry (DSC). *In vitro* drug release and in vivo antidiabetics tests in rats were done. EE ranged within 78.84 ± 0.24 to 89.43 ± 1.13% with Y4 as the highest. SEM indicated spherical shapes and rough surfaces with pores. Particle sizes ranged within 6.22 ± 3.07 to 18.27 ± 0.02 µm. Y3 depicted the broadest peak and lowest enthalpy indicating an amorphous state and enhanced drug entrapment to be sustained over a while. *In vitro* insulin release showed a characteristic slow-release pattern that may be attributed to mucoadhesiveness of microparticles caused by slow hydration, swelling, and gelling of the particles in the buffer system. *In vivo* oral antidiabetic activity was significantly ($p < 0.05$) more effective with prolonged duration than the controls. Thus, insulin oral delivery could be improved and enhanced using copolymers Eudragit-gelatin microparticles (EGel-MPs).

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Zinc oxide nanoparticles biosynthesized using aqueous aerial-leaf extract of *Vachellia sieberiana* mitigated hepatic and renal DMH/DSS-induced oxidative-stress in Wistar rats

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Keywords
Zinc oxide nanoparticles
Oxidative stress
Nanotechnology
1,2-dimethylhydrazine
Vachellia sieberiana

Abstract

Colon cancer is the second largest cause of mortality globally. Chemical-induced cancer in a particular tissue can affect other tissues' defense antioxidant mechanisms. The combinatorial use of medicinal plants and nanotechnology has recently gained significant attention because of low toxicity, providing innovative solutions to mitigate oxidative stress-related damage. This study investigates the protective effects of zinc oxide nanoparticles (ZnONPs) synthesized using *Vachellia sieberiana* aqueous aerial-leaf extract against oxidative stress induced by 1,2-dimethylhydrazine (DMH) and dextran sodium sulphate (DSS) in male Wistar rats. Zinc oxide nanoparticles was green-fabricated using 1 g/ml of aqueous aerial extract of *Vachellia sieberiana* and 0.1M zinc nitrate hexahydrate solution following standard method. Male Wistar rats (thirty-five) were randomly divided into seven groups of five animals each. Group 1 (negative control) un-exposed group, Group 2 (positive control) was treated with DMH and DSS only, and Groups 3, 4, and 5 were administered (DMH +3% DSS) plus 100, 200, and 400 mg/kg of ZnONPs respectively. Group 6 received DMH + 2mg/kg b.w of Doxorubicin while Group 7 received 400 mg/kg ZnONPs. Treated groups received daily administration of ZnONPs a week before DMH administration. DMH (25 mg/kg) was given to the animals subcutaneously once per week for 5 weeks and 2 cycles of 7 days each of 3% DSS in drinking water. Animals were allowed access to food and water *ad libitum* and sacrificed at the end of the 5th week. Hepatic and renal reduced glutathione (GSH) levels and the activities of glutathione peroxidase (GPx), glutathione-S-

transferase (GST), superoxide dismutase (SOD), and levels of malondialdehyde (MDA) were evaluated. The data were visualized using One-way ANOVA followed by Tukey's post hoc test with a significance level set at $p<0.05$ using GraphPad Prism Version 9.3.2. Exposure to DMH/DSS significantly reduced hepatic and renal GSH levels, GPx, and GST activities. ZnONPs significantly reversed the disrupted levels of renal and hepatic antioxidant enzymes and molecules occasioned by DMH/DSS treatment compared with the negative control. DMH/DSS induced a non-significant increase in hepatic SOD and a reduction in renal SOD activities compared with the negative control. The ZnONPs treatment insignificantly reversed both the hepatic and renal effects of DMH/DSS. Hepatic and renal MDA significantly increased levels observed in Group 2 compared with Group 1 (Negative control). Remarkably, ZnONPs significantly ameliorated DMH/DSS-induced MDA increase in a dose-dependent manner. The ZnONPs could be a plausible agent against chemical-induced tissue oxidative stress in the colon cancer rat model.

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Roles of zinc oxide nanoparticles synthesized from *Vachellia sieberiana* aqueous aerial part extract in DMH/DSS-induced colon cancer inflammation, apoptosis, and DNA damage

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Keywords
Zinc oxide nanoparticles
Colon cancer
Caspase-3, 8-hydroxyl-2-deoxyguanosine
Tumor necrosis factor-α
Interleukin-1β
Green synthesis
Vachellia sieberiana

Abstract

Plants contain bioactive compounds with remarkable properties such as antioxidant, anti-inflammatory, and anti-cancerous effects. The use of nanostructures as carriers of bioactive compounds of medicinal plants is of special interest in biomedicine. This study was designed to evaluate the impact of zinc oxide nanoparticles (ZnONPs) fabricated using aqueous aerial-leaf extract of *Vachellia sieberiana* on inflammatory (Il-1β and TNF-α) and apoptotic biomarkers (Caspase-3) and level of DNA damage (8-hydroxyl-2'-deoxyguanosine) in the colon of 1,2-dimethylhydrazine (DMH)-induced male Wistar rats. Zinc oxide nanoparticles was green-fabricated using *Vachellia sieberiana* aerial part. Male Wistar rats (Thirty-five) were divided into seven groups of five animals each. Group 1 unexposed control was designated as negative control, Group 2 received 25 mg/kg body weight (b.w) of DMH subcutaneously once per week + 2 cycles of 3% DSS in their drinking water (positive control). Groups 3, 4, and 5 received DMH/ DSS administration and 100, 200, and 400 mg/kg b.w of ZnONPs respectively. Group 6 received DMH/DSS and 2 mg/kg b.w of Doxorubicin. Group 7 received 400 mg/kg b.w ZnO NPs. The rats received DMH subcutaneously once per week for 5 weeks and 3% DSS in two cycles of 7 days each. The animals were sacrificed at the end of 6th week and the colons were harvested. The inflammatory (TNF-α, IL-1β), apoptotic (Casp-3), and DNA damage (8-OHdG) biomarkers were analyzed using the ELISA method. The data were analyzed using One-way ANOVA followed by the Post Hoc Tukey test with a level of significance set

at $p<0.05$ using GraphPad Prism version 9. The results showed that DMH/DSS exposure induced a 43.89% increase in colon IL-1β and an 8.39% increase in TNF-α compared with group 1 (negative control). The DMH/DSS-induced IL-1β and TNF-α increase was significantly reversed by the treatments with different concentrations of the ZnONPs with the highest treatment (group 5) recording a 27.22% decrease in IL-1β and a 16.27% decrease in TNF-α. In addition, DMH/DSS induced 12.42% and 18.94% increases in caspase-3 and 8-OHdG levels respectively compared with Group 1 (negative control). The treatment with the nanoparticles significantly lowered the levels of caspase-3 and 8-OHdG compared with Group 2. The reduction of 8-OHdG followed a concentration-dependent manner while significant caspase-3 reduction was observed only in group 5 (15.92%). This study demonstrated that ZnONPs can mitigate inflammation, apoptosis, and DNA damage in chemical-induced colorectal cancer. It further provides preliminary guidance for possible colon cancer therapy using ZnONPs.

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In vitro antioxidant, anti-inflammatory, and antidiabetic of titanium dioxide nanoparticles synthesized using aqueous aerial parts extract of *Vachellia sieberiana*

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Keywords
Titanium dioxide
Antioxidant
Anti-diabetic
Green synthesis
Vachellia sieberiana

Abstract

The synthesis of metal oxide nanoparticles (NPs) using plant-based extracts for bio-medicinal applications is emerging because of its eco-friendliness and sustainable approach. This study explores the nanoparticles's antioxidant, anti-inflammatory, lipid peroxidation inhibitory, and anti-diabetic. Titanium dioxide nanoparticles (Vs-TiO_2NPs) were synthesized using aqueous aerial-leaf extract of *Vachellia sieberiana* (0.1g/ml) and 1 mM titanium dioxide. The antioxidant activity of the synthesized TiO_2NPs was evaluated using DPPH, ABTS, and hydroxyl radical scavenging model. The inhibition of protein denaturation and proteinase activity for anti-inflammatory potential were assessed. Lipid peroxidation inhibition was measured using the thiobarbituric acid reactive substances (TBARS) assay. While the *in-vitro* anti-diabetic ability was evaluated using α-amylase inhibition. The IC50 values of the activities were estimated with regression curve analysis using Prism version 9 software. The nanoparticles scavenged DPPH, ABTS, and hydroxyl radical($^{\cdot}OH$) in a dose-dependent manner with IC50 values of 9.86 µg/ml, 116.6 µg/ml, and 265.2 µg/ml respectively, compared to the standard (ascorbic acid) with IC50 of 202.6 µg/ml (DPPH) and gallic acid with IC50 of 25.75 µg/ml ($^{\cdot}OH$). The IC50 values of the nanoparticles for protein denaturation and proteinase inhibition are 154.6 µg/ml and 94.73 µg/ml respectively. The nanoparticles displayed strong lipid peroxidation inhibition with IC50 of 188.4 µg/ml showing 62% inhibition at 476 µg/ml. Furthermore, Vs-TiO_2NPs effectively inhibited α-amylase activity, indicating anti-

diabetic potential with an IC50 value of 30.52 µg/ml and exhibiting 61% inhibition at 200 µg/ml. This finding indicates that bio-fabricated TiO_2NPs hold significant potential as multifunctional therapeutic agents capable of managing inflammation and oxidative stress-related conditions. The nanoparticles' antioxidant and anti-inflammatory effects may be related to their anti-diabetic potential.

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Exploring the antioxidant, anti-inflammatory, and anti-diabetic potential of zinc oxide nanoparticles bio-fabricated using *Vachellia sieberiana* aqueous aerial parts extract

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Keywords
Zinc oxide nanoparticles
Antioxidant
Anti-diabetic
Green synthesis
Vachellia sieberiana

Abstract

Vachellia sieberiana, known for its medicinal properties, provides bioactive compounds to facilitate nanoparticle formation and potentiate its therapeutic efficacy. This study evaluated the antioxidant, anti-inflammatory, lipid peroxidation inhibition, and anti-diabetic potential of zinc oxide nanoparticles using *Vachellia sieberiana* aqueous aerial-leaf extract. Zinc oxide nanoparticles (ZnONPs) were synthesized using an aqueous extract of *Vachellia sieberiana* (0.1g/ml) as a reducing agent and 0.1M zinc nitrate hexahydrate solution. The bio-medicinal potential of ZnONPs was assessed through DPPH, ABTS, and hydroxyl radical scavenging activities. Inhibition of protein denaturation was used as a marker of anti-inflammatory properties. Furthermore, the inhibition of Fe^{2+} induced lipid peroxidation in egg yolk homogenate, and the anti-diabetic potential of the synthesized ZnONPs were assessed using α-amylase inhibition. The UV-visible spectra confirmed the successful synthesis of ZnONPs, with characteristic absorption peaks of 370 nm. The ZnONPs exhibited strong DPPH, ABTS, and hydroxyl radical inhibitions with IC50 values of 9.37, 222.4, and 187.5 µg/mL respectively. The lipid peroxidation inhibitory activity IC50 value of the nanoparticles showed 225.5 µg/mL. The nanoparticles inhibited Protein denaturation in a dose-dependent concentration with an IC50 value of 54.56 µg/mL. ZnONPs also displayed significant α-amylase inhibition with an IC50 value of 31.08 µg/ml. The strong in-vitro anti-diabetic effect displayed by the nanoparticles may not be unconnected with its compelling antioxidant and anti-inflammatory activities. This study projects ZnONPs as a plausible alternative to synthetic substances for

antioxidants, antibacterial, and anti-inflammatory uses in the biomedical and pharmaceutical industries.

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Evaluation of the chicken feather-mediated zinc oxide nanoparticles fortified fish meal on the growth and haematological profile of juvenile *Clarias gariepinus*

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Keywords
Zinc oxide nanoparticles
Green synthesis
Fish feed
Growth
Haematology
Clarias gariepinus

Abstract

Nanotechnology, an emerging scientific field has demonstrated its value in various sectors, including aquaculture, by providing innovative solutions to improve fish health and productivity. This study aimed to explore the potential of chicken feather-mediated zinc oxide nanoparticles (CFE-ZnO-NPs) as a fish meal fortifying agent to enhance the growth performance and healthy condition of juvenile *Clarias gariepinus*. The chicken feather extract (CFE) was prepared by hydrolyzed 1 g of feather in 100 ml of 0.1M NaOH at 90 °C for 1 hour, cooled and then centrifuged at 4000 rpm for 30 minutes. It was filtered using Whatman filter paper, and stored at 4 °C. The CFE-ZnO-NPs was synthesized by mixing 100 ml of zinc nitrate solution with 15 ml of feather extract at 60 °C, with the pH adjusted from 6.0 to 12.0 by 1M NaOH. The white precipitate formed was centrifuged at 4000 rpm for 20 minutes, dried at 150 °C to form pellets designated CFE-ZnO-NPs. It was characterized using UV-Visible Spectroscopy and Fourier Transform Infrared Spectroscopy (FTIR). Juvenile *C. gariepinus* (125) were procured, acclimatized for two weeks, and divided into 5 groups of 25 each. The group from 1 to 3 were fed with meal fortified 0.25, 0.5 and 1.0 g/kg bw of CFE-ZnO-NPs, while group 4 and 5 were fed Fish meal without CFE-ZnO-NPs and standard fish meal designated negative and positive controls, respectively. Fish in each of the groups were fed 2.5% of their body weight twice a day while water was changed at every 24 h for 56 days. Growth parameters (length and weight) were measured at every 2 weeks. Haematological parameters; packed cell volume (PCV), red blood

cell count (RBC), hemoglobin (Hb), white blood cell count (WBC), mean cell volume (MCV), mean cell haemoglobin (MCH), and mean cell haemoglobin concentration (MCHC) were measured on Days 14, 28, 42, and 56. Data obtained were analyzed using SPSS 27 with ANOVA and Duncan's Multiple Range test done at $p<0.05$. The white cloudy precipitate indicated the formation of CFE-ZnO-NPs with the absorption value of 371.5 nm. The FTIR peaks of 3394.50, 1500.18, 1387.75, 1045, 832.19, 706.24 cm^{-1} correspond to O-H, C=C and N–H, C–O, C–O, C-H and C-H stretch were obtained, indicating protein as major macromolecule serving as reducing and capping agent. Fish growth results showed that the positive control group had the highest weight gain which was consistent throughout the period of evaluation compared to CFE-ZnO-NP treated fish groups. Fish treated with 0.25 g/kg manifested higher weight values compared to negative control, 0.5 and 1.0 g/kg bw ($p>0.05$). The weight gain of 9.35g and 89.54g were respectively obtained for fish treated with 0.25g/kg CFE-ZnO-NPs and Standard meal. However, the cost equivalent for 15kg meal of CFE-ZnO-NPs was half of the cost for the standard meal. Haematological profile (PCV, RBC, Hb, WBC, MCV. MCH and MCHC) showed variations within the treatments and across the days of evaluation with the values of RBC and Hb obtained for fish treated with standard meal significantly different at day 28 ($p<0.05$). Biogenic CFE-ZnO-NPs fortified fish meal at 0.25g/kg bw resulted in weight gain of 9.35g, suggesting the usefulness of CFE-ZnO-NPs for improvement of growth and yield of fish. With further modification, this technique could assist in sustainable aquaculture production, supporting growth at low dosage without any observable effect on haematological profiles.

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Development of green synthesized calcium nanoparticles coatings as preservative for tomatoes (*Solanum lycopersicum* L.), peppers (*Capsicum chinense*) and potatoes (*Solanum tuberosum*)

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Keywords
Vegetables
Green CaNPs
Nanocoating
Preservative agent
Shelf-life
Keeping quality

Abstract

Fresh vegetables are less commonly preserved in Nigeria due to unavailability of appropriate technology, leading to high postharvest losses, high cost and limited access to micronutrients. This study was designed to evaluate the preservative potentials of green synthesize calcium nanoparticle (CaNPs) coatings on the physical, chemical and microbial composition of pepper, tomatoes and potatoes. Orange peel extract was used to synthesize green calcium nanoparticles (CaNPs), which was later characterized using UV-vis spectroscopy and Transmission Electron microscopy methods. The synthesized CaNPs was used to coat fresh tomatoes, peppers and potatoes through soaking methods for 1 minute. The fresh vegetables were preserved and later evaluated for weight loss, changes in parameters such as colour, texture, firmness, microbial contamination and chemical composition. Data obtained were subjected to Analysis of Variance (ANOVA) and significant means separated at $p \leq 0.05$ level of probability. The results of this study showed that coating of tomatoes, peppers and potatoes with green synthesized calcium nanoparticles had no significant effects on the colour change, weight loss, firmness and chemical composition of treated and untreated samples. The shelf-life of the tomatoes and peppers were extended for 28 days while that of potatoes were extended for 35 days. Therefore, valorisation of orange peel bioactive for the synthesis of green calcium nanoparticles used for fresh vegetable coating offers a promising solution for increasing the shelf life of produce, reducing food waste, and contributing to the sustainability of the food industry..

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Development of nanotechnology-based sensors for monitoring environmental pollutants and their potential impact on biodiversity conservation

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Keywords
Pollutants
Bioindicator
Biosensors
Nanotechnology
Biodiversity

Abstract

Species of organisms are under the threat of environmental pollutants despite the health status displayed by those that served as bioindicators in ecosystem. Pollutants are from many sources as a result of industrial and agricultural revolution. Call for appropriate monitoring systems are required to put at bay terrible damage from pollution fall out. Bioindicator health status dependent signal to harmful effects of pollutants discharged into environment is not enough and may not be enough to predict healthy state of the environment. There is therefore need to design nanotechnology-based sensors for monitoring and detection of pollutants' presence, level and harmful effects in ecosystem. Technological advancement of nanobiosensors in comparison to conventional biosensors is owing to their nanomaterials' flexibility with advance novelty in development of nanobiosensor. So, depending on nanomaterials' properties, nanotubes, nanoparticles, nanorods, nanowires, nanostructured hydrogel, dendrimer and polymer nanocomposites may be adapted to design biosensor devices which can interact with biomolecules mediated by isolated enzymes, immune systems, tissues or all cells to detect chemical components in form of electrical, thermal or optical owing to their improve sensitivity and performance. There are many metallic nanoparticles but gold nanoparticle is one of the suitable candidates to design nanobiosensors to detect and monitor pollutants levels of diverse organisms. This is owing to AuNPs' ability to capture analyte molecules because its electrical/optical possessions are used to intensify signals which are relative to the analyte concentration. Precisely, transduction of bio-chemical signals into measurable electrical signals is easy. Aside that, AuNPs has biocompatibility, unique opto-electronic possessions,

easy fabrication and modification approach. AuNPs biosensor is relatively simple in design, development and has low-cost detection capabilities. In conclusion, better selection and interconnectedness of appropriate gold nanomaterials and transducers could offer better efficient AuNPs-based biosensors as the later has the capacity of converting biological signals from AuNPs-based biosensor into digital signals for further interpretation and analysis. Development of this handy instrument of multi-tasking capability is inexpensive, safer and non-toxic and could offer a lot in biodiversity conservation programs.

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