UNIVERSITY OF KWAZULU-NATAL™
INYUVESI YAKWAZULU-NATALI

COLLEGE OF AGRICULTURE, ENGINEERING AND SCIENCE

PRIS 2025

POSTGRADUATE RESEARCH & INNOVATION SYMPOSIUM

DATE:
28 & 29 October 2025
(Tuesday and Wednesday)

VENUE:
Coastlands Hotel,
Musgrave Durban

THEME:
INTERNATIONAL YEAR OF QUANTUM SCIENCE AND TECHNOLOGY

pris.ukzn.ac.za

INSPIRING GREATNESS

UNIVERSITY OF KWAZULU-NATAL
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The College of Agriculture, Engineering and Science would like to express its appreciation to the following external partners who have supported Postgraduate Research and Innovation Symposium 2025

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Dr Mervlyn Moodley, Quantum Research Group, School of Agriculture and Science, Discipline of Physics

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Dr Nontokozo Mkhonza
Dr Zamalotshwa Thungo
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Chair: Prof Nishani Harinarain
Assistant Chair: Prof Jules-Raymond Tapamo
Assistant Chair: Dr Joy Adu
Moodle Co-ordinator: Mrs Rosanne Els
Moodle Co-ordinator: Mr Shridhar Singh

Judges:

Dr Andronicus Akinyelu
Dr Nivaar Brijmohan
Mr Javhaid Hammujuddy
Prof Pradeep Kumar
Dr Cerene Rathilal
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MESSAGES OF SUPPORT

Welcome to PRIS 2025 – the fifteenth College of Agriculture, Engineering and Science Postgraduate Research and Innovation Symposium. We are striving to ensure that the research carried out by our postgraduate students is relevant to society and contributes to the wellbeing of South Africans. This event highlights the cutting-edge research conducted by our postgraduate students and provides them with an opportunity to present their work to peers, academic staff and research partners. I would like to thank and congratulate the large number of postgraduate students who have shown the courage and enthusiasm to present their work today. The standard of proceedings is very similar to what students can expect at national and international conferences. Many students have used occasions such as this to hone their presentation skills and have gone on to win awards at international conferences. Behind every postgraduate student is a supervisor or supervisory team, who challenges, encourages and today will be sharing in your success – we owe you a debt of gratitude. Finally, we are grateful to all the sponsors whose generous contributions made this day possible, and we continue actively to seek ongoing collaboration and partnerships with industry and with all relevant role players.

Professor Nana Poku, Vice-Chancellor and Principal, UKZN

One of the most influential scientists of modern times, Albert Einstein, stated, "If we knew what it was we were doing, it would not be called research, would it?" Given the pace at which our world is changing, it is no wonder that the human race is under increasing pressure to become "experts" – to know more and more about less and less. The big challenge for us is rapidly to discover, inform and implement our small and big discoveries to make real changes. We have economic, environmental, health and cultural questions to respond to, for the benefit of the present and future generations. The mission of UKZN is to be relevant to our local communities, South Africa and the world. Our postgraduate students have made it possible for UKZN to deliver on its mission. The College Postgraduate Research and Innovation Symposium is a significant moment for UKZN to highlight the efforts and successes of our students and their supervisors. Every presentation over these two days is valuable and I encourage that you should start working on publishing your work. We are thankful to all the students who took time to share their knowledge with us. We also thank their supervisors who guided them to the point of being able to share their research with us. Without the support of our funders, partners and collaborators in research, we would not be celebrating the global recognition we currently enjoy and showcase through this special symposium.

Professor Fhatuwani Mudau,
Deputy Vice-Chancellor and Head of College: Agriculture, Engineering and Science, UKZN

The research community from the College of Agriculture, Engineering and Science continues to set the pace in terms of research outputs produced across the university. An important part of UKZN's Strategy is the emphasis it places on growing the impact of the research that is produced at UKZN. Impact is not only measured in terms of the influence our research has on the community in which we function and the manner in which it shapes the policy environment but also the citations our published research attracts from the broader research community. This requires a focus on high-impact journals and increasing the international collaborations we engage with. These two factors alone will significantly strengthen the research profile of UKZN. Please use the opportunity afforded by this event to encourage all our students and academics to build their research profiles and to focus on the quality of the research produced to ensure that UKZN becomes well-known for the transformative character of its research.

Professor Rituparno Goswami, Dean of Research: College of Agriculture, Engineering and Science, UKZN

Welcome to the fifteenth College of Agriculture, Engineering and Science Postgraduate Research and Innovation Symposium. This year, the newly formed School of Agriculture and Science is the proud host of this flagship College event and the two days we have lined up are aimed at showcasing our master's and PhD research across the College, under the banner: "International Year of Quantum Science and Technology". The scientific programme promises to be exciting with a good mix of fundamental and applied research presentations. Of particular importance is communicating this research to a wider audience, demonstrating the impact it has on communities and industry. It is my hope that the event will be a catalyst for interdisciplinary dialogue among academics and researchers, and for future collaborative projects with community, government and industry stakeholders.

Part of conducting scientific research is to improve the lives of mankind. These two days will provide a platform for our postgraduate students to demonstrate this to their peers, professors and to the public. I applaud all presenters who have come forward to present their research - This is not just a platform to present your research but also a stepping stone on your journey towards becoming thought leaders and change makers in science. Please enjoy the moment, embrace the feedback and let it inspire your pursuit of excellence. Hosting an in-person symposium at one of our premier hotels in Durban allows students to get the full experience of attending a conference similar to a national or international format. This is an experience every postgraduate student should have. The symposium will take place in two formats, the conventional oral presentations, and flash presentations, which are a shorter, more concise version of the oral presentation. This is a common practice at many international conferences on various continents. As such, our students will be exposed to this way of presenting their research that will allow them to make an impact to a large audience.

Finally, I would also like to take this opportunity to thank and congratulate the supervisors and mentors for their unwavering commitment to guiding and supporting the postgraduate students. To both the presenters and their supervisors, well done. I look forward to an interesting two days.

Professor Ademola Olaniran, Dean and Head of the School of Agriculture and Science, UKZN

PROGRAMME

Tuesday, 28 October and Wednesday, 29 October 2025

DAY ONE: Tuesday 29 October

09:00 – 09:15 **OPENING PLENARY** *(Sapphire Hall)*
Introduction – Professor Rituparno Goswami, *College Dean of Research*
Official Welcome – Professor Anil Chuturgoon, *Deputy Vice-Chancellor of Research, University of KwaZulu-Natal*

09:15 – 09:45 **Keynote Lecture – Professor Val Zwiller,** *Professor of Physics at the Royal Institute of Technology, Sweden & Chief Science Officer at Single Quantum*

09:45 – 9:50 **Programme overview - Professor Rituparno Goswami**

10:00 – 11:20 **Session 1 – ORAL PRESENTATIONS** *(Suite 1 – 4 & Ruby 1 – 2)*

Timeslot	AEES	CP	ENG	LS	MSCS
10:00 – 10:20	AEES-O-1-Cebiso-Zodidi	CP-O-1-Akano-Mary	ENG-O-1-Ahmad-Fazeel	LS-O-1-Magwaza-S'thandiwe	MSCS-O-1-Cele-Lindani
10:20 – 10:40	AEES-O-2-Chatara-Tinashe	CP-O-2-Gcabashe-Nontobeko	ENG-O-2-Ganapathie-Adheesh	LS-O-2-Maswanganye-Carol	MSCS-O-2-Dlamini-Nqobile
10:40 – 11:00	AEES-O-3-Mauyo-Lianda	CP-O-3-Hlapisi-Nthabeleng	ENG-O-3-Gasa-Siyabonga ***(UUW)***	LS-O-3-Mgabhi-Nelisiwe	MSCS-O-3-Haroon-Ali
11:00 – 11:20	AEES-O-4-Mkhonta-Glen ***(UUW)***	CP-O-4-Hlongwane-Michael	ENG-O-4-Joseph-Elijah	LS-O-4-Moeketsi-Bonolo	MSCS-O-4-Malope-Ben

11:20 – 11:40 **Tea and viewing of industry exhibits** *(Sapphire Hall)*

11:40 – 13:00 **Session 2 – ORAL PRESENTATIONS** *(Suite 1 – 4 & Ruby 1 – 2)*

Timeslot	AEES	CP	ENG	LS	MSCS
11:40 – 12:00	AEES-O-5-Mthiyane-Sfundo	CP-O-5-Madhunlall-Aavishkar	ENG-O-5-Mcwabe-Nolwazi	LS-O-5-Ndlangamandla-Valencia	MSCS-O-5-Ndebele-Lethukuthula
12:00 – 12:20	AEES-O-6-Buthelezi-Kwenama	CP-O-6-Khubone-Lungisani	ENG-O-6-Monyetsware-Dikeledi	LS-O-6-Ndlovu-Sphamandla	MSCS-O-6-Ogutu-Sarah
12:20 – 12:40	AEES-O-7-Mthembu-Thando	CP-O-7-Maluleka-Sizwe	ENG-O-7-Mupfiga-Elvis	LS-O-7-Nuse-Xolile	MSCS-O-7-Oliobi-Chidimma

12:40 – 13:00	AEES-O-8-Ncisana-Lusanda	CP-O-8-Mazibuko-Kwanele	ENG-O-8-Mutuku-Peter	LS-O-8-Radebe-Nkanyezi	MSCS-O-8-Revesai-Zvinodashe

13:00 – 14:00 **Lunch** *(Sapphire Hall)*

14:00 – 15:20 **Session 3 – ORAL PRESENTATIONS** *(Suite 1 – 4 & Ruby 1 – 2)*

Timeslot	AEES	CP	ENG	LS	MSCS
14:00 – 14:20	AEES-O-9-Phelako-Andile	CP-O-9-Mthimkhulu-Sakhile	ENG-O-9-Netshirungulu-Wamashudu	LS-O-9-Ramklowan-Dhamini	MSCS-O-9-Sekhoasha-Tsepo
14:20 – 14:40	AEES-O-10-Tseku-Simphiwe	CP-O-10-Ngwenya-Asanda	ENG-O-10-Ramruthan-Caleb	LS-O-10-Sibiya-Mbalenhle	MSCS-O-10-Sola-Lutho
14:40 – 15:00	AEES-O-11-Valentine-Emmanuel	CP-O-11-Nkosi-S'busiso	ENG-O-11-Thabede-Mduduzi	LS-O-11-Tokota-Dineo	MSCS-O-11-Zengeya-Tsitsi
15:00 – 15:20	AEES-O-12-Zabuloni-Byamungu	CP-O-12-Ruwhizi-Ngonidzashe	ENG-O-12-Zenani-Khayelihle	LS-O-12-Tsalong-Sipho	MSCS-O-12-Zuma-Ntuthuko

16:00 – 16:30 **Guest Talk** *(Suite 1 – 4)*

Welcome: Professor Neil Koorbanally, *Acting Dean of Research, University of KwaZulu-Natal*

Speaker: Dr Ntsapokazi Deppa, *Executive: Scientific Services, uMngeni-uThukela Water (UUW)*

16:30 – 18:00 **SCIENCE WITH JAZZ** *(Suite 1- 4)*

Speaker: Professor Thomas Konrad, *Director, CQCtec, University of KwaZulu-Natal*

Musicians: Linda Sikhakhane *(saxophone)* and Paras Dlamini *(vocals)*

18:00 – 22:00 **Gala Dinner** *(Sapphire Hall)*

Master of Ceremonies: Professor Alan Mathews

Welcome: Professor Ademola Olaniran, *Dean: School of Agriculture and Science, University of KwaZulu-Natal*

Keynote Speaker: Dr Happy Sithole, *Centre Manager: Council for Scientific and Industrial Research, Cyberinfrastructure*

Entertainment: Ms Jamie-Lee Simons

UKZN Foundation Presentation: Mr Steve Camp, *Executive Director, UKZN Foundation*

Acknowledgement of Donors: Mr Steve Camp and Professor Rituparno Gowami

Acknowledgement of PRIS Supporters: Professor Fhatuwani Mudau, *Deputy Vice-Chancellor and Head of College* and Professor Ademola Olaniran, *Dean, School of Agriculture and Science*

Entertainment: Ms Keamogetswe Magau

Closing Remarks

Dinner

Entertainment: Ms Jamie-Lee Simons

DAY TWO: Wednesday, 29 October

FLASH PRESENTATIONS *(Suite 1 – 4 & Ruby 1)*

Timeslot	AEES	CP	MSCSENG	LS
09:00 – 11:20	AEES-F-1-Bixa-Aluvuyo	CP-F-1-Adegoke-Oyeladun ***(UUW)**	MSCSENG-F-1-Abejide-Kolawole	LS-F-1-Alabi-Mercy
TEA: 11:25 – 11:45	AEES-F-3-Curtis-Tanisha ***(UUW)**	CP-F-2-Afolabi-Olumide	MSCSENG-F-2-Dladla-Thembelihle	LS-F-2-Ally-Muhammad
Cont. 11:50 – 13:00	AEES-F-4-Dlamini-Siyabonga	CP-F-3-Ally-Numeerah ***(UUW)**	MSCSENG-F-3-Dladla-Sandile ***(UUW)**	LS-F-3-APO-KAYODE
	AEES-F-5-Gule-Melisa	CP-F-4-Ayo-Ojo-Oluwatumininu	MSCSENG-F-4-Dlamini-Ayanda	LS-F-4-Buthelezi-Khanyisile
	AEES-F-6-Gumbi-Sikhulile	CP-F-5-Badu-Godfred	MSCSENG-F-5-Dlamini-Welcome	LS-F-5-Buthelezi-Lindiswa
	AEES-F-7-Gwala-Sinethemba	CP-F-6-Bala-Sandisiwe	MSCSENG-F-6-Govender-Dylan	LS-F-6-Chabalala-Vunene
	AEES-F-8-Hadebe-Nombuso	CP-F-7-Bauchoo-Yastheer	MSCSENG-F-7-Govender-Cherise	LS-F-7-Dayanand-Shreya
	AEES-F-9-Khaba-Nkanyezi	CP-F-8-Diplal-Amisha	MSCSENG-F-8-Ibrahim-Amna	LS-F-8-Dlamini-Sthembile
	AEES-F-10-Khumalo-Phindile	CP-F-9-Dlangalala-Celiwe	MSCSENG-F-9-Joosab-Zaakirah	LS-F-9-Dlamini-Khanyisani
	AEES-F-11-Khumalo-Thalente	CP-F-10-Doncabe-Mandisa	MSCSENG-F-10-Kajola-Shamsudeen	LS-F-10-Doyisa-Sinenhlanhla
	AEES-F-12-Luthuli-Ayanda	CP-F-11-Ghumran-Safiyah	MSCSENG-F-11-Kariga-Progress	LS-F-11-Dube-Alwande
	AEES-F-13-Maereka-Enock	CP-F-12-Gobind-Dipika	MSCSENG-F-12-Khumalo-Phangisile	LS-F-12-Fayomi-Samuel
	AEES-F-14-Mahlanya-Reneilwe	CP-F-13-Goge-Mangaliso	MSCSENG-F-14-Manyathi-Snothile	LS-F-13-Govender-Kyle
	AEES-F-15-Majija-Yolisa	CP-F-14-Hadebe-Lungile	MSCSENG-F-15-Mayise-Yamkela	LS-F-14-Govender-Kuyurie
	AEES-F-16-Makhanya-Siphiwe	CP-F-15-Hajee-Mariam	MSCSENG-F-16-Mchunu-Bongekile	LS-F-15-Gumenku-Lemohang
	AEES-F-17-Mkhize-Nonkululeko	CP-F-16-Ijimdiya-Racheal	MSCSENG-F-17-Mngadi-Siyamthanda	LS-F-16-Gwayi-Yamkela
	AEES-F-18-Mkhwenkwana-Anela	CP-F-17-Jili-Ncedo	MSCSENG-F-18-Moleele-Surprise	LS-F-17-Harpal-Saiesha

	AEES-F-19-Mncwabe-Ntuthuko	CP-F-18-Jimoh-Saheed	MSCSENG-F-19-Morake-Relebogile ***(UUW)**	LS-F-18-Hlamaphi-Luyanda
	AEES-F-20-Mngoma-Mlungisi	CP-F-19-Khubone-Lungisani	MSCSENG-F-20-Mothiba-Koena	LS-F-19-Hussan-Ayesha
	AEES-F-21-Mofurutsi-Tholoana	CP-F-20-Kontile-Lelethu ***(UUW)**	MSCSENG-F-21-Mthethwa-Sbongiseni	LS-F-20-Ismail-Huda
	AEES-F-22-Mpungose-Thobeka	CP-F-21-Kumar-Gobind	MSCSENG-F-22-Mthethwa-Sbahle	LS-F-21-Ismail-Nuhaa
	AEES-F-23-Mthethwa-Zimbili	CP-F-22-Machakaire-Tatenda	MSCSENG-F-23-Mukansi-Demian ***(UUW)**	LS-F-22-Khuzwayo-Thandeka
	AEES-F-25-Nasimiyu-Lydia	CP-F-23-Madlala-Ayanda	MSCSENG-F-24-Ncama-Samkelo	LS-F-23-Khwela-Thembeka
	AEES-F-26-Nemukula-Lufuno	CP-F-24-Magqira-Bavuyile	MSCSENG-F-25-Ndlovu-Disang	LS-F-24-Kola-Elizabeth
	AEES-F-27-Ngcobo-Noluthando	CP-F-25-Maharaj-Shamik	MSCSENG-F-26-Ngcobo-Ndumiso	LS-F-25-Kumalo-Gcinile
	AEES-F-28-Ngwazi-Thobani ***(UUW)***	CP-F-26-Maphalala-Aphiwe	MSCSENG-F-27-Ntombela-Onesipho	LS-F-26-Madikizela-Snothile
	AEES-F-29-Njomi-Ongeziwe	CP-F-27-Maphanga-Nsindiso	MSCSENG-F-28-Nxumalo-Luthando	LS-F-27-Madlala-Thabile
	AEES-F-30-Oyebamiji-Emmanuel	CP-F-28-Mbatha-Thandeka	MSCSENG-F-29-Nyakujipa-Evangelista	LS-F-28-Maduna-Nolufefe
	AEES-F-31-Poswa-Nonkululeko	CP-F-29-Mbhele-Amanda	MSCSENG-F-30-Okem-Eche	LS-F-29-Maharaj-Arvish
	AEES-F-32-Shangase-Mxolisi	CP-F-30-Mbuyazi-Thandi	MSCSENG-F-31-Onifade-Olayinka	LS-F-30-Mathonsi-Shilombe
	AEES-F-33-Sibanyoni-Mphoentle	CP-F-31-MedieFah-Helarie	MSCSENG-F-32-Pather-Yashlen ***(UUW)**	LS-F-32-Mdluli-Njabulo
	AEES-F-34-Sibiya-Faith ***(UUW)**	CP-F-32-Migwi-Francis	MSCSENG-F-33-Qhoboshiyane-Isibabale	LS-F-33-Mdluli-S'phosakhe
		CP-F-33-Mjwara-Pinky	MSCSENG-F-35-Rampersad-Kirthi ***(UUW)**	LS-F-34-Misra-Ashish
		CP-F-34-Mthembu-Thalente	MSCSENG-F-36-Seodi-Lehlohonolo	LS-F-35-Mlondo-Silindokuhle
		CP-F-35-Mthethwa-Tshengisile	MSCSENG-F-37-Ssengonzi-Charles	LS-F-36-Moodley-Eden
		CP-F-36-Muritala-Abubakar	MSCSENG-F-38-Subramoney-Mickalan	LS-F-37-Moshobane-Moleseng
		CP-F-37-NA-Ankit	MSCSENG-F-39-Tshibase-Slungile	LS-F-38-Msele-Kwanele
		CP-F-38-Ndlovu-Nkanyiso	MSCSENG-F-40-VanWyk-JoAnne	LS-F-39-Mudau-Ndivhuwo
		CP-F-39-Ndlovu-Fathima	MSCSENG-F-41-Zakwe-Siboniso	LS-F-40-Naicker-Diveshni
		CP-F-40-Ngcobo-Nkosinathi	MSCSENG-F-43-Zviuya-Colleen	LS-F-41-Ndou-Petunia

		CP-F-41-Ngubane-Ntombenhle		LS-F-42-Ngcongo-Bahle
		CP-F-42-Nkosi-Nonhlanhla		LS-F-43-Ngozi-Lwandile
		CP-F-43-Norton-Peter		LS-F-44-Nomnganga-Busisiwe
		CP-F-44-Nxumalo-Sifiso		LS-F-45-Nomsuka-Babalwa
		CP-F-45-Nyanda-Frank		LS-F-47-Ramasar-Reshika
		CP-F-46-Pillay-Keleish		LS-F-48-Ramdass-Sristhi
		CP-F-47-Rajkumar-Nerissa		LS-F-49-Sahadeo-Adhir
		CP-F-48-Shange-Namisa		LS-F-50-Sancho-Rebekah
		CP-F-49-Sibiya-Simphiwe		LS-F-51-Sebothoma-Surprise
		CP-F-50-Singh-Bianca		LS-F-52-Sibuta-Apiwe
		CP-F-51-Sishi-Aphiwe		LS-F-53-Singh-Savarna
		CP-F-52-Soorni-Yugendhar		LS-F-54-Thekiso-Keneilwe
		CP-F-53-Uwumubyeyi-Valentine		
		CP-F-54-Wahab-Tasmia ***(UUW)**		
		CP-F-55-Zulu-Delisile		

09:00 – 11:05 **CONCURRENT INDUSTRY SESSION** *(Ruby 2)*

09:05: **uMngeni-uThukela Water:** Ms Nelisiwe Mbatha

09:20: **First National Bank:** Ms Candace Naidoo

09:35: **Standard Bank:** Ms Vanessa Oger

09:50: **National Research Foundation:** Ms Kgaugelo Molepo

10:05: **Feenix Trust:** Ms Yanga Totyi

10:20: **KZNDoT**: Nasiphi Ntengo

10:35: **Department of Agriculture**: Votelwa Ndana

10:50: **Eskom**: Ms Thuto Manthoko

11:05 – 11:40 **Tea and viewing of industry exhibits** *(Sapphire Hall)*

11:45 – 13:00 **CONCURRENT INDUSTRY SESSION** *(Ruby 2)*

11:45: **South African Council for Natural Scientific Professions**: Mr Phuti Seanego

12:05: **Council for Scientific and Industrial Research:** Mr Justice Komane

12:25: **South African National Roads Agency SOC Limited**: Ms Rhona Erasmus

Session 7: **Agricultural Research Council**: Ms Pearl Ndalasi

13:00 – 14:00 **Lunch** *(Sapphire Hall)*

14:30 – 16:00 **Networking Session:** Tea and Coffee *(Suite 1 – 4)*

16:00 – 17:00 **Closing, Prize-Giving, and Lucky Draws** *(Sapphire Hall)*

Professor Rituparno Goswami, *College Dean of Research*

Professor Ademola Olaniran, *Dean, School of Agriculture and Science*

Professor Glen Bright, *Dean, School of Engineering*

Professor Fhatuwani Mudau, *Deputy Vice-Chancellor and Head of College*

Dr Sally Frost, *College Public Relations Manager*

**** (UUW) denotes presentations by students funded through the uMngeni-uThukela Water Chair of Water Resources Research and Innovation***

Keynote Lecture

"Detecting light at the single photon level: quantum devices and applications"

by

PROFESSOR VAL ZWILLER

Professor of Physics at the Royal Institute of Technology, Sweden, & Chief Science Officer at Single Quantum

Quantum devices can control light at the single photon level and enable novel instrumentation. Future quantum communication and sensing will require high-performance devices able to generate and detect light one photon at a time. The ability to detect single photons is crucial for quantum optics as well as for a wide number of applications. Several technologies have been developed for efficient single photon detection in the visible and near infrared. The invention of the superconducting nanowire single photon detector in 2001 enabled the development of a new class of detectors that can operate close to physical limits. Different aspects will be discussed, including wavelength detection range, time resolution, dark counts, saturation rates and photon number resolution, along with various applications such as Lidar, quantum communication, deep space communication, microscopy and bio-medical measurements.

Multipixel single photon detectors based on superconducting nanowires will also be discussed, including a quantum spectrometer based on an array of high-performance single photons. By time stamping single photon detection events at the output of a spectrometer, we generate data that can yield spectra as well as photon correlations and cross correlations among different spectral lines, under pulsed excitation, transition lifetimes can also be extracted. This instrument therefore replaces a spectrometer, a streak camera, and a Hanbury-Brown Twiss interferometer and operates with a far higher signal-to-noise ratio than is possible with existing detectors that are commonly used in the infrared.

The generation of single photons on demand, as well as pairs of entangled photons, can be realised with semiconductor quantum dots to enable the implementation of long-distance quantum communication. We operate a quantum network made of deployed optical fibres in the Stockholm area and demonstrate single photon transmission and quantum key generation over 34 km.

Guest Talk

"Inspiring u-Mngeni-uThukela Water's Research and Innovation through: Research and Innovation Chairs"

by

DR NTSAPOKAZI DEPPA

Executive: Scientific Services, uMngeni-uThukela Water (UUW)

Gala Dinner Keynote Address

"What will happen if all Classical Computers are swept from our feet today? Are you ready for Quantum Computers?"

by

Dr Happy Sithole

Centre Manager: Council for Scientific and Industrial Research, Cyberinfrastructure

There is increased demand for computational power due to success in modelling and simulation to accurately predict the physical processes. These areas emanating from medical sciences, engineering designs, climate change and the like, has pushed the need for computing power to trillions of Floating-Point Operations (FLOPs). This has also put significant strain on classical computer development due to the size of the processors and the need for cooling. The developments in computing have seen a slight transition from X-86 systems to accelerated computing architectures, which have provided significant demand for Graphical Processing Units (GPUs) in mainstream scientific computing. However, this has also demonstrated that increasing power also comes at the cost of operations with power requirements for computing, storage and cooling. Quantum computing seems to be an alternative, but the main question is, how ready are we, from the technology to build the quantum computers to their utilisation, in terms of application algorithms. This talk will take us through the advancements in Quantum Computing and the research that is still required to make it a viable solution to classical computers' limitations.

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

COLLEGE OF AGRICULTURE, ENGINEERING AND SCIENCE

CQCtec Centre for Quantum Computing & Technology

CENTRE FOR JAZZ AND POPULAR MUSIC

SCIENCE WITH JAZZ SEMINAR SERIES

"Where Science and Jazz combine"

28 OCT Tuesday 2025

16h30

Coastlands Hotel Musgrave, Suite1-3

SPEAKER:

Professor Thomas Konrad,
Director: CQCtec, UKZN

TOPIC:

The Present and Future of Quantum Technology

MUSICIANS

Linda Sikhakhane
(saxophone)

Paras Dlamini
(vocal)

SYNOPSIS: When Paul Dirac received the Nobel Prize for his contribution to Quantum Physics in 1933, he claimed when asked that the new theory would never have a technological application. Subsequently, it essentially contributed to the development of computers, lasers and electron microscopes, nuclear weapons, power plants, atomic clocks and X-rays, MRI and PET scans, among other inventions, in what is known as the first quantum revolution. What can we expect from the second quantum revolution, which is still in its infancy? This talk presents the new paradigm of Quantum Information, and its potential impact on computation, communication and sensing/imaging technologies. How do we understand it? What should we do with it at UKZN? What may we hope for in Africa? The talk is combined with music to give a holistic picture of the subject.

PROFESSOR THOMAS KONRAD holds a Master of Science from the Eberhard-Karls University in Tübingen (Germany) with a dissertation in celestial mechanics, a Master of Science of the University of London (Imperial College) in quantum field theory and a doctorate in theoretical physics from the University of Konstanz. He joined UKZN in 2006, served on the Council of the South African Institute of Physics (SAIP), on Senate of UKZN, as editor of the SAIP online journal Physics Comment from 2012 to 2017 and as editor of the New Journal of Physics (IOP) since 2023. He is a Research Professor in the School of Agriculture and Science at UKZN and Director of the UKZN Centre for Quantum Computing and Technology (CQCtec). Thomas Konrad pioneers research in quantum information processing and communication. He is an internationally recognised researcher with a NRF B-rating. Konrad promotes the interplay between science and arts.

LINDA SIKHAKHANE IS a South African Composer and Saxophonist, who began his musical journey at the Siyakhula Music Centre under the gentle guidance of the late Dr Brian Thusi. His determination led to a relentless work schedule performing live and also in the studio with Nduduzo Makhathini and the H3 horn ensemble. Emerging victorious at the SAMRO Overseas Scholarship competition, he utilized the prize money to fund his degree programme at The New School in New York. Here, he was mentored by greats such as Billy Harper, Reggie Workman, David Schnitter and Charles Tolliver. Linda Sikhakhane has worked with a broad array of artists: Sibongile Khumalo, Khaya Mahlangu, Nduduzo Makhathini, Gregory Porter, Rodney Kendrick, Rhonda Ross Kendrick, Logan Richardson, Derrick Hodge, Ted Daniel, Thandiswa Mazwai, Herbie Tsoaeli and more. His 2022 release under Ropeadope is titled Isambulo, which translates from Zulu to revelation.

PARAS *"SIBALUKHULU"* DLAMINI is an internationally acclaimed South African singer and songwriter. His discography spans a plethora of musical genres but majors in Jazz and world music. He draws inspiration from his African paradigm and his personal spiritual journey. His debut album, "Ingoma Busuku" has received widespread media coverage and critical praise. Born and raised in KwaMashu and Ulundi he discovered his musical talent through Church, where he learnt how to play the drums. His sound he calls "Ubuntu Music" (world music). He has made an appearance on several platforms including TV and radio and has toured internationally and collaborated on stage. Singing in his native isiZulu, his voice carries an authenticity and emotional resonance, with soulful melodies and rhythmic improvisations, offering a fresh, globally relevant perspective on South African jazz.

ABOUT THE SCIENCE WITH JAZZ SEMINAR SERIES:

2025 is the UNESCO year of Quantum Science and Quantum Technology. In this context the Centre for Quantum Computing and Technology at UKZN presents a series of science seminars combined with Jazz concerts, that informs about relevant concepts in science and technology and their societal impacts. This monthly series intends to inspire inter-disciplinary discussions and synergies, in particular between the sciences and the arts.

Professor Thomas Konrad, Director: Centre for Quantum Computing and Technology, UKZN

INTERNATIONAL YEAR OF Quantum Science and Technology

Refreshments will be available

ENQUIRIES: Sally Frost / frosts@ukzn.ac.za / **073 160 1409**

PROFESSOR VAL ZWILLER

Biography:

Professor Val Zwiller is a Professor of Physics at Sweden's Royal Institute of Technology (KTH), where he heads the Quantum Nano Photonics research group. His work sits at the crossroads of quantum optics and nanoscale physics, pushing the boundaries of how we control and measure light at the single-photon level.

Beyond academia, he is a scientific entrepreneur, serving as Chief Science Officer at Single Quantum a company he co-founded to develop cutting-edge single-photon detectors. His career spans leading institutions across Europe, including faculty positions at ETH Zurich, EPFL, and TU Delft, before joining KTH with a dual affiliation at the Karolinska Institute to explore quantum technologies for life sciences.

Recognized as a key figure in the quantum community, he advises major research initiatives as Sweden's deputy representative to the European Quantum Flagship. He also shapes the field as Chief Editor for Quantum Optics at *Frontiers in Photonics* and as a frequent reviewer for *Nature*, *Science*, and premier physics journals.

In the lab, his team combines nanofabrication, cryogenics, and quantum optics to build devices that harness quantum light. Their work—from fundamental discoveries to applied systems—relies on custom-built tools that probe the quantum world with unprecedented precision.

DR NTSAPOKAZI DEPPA

Biography:

Dr Ntsapokazi Deppa is the Executive: Scientific Services for uMngeni-uThukela Water (UUW) and holds a PhD in Chemistry from the University of Cape Town, focusing on research in medicinal, physical and analytical chemistry. She graduated with her MBA *cum laude* from the University of KwaZulu-Natal and began her career as a contract chemistry lecturer at the Vaal University of Technology. She proceeded to work as a chemist and later as an Analytical Manager at Tongaat Hulett for nine years. She joined UUW as the Laboratory Manager in 2016.

In her role at UUW, she provides strategic leadership in:

- Ensuring compliance with water and wastewater quality standards and regulations, which includes appropriate planning, sampling, monitoring, analysis, auditing, and treatment process rectification functions throughout the water management cycle.
- The organisation's environmental sustainability initiatives include the development and implementation of appropriate sustainability plans and ensuring that all the organisation's operations function per its environmental values.
- Research and innovation programs of the organisation that are in line with the organisation's strategic direction

PROFESSOR THOMAS KONRAD

Biography:

Professor Thomas Konrad is an internationally recognised researcher within the Physics discipline at UKZN's College of Agriculture, Engineering and Science. Prof Konrad joined UKZN in 2006, served on the Council of the South African Institute of Physics (SAIP), on the Senate of UKZN, as editor of the SAIP online journal Physics Comment from 2012 to 2017 and as editor of the New Journal of Physics (IOP) since 2023. He pioneers research in quantum information and communication. He also holds an NRF B-rating and is currently setting up the Centre for Quantum Computing and Technology.

DR HAPPY SITHOLE

Biography:

Dr Happy Sithole is the Centre Manager for the South African cyberinfrastructure (CI) system, NICIS since 2019. This involves the three main entities of the CI, CHPC, SANReN and DIRISA.

Dr Sithole spent 12 years as the Director of CHPC. He completed his PhD in materials science. He has applied high-performance computing to solve problems in mining industries and nuclear power plant designs, such as at his time at the PBMR. Sithole also sits on the steering committees of HPC meetings in Germany, Russia, Singapore and Poland. He was the Chairperson of the ICT Committee of the National Library Board and is currently a board member at the Centre for Nuclear Safety (CNSS) at the National Nuclear Regulator. Dr Sithole also chairs NITheCS.

ORAL PRESENTATIONS

AGRICULTURAL, EARTH AND ENVIRONMENTAL SCIENCES

Chair: Dr Denver Naidoo			
10:00 – 11:20	Session One		
Time	Presenter	Title	Page No.
10:00 –10:20	AEES-O-1: **Zodidi Cebiso** PhD 220112618	The effects of food environments on the consumption of ultra-processed foods and quality of diet in poor urban communities: A case of KwaZulu-Natal Province, South Africa	37
10:20 – 10:40	AEES-O-2: **Tinashe Chatara** PhD 219098910	Morpho-physiological and biochemical characterization of African spider plant (*Gynandropsis gynandra* (L.) Briq.) genotypes under drought and non-drought conditions.	37
10:40 – 11:00	AEES-O-3: **Lianda Mauyo** PhD 220107918	The factors influencing cross- border market participation decisions and intensity of participation by smallholder maize farmers in Eastern Uganda.	38
11:00 – 11:20	AEES-O-4: **Glen Mkhonta** MSc 219091736	Evaluating the Predictive Accuracy of Coupled HEC-HMS–HEC-RAS Models for Flood Simulation in the Lowest Sub-Catchment of the uMngeni River, KwaZulu-Natal, South Africa	39
11:40 – 13:00	Session Two		
11:40 – 12:00	AEES-O-5: **Sfundo Mthiyane** PhD 218030355	Modelling soil organic carbon at multiple depths in woody encroached grasslands using integrated remotely sensed data	39
12:00 – 12:20	AEES-O-6 **Kwenama Buthelezi** PhD 216073880	Effect of Long-Term (70 Years) Nitrogen Fertilization and Liming on Carbon Storage in Water-Stable Aggregates of a Semi-Arid Grassland Soil	40
12:20 – 12:40	AEES-O-7: **Thando Mthembu** PhD 216017665	Developing a Machine Learning Meta-Model Trained on AquaCrop Simulations to Predict Taro (*Colocasia esculenta* L. Schott) Yield in Southern Africa	41
12:40 – 13:00	AEES-O-8: **Lusanda Ncisana** PhD 217047385	Water Use Efficiency and Nutrient Concentration of Selected Fodder Radish (*Raphanus Sativus*) Genotypes for Sustainable Diets	42
14:00 – 15:20			
14:00 – 14:20	AEES-O-9: **Andile Phelako** MSc 216019268	A combination of Thermotherapy, Chemotherapy and Tissue culture for the Elimination of Sugarcane yellow leaf virus (SCYLV) in Sugarcane.	42
14:20 – 14:40	AEES-O-10: **Simphiwe Tseku** MSc 220028988	AVOCADO POSTHARVEST DISEASE DETECTION USING NIR SPECTROSCOPY	43
14:40 – 15:00	AEES-O-11: **Emmanuel Valentine** MSc 223152779	Effect of municipal wastewater supplementation on growth, leaf gas exchange, and chlorophyll fluorescence of *Lycopersicum solanum* in non-circulating hydroponics	44
15:00 – 15:20	AEES-O-12: **Byamungu Zabuloni** PhD 219076497	Phenotyping sorghum for maturation period, harvest index, and associated traits	44

ORAL PRESENTATIONS

CHEMISTRY AND PHYSICS

Chair: Professor Brenda Moodley			
10:00 – 11:20	Session One		
Time	Presenter	Title	Page No.
10:00 –10:20	CP-O-1: **Mary Akano** PhD 219084161	Boron nitride doped graphitic carbon nitride nanocomposites for the photocatalytic degradation of PFAS	45
10:20 – 10:40	CP-O-2: **Nontobeko Gcabashe** MSc 220012265	A RAPID, GREENER AND SUSTAINABLE SYNTHESIS OF N-ACYL HYDRAZONES OF ISONIAZID IN A DEEP EUTECTIC SOLVENT	46
10:40 – 11:00	CP-O-3: **Nthabeleng Hlapisi** PhD 221121728	BSA and DNA binding interactions studies of silver nanoparticles conjugated with an electron-donating porphyrin	46
11:00 – 11:20	CP-O-4: **Michael Hlongwane** PhD 220046398	THERMOELECTRIC PROPERTIES OF Bi_(1-x) Sb xTHIN FILMS PREPARED BY PULSED LASER DEPOSITION	47
11:40 – 13:00			
11:40 – 12:00	CP-O-5: **Aavishkar Madhunlall** MSc 220054079	Absence of Curvature Singularities in Symmetric Perfect Fluid Spacetimes in Einstein-Gauss-Bonnet Gravity	48
12:00 – 12:20	CP-O-6: **Lungisani Khubone** MSc 217079514	Molecular Hybrids of Quinoline and Indoline-2,3-dione via 1,2,3-triazole linkers: Synthesis and Antimicrobial Evaluation	49
12:20 – 12:40	CP-O-7: **Sizwe Maluleka** MSc 220006626	INTRODUCTION OF HETEROATOM VACANCIES IN BISMUTH TUNGSTATE AND GRAPHITIC CARBON NITRIDE	49
12:40 – 13:00	CP-O-8: **Kwanele Mazibuko** MSc 223036470	Development of the atmospheric monitoring system for a balloon-borne system.	50
14:00 – 15:20			
14:00 – 14:20	CP-O-09: **Sakhile Mthimkhulu** MSc 224193376	Design and Characterization of Polymer-Coated Mg-Zn Ferrite Nanoparticles: A Glycol-Thermal Approach for Biomedical Application.	51
14:20 – 14:40	CP-O-10: **Asanda Ngwenya** MSc 221009466	Synthesis and structural characterization of O^N^O-donor Zn and Mn complexes as catalysts for the production and depolymerization of PLAs	52
14:40 – 15:00	CP-O-11: **S'busiso Nkosi** PhD 223060986	SYNTHESIS AND APPLICATION OF MOLECULARLY IMPRINTED POLYMERS-SOLID PHASE EXTRACTION PROCEDURE FOR THE ANALYSIS OF SELECTED PHARMACEUTICALS IN VEGETABLE SAMPLES	53
15:00 – 15:20	CP-O-12: **Ngonidzashe Ruwhizi** PhD 222128440	Novel piano-stool pyrazolyl-functionalized Ru(II)-NHC complexes: synthesis, characterization, antibacterial and theoretical studies	53

ORAL PRESENTATIONS

ENGINEERING

Chair: Professor Kuveneshan Moodley			
10:00 – 11:20	Session One		
Time	Presenter	Title	Page No.
10:00 –10:20	ENG-O-1: **Fazeel Ahmad** PhD 225174345	Modelling and Simulation of the Control of Turbulent Flow in Pipes Using Ansys Fluent & Machine Learning Tools	55
10:20 – 10:40	ENG-O-2: **Adheesh Ganapathie** MSc 216007745	CHARACTERIZATION AND VALORIZATION OF FAECAL SLUDGE FROM THE LOOWATT SANITATION SYSTEM FOR SUSTAINABLE RESOURCE RECOVERY	56
10:40 – 11:00	ENG-O-3: **Siyabonga Gasa** PhD 212505757	ADVANCING CROP MONITORING: A SYSTEMATIC REVIEW OF SATELLITE AND UAV REMOTE SENSING, DATA FUSION, AND AI/ML TECHNIQUES	56
11:00 – 11:20	ENG-O-4: **Elijah Joseph** MSc 222037450	DESIGN AND DEVELOPMENT OF A METAMATERIAL-BASED MIMO ANTENNA FOR UWB APPLICATIONS	57
11:40 – 13:00	Session Two		
11:40 – 12:00	ENG-O-5: **Nolwazi Mncwabe** MSc 216009858	Pioneering Native Research: Optimization and Analytical Analysis of Bio-wax Extracted from Indigenous South African Plants Using Established Methods for Potential Industrial Use	58
12:00 – 12:20	ENG-O-6: **Dikeledi Monyetsware** PhD 222129258	EXTRACTION AND CHARACTERIZATION OF CHITIN BIOPOLYMER FROM MOPANE WORM (IMBRASIA BELINA)	59
12:20 – 12:40	ENG-O-7: **Elvis Mupfiga** PhD 224194915	STATUS OF INTEGRATED TOOLS FOR APPRAISING IRRIGATED AGRICULTURE: A SYSTEMATIC ANALYSIS	59
12:40 – 13:00	ENG-O-8: **Peter Mutuku** PhD 218088282	SOLAR PV ARRAY FIXED ORIENTATION ASSESSMENT USING THE OSM-MEPS MODEL	60
14:00 – 15:20	Session Three		
14:00 – 14:20	ENG-O-9: **Wamashudu Netshirungulu** MSc 216042918	MODELLING THE POST-HARVEST LOSSES OF UNDERUTILISED CROPS: A LITERATURE REVIEW	61
14:20 – 14:40	ENG-O-10: **Caleb Ramruthan** MSc 221001952	Fry Drying of Faecal Sludge for Briquette Production	61
14:40 – 15:00	ENG-O-11: **Mduduzi Thabede** MSc 219014496	CURRENT SHARING IMBALANCE IN PARALLEL HTS TAPES: THE CRITICAL ROLE OF CONTACT RESISTANCE FOR BUSBAR APPLICATIONS	62
15:00 – 15:20	ENG-O-12: **Khayelihle Zenani** PhD 224196781	Governance Fragmentation and Implementation Deficits in Duban's Sustainable Transportation Transition	62

ORAL PRESENTATIONS

LIFE SCIENCES

Chair: Professor Evariste Gueguim Kana			
10:00 – 11:20	Session One		
Time	Presenter	Title	Page No.
10:00 –10:20	LS-O-1: **S'thandiwe Magwaza** PhD 221033136	*Chaetomorpha linum* Extract Enhances Glucose Uptake, Modulates Polyol Pathway and Glucose Metabolic Enzymes in Glucotoxic Adipose Tissue *Ex Vivo*	64
10:20 – 10:40	LS-O-2: **Carol Maswanganye** MSc 223020231	Cervicovaginal Microbiota and Immune Profiles Associated with HPV Genotypes in South African Women	64
10:40 – 11:00	LS-O-3: **Nelisiwe Mgabhi** MSc 220034234	Characterisation, Yield Optimisation, and Anti-Inflammatory Potential of Vaginal Lactobacillus-Derived Extracellular Vesicles	65
11:00 – 11:20	LS-O-4: **Bonolo Moeketsi** MSc 215080419	Potential use of epinecrotic bacterial community succession for estimating post-mortem interval in decomposing pig carcasses-an experimental study	66
11:40 – 13:00	Session Two		
11:40 – 12:00	LS-O-5: **Valencia Ndlangamandla** PhD 222129381	Genome-wide Single Nucleotide Polymorphism (SNP) Discovery, Genetic Variation, and Population Structure of South African and Eswatini Cannabis sativa L. Varieties	67
12:00 – 12:20	LS-O-6: **Sphamandla Ndlovu** MSc 220031542	The Role of Histidine 382 on the Stability and Ligand Binding of the E2 Domain of Amyloid Precursor Protein	68
12:20 – 12:40	LS-O-7: **Xolile Nuse** PhD 220052695	Molecular Epidemiology and Genetic Diversity based on pCS20 Gene of Ehrlichia ruminantium in Indigenous Goats and Amblyomma hebraeum ticks	68
12:40 – 13:00	LS-O-8: **Nkanyezi Radebe** MSc 220025038	Improving the nutritional composition of bread through supplementation with edible insects	69
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ORAL ABSTRACTS

AGRICULTURAL, EARTH AND ENVIRONMENTAL SCIENCES

AEES-O-1

The effects of food environments on the consumption of ultra-processed foods and quality of diet in poor urban communities: A case of KwaZulu-Natal Province, South Africa

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The increasing consumption of ultra-processed foods (UPFs) is reshaping global dietary patterns and quality in low-income and food-insecure settings. Structural and environmental factors drive these changes and influence individual food choices. Research into food environments can offer valuable insights into these determinants and assist in developing effective nutrition interventions. In this context, the present study examined the association between food environments, UPF consumption, and diet quality in four low-income neighbourhoods of Msunduzi Local Municipality, KwaZulu-Natal, South Africa. Data were collected from 384 respondents through structured surveys incorporating elements of Public Participation Geographic Information Systems (PPGIS) and the Diet Quality Questionnaire (DQQ). The statistical analysis used a two-stage OLS regression to address potential endogeneity in ultra-processed food consumption.

The study reveals that diets primarily comprise staple carbohydrates and sugary beverages, with low dietary diversity and minimal vegetable intake. While UPFs constitute a small share of total food consumption, hunger and economic constraints shape nutritional choices, leading to the preference for energy-dense, nutrient-poor staples such as rice and maize meal porridge. Socio-economic factors such as low household income, receipt of social grants, household size, and dependence on public transportation significantly led to poorer quality diet and higher UPF intake. Additionally, greater proximity to and density of formal food outlets correlated positively with increased UPF consumption. Results show that the food environment and socio-economic status are moderate but statistically significant predictors of UPF intake. A negative association between UPF consumption and overall diet quality reflected adverse effects on nutritional status. These outcomes highlight the need for targeted interventions to enhance access to affordable, nutritious foods while addressing underlying socio-economic inequalities.

Keywords: food environments; food choices; ultra-processed foods; diet quality; two-stage OLS regression.

AEES-O-2:

Morpho-physiological and biochemical characterization of African spider plant (Gynandropsis gynandra (L.) Briq.) genotypes under drought and non-drought conditions.

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The African spider plant (*Gynandropsis gynandra* (L.) Briq.) is a nutrient-dense, climate-resilient indigenous vegetable with a C4 carbon fixation pathway. Understanding African spider plant drought tolerance mechanisms is essential for improving its performance in water-stressed areas. The objective of this study was to evaluate the stress tolerance potential of African spider plant accessions based on thirteen morphological, physiological, and biochemical traits under three different water treatment regimes. Eighteen accessions were evaluated over two growing seasons in the greenhouse using a split-split plot design with four replications and three water treatment-regimes namely optimum (100% field capacity), intermediate drought (50% field capacity) and, severe drought (30% field capacity). The results revealed that water regime had a significant effect ($P< 0.01$) on the accessions for the traits studied. A significant reduction across most of the studied traits was observed under drought conditions. However, proline content in all the accessions significantly rose under drought conditions. The principal component analysis revealed a considerable difference in the performance of the 18 African spider plant accessions under optimum and drought stress conditions. Several morphological and physiological parameters, including days to 50% flowering ($r = 0.80$), leaf length ($r = 0.72$), net photosynthesis ($r = 0.76$) and number of leaves per plant ($r = 0.79$), were positively associated with leaf yield under drought conditions. Cluster analysis categorized the 18 accessions and 13 measured parameters into 4 clusters, with cluster-1 exhibiting greater drought tolerance for most of the studied traits, and cluster-4 having the most drought-sensitive accessions. Among the accessions tested, accessions L3 and L5 demonstrated excellent drought tolerance and yield performance under both conditions. As a result, these accessions were selected as candidates for African spider plant drought tolerance breeding programs. These findings will serve as the foundation for future studies and will aid in improving food and nutrition security in the face of drought.

AEES-O-3

The factors influencing cross-border market participation decisions and intensity of participation by smallholder maize farmers in Eastern Uganda.

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Agriculture enhances development and poverty reduction among people through its provision of food and raw industrial materials. Maize represents the major food staple in the East African region and plays an important role in intra-regional trade. However, smallholder farmers, who are the main producers in East Africa, have limited access to markets thus reducing their potential to earn income from maize farming. Market barriers and inaccessibility to information prevent smallholder farmers from participating in commercial markets. Access to markets plays a crucial role in allowing the exploitation of income earning opportunities. This study sought to analyze smallholder farmers' participation in cross-border maize markets in Eastern Uganda. The study was conducted in three border districts of Eastern Uganda with a population of 281,300 households. Purposive, multistage and systematic random sampling techniques were used to select the study area and 400 smallholder maize producing households respectively. Data collected using questionnaires was analyzed using double-hurdle regression model. Findings showed that age, farm size, distance to market, group membership, gender, transport ownership, and quantity of maize harvested influenced local and cross-border market participation The age, farm size, distance to market and group membership influenced the intensity of market participation in the local markets, while credit, quantity of maize harvested, and household location influenced intensity of participation in cross-border markets. The study recommends policies that provide, improved access to rural road infrastructure, market information, strengthening farmer associations and those that

support household capacity to produce surplus production and inclusion of smallholder farmers in more profitable markets, could increase market participation.

Keywords: Market participation, maize, smallholder farmers, Uganda

AEES-O-4

Evaluating the Predictive Accuracy of Coupled HEC-HMS–HEC-RAS Models for Flood Simulation in the Lowest Sub-Catchment of the uMngeni River, KwaZulu-Natal, South Africa

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Flood forecasting is essential for disaster preparedness and risk mitigation, especially in flood-prone regions like the uMngeni River catchment in KwaZulu-Natal, South Africa. This study focuses on the lowest sub-catchment of the uMngeni catchment and compares the predictive accuracy of two modelling approaches: a standalone hydrologic simulation using HEC-HMS, and a coupled hydrologic-hydraulic simulation that integrates HEC-HMS with HEC-RAS. The objective is to determine which approach provides a more accurate representation of flood events in data-scarce environments.

Accurate flood modelling relies heavily on the availability of quality rainfall and flow-gauged data for model calibration and validation. However, the 2022 flood event in the study area is characterised by the absence of flow-gauged discharge data and official flood extent maps, presenting significant validation challenges. To overcome these limitations, flood extent maps generated through Google Earth Engine (GEE) are explored as a potential alternative for model validation.

The methodology involves simulating the 2022 flood event using both HEC-HMS alone and a combined HEC-HMS–HEC-RAS configuration. HEC-HMS is used to generate runoff hydrographs from rainfall input, which are then routed through the river system using HEC-RAS to simulate floodplain inundation. The resulting flood extents are compared against GEE-derived flood maps using spatial and statistical metrics to assess model performance.

Preliminary findings suggest that the coupled HEC-HMS and HEC-RAS approach offers improved spatial accuracy in flood extent representation compared to the standalone HEC-HMS model. The results highlight the critical role of hydraulic modelling in floodplain simulation and emphasize the value of remote sensing tools in data-limited contexts. This study contributes to enhancing flood prediction capability in the uMngeni catchment and supports the broader development of flood early warning systems in similar regions facing hydrometeorological data constraints.

AEES-O-5

Modelling soil organic carbon at multiple depths in woody encroached grasslands using integrated remotely sensed data

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Woody plants encroachment into grasslands has considerable hydrological and biogeochemical consequences to grassland soils that include altering the Soil Organic Carbon (SOC) pool. Consequently, continuous SOC stock assessment and evaluation at deeper soil depths of woody encroached grasslands is essential for informed management and monitoring of the phenomenon. Due to high litter biomass and deep root structures, woody encroached landscapes have been suggested to alter the accumulation of SOC at deeper soil layers; however, the extent at which woody plants sequester SOC within localized protected grasslands is still poorly understood. Remote sensing methods and techniques have recently been popular in SOC analysis due to better spatial and spectral data properties as well as the availability of affordable and eco-friendly data. In this regard, this study sought to quantify the accumulation of SOC at various depths (30 cm, 60 cm, and 100 cm) in a woody-encroached grassland by integrating Sentinel-1 (S1), Sentinel-2 (S2), PlanetScope (PS) satellite imagery, and topographic variables. SOC was quantified from 360 field-collected soil samples using the loss-On-Ignition (LOI) method and spatial distribution of SOC across the Bisley Nature Reserve modelled by employing the Random Forest (RF) algorithm. The study's results demonstrate that the integration of topographic variables, Synthetic Aperture Radar (SAR), and PlanetScope data effectively modelled SOC stocks at all investigated soil depths, with a high R2 values of 0.79 and RMSE of 0.254 t/ha. Interestingly, SOC stocks were higher at 30 cm compared to 60 cm and 100 cm depths. The horizontal reception (VH), Slope, Topographic Weightiness Index (TWI), Band 11 and vertical reception (VV) were optimal predictors of SOC in woody encroached landscapes. These results highlight the significance of integrating RF model with spectral data and topographic variables for accurate SOC modelling in woody encroached ecosystems. The findings of this study are pivotal for developing a cost-effective and labour-efficient assessment and monitoring system for the appropriate management of SOC in woody encroached habitats.

Keywords. Grassland, Soil Organic Carbon, Woody Encroachment, Remote sensing

AEES-O-6

EFFECT OF LONG-TERM (70 YEARS) NITROGEN FERTILIZATION AND LIMING ON CARBON STORAGE IN WATER-STABLE AGGREGATES OF A SEMI-ARID GRASSLAND SOIL

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Grasslands cover up to 40.5% of the world's landmass and store 30% terrestrial carbon (C). Various practices, including mineral fertilization and liming, are used to manage these ecosystems with potential long-term effects on the size and distribution of soil aggregates and inevitably carbon dynamics. The objective of this study was to examine the long-term effects of nitrogen fertilization and liming on soil carbon storage and its dynamics in water-stable aggregates of a semi-arid grassland. Soil samples (0–10 cm) were collected from Ukulinga long-term grassland trial in Pietermaritzburg, South Africa where nitrogen fertilizers have been applied annually and lime every five years for 70 years. Ten treatments were studied: the control (0 kgN/ha and unlimited), lime at 2250 kg/ha (L), ammonium sulphate at 70 kg/ha (AS70) and 211 kg/ha (AS211); ammonium nitrate at 70 kg/ha (AN70) and 211 kg/ha (AN211); AS70 + lime (AS70L); AS211 + lime (AS211L); AN70 + lime (AN70L) and AN211 + lime (AN211L).

Nitrogen fertilizers significantly reduced soil pH and increased total soil N. Liming increased soil pH with no effect on total soil N. Lime and lime + N fertilizer treatments had no effect on mean weight diameter (MWD) while separate N application decreased MWD and large macro-aggregates (LMA). Lime only treatment had no effect on water stable aggregate (WSA) fractions. Nitrogen fertilization and liming (separately or in

combination) did not affect total C concentration and stocks. Overall, soils had very high total soil organic carbon ranging from 49.7 – 57.6 g/kg across treatments. Nitrogen fertilization decreased organic carbon in LMA in AS70 (1.52%) and AN211 (1.67%) treatments compared to the control (3.40%) which was in concert with increases in C associated with small macro-aggregates (SMA) and micro-aggregates (MiA and SCA). Organic carbon in SMA was 2.67 % (AS70); AS211 (2.62 %); AN70 (2.02 %); AN211 (2.49 %) compared to 1.26 % in the control. Lime + N fertilizer treatments increased C storage in all aggregate fractions compared to N fertilizer only treatments. The lack of response in total SOC to 70 years of N fertilization and liming suggests possible C saturation given the high soil C concentration. Changes in C associated with WSA fractions suggest their importance as diagnostic indicators of N fertilization and liming induced changes in SOC. Findings also show that ammonium-based N fertilization is associated with soil acidification, dispersion of LMA resulting in an increase of microaggregates and C stored in them. Liming can counteract acidifying and the dispersive effect on NH4+ associated with ammonium-based fertilizers thus restoring macro-aggregation in N fertilized grasslands. These findings suggest that long-term N addition may result in poor soil physical condition and possible stabilization of C in stable fractions.

Keywords: Carbon storage, Mean weight diameter, Soil aggregates, Ammonium sulphate, Ammonium nitrate

AEES-O-7

Developing a Machine Learning Meta-Model Trained on AquaCrop Simulations to Predict Taro (Colocasia esculenta L. Schott) Yield in Southern Africa

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Neglected and underutilised crops (NUCs) offer potential to diversify agricultural systems and strengthen food and nutrition security in climate-vulnerable regions. Among these, taro (*Colocasia esculenta* L. Schott) has demonstrated resilience to drought and heat stress, making it well-suited to predominantly rainfed smallholder farming systems. However, its commercialisation has been constrained by limited agronomic data describing its yield and the lack of spatially explicit yield prediction tools. This study addressed these gaps by integrating process-based crop simulation with machine learning (ML) meta-modelling. The AquaCrop model was used to simulate taro yield and crop water productivity (CWP) across southern Africa (South Africa, Eswatini, and Lesotho), incorporating a frost risk module to improve accuracy in high-altitude, frost-prone regions. Using 49 years of simulations across 5 838 altitude zones, the study identified frost impacts, optimal planting dates, and spatial patterns of yield and CWP. Taro's iron content and simulated CWP were further used to estimate its nutritional water productivity, highlighting its potential to alleviate micronutrient deficiencies such as anaemia. ML meta-models (Random Forest and Gradient Boosting) were then trained on AquaCrop-simulated yield using climate, soil, altitude, and vegetation indices as inputs. The meta-models achieved high predictive accuracy ($R^2 > 0.80$) while reducing data and computational requirements, enabling fast, interpretable, and scalable yield predictions suitable for smallholder farming contexts. This study illustrated how ML meta-modelling of AquaCrop simulations can bridge advanced crop modelling and practical decision support, facilitating climate adaptation, guiding land-use planning, and promoting the adoption of nutrient-dense, climate-resilient NUS such as taro in southern Africa.

Keywords: AquaCrop; climate-resilient agriculture; machine learning; underutilised crops; yield

AEES-O-8

Water Use Efficiency and Nutrient Concentration of Selected Fodder Radish *(Raphanus Sativus)* Genotypes for Sustainable Diets

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As climate challenges increase rapidly, dryland production threatens crop yield, including feed and fodder. Radish is one of the major fodder crops in the world due to its high nutrient content. The study's objective is to determine the response of two radish cultivars to water availability during growth over two seasons (2021/2022 and 2022/2023). Employed a factorial design, incorporating three water regimes (W1 = well-watered; W2 = moderate water stress; W3 = severe water stress) with two fodder radish genotypes (Line 2 and Endurance), and two leaf harvesting options (with and without harvesting). Water use efficiency (WUE) showed no significant interactions among water regime, genotype, and season ($p < 0.05$). W2 exhibited higher WUE, with greater means in 2021/22 than in 2022/23. In W3, Line 2's total biomass decreased by approximately 60.09% and 71.06% in 2021/22 and 2022/23, respectively, while Endurance saw reductions of 63.9% and 53.33% in those seasons. Tuber yield was high under W1 and W2. Endurance yielded 59 tons/ha for W1 in both seasons, 48 tons/ha in 2021/22 and 20 tons/ha in 2022/23 for W2, and 22 tons/ha and 8 tons/ha for W3, respectively. Water stress reduced the nutritional yield (NY) of iron, zinc, β-carotene, and vitamin C in both genotypes, yet W2 yielded more crude protein (CP) and vitamin E. Under W2, vitamin A needs are met for women and infants aged 1 to 3 years, while under W3, both genotypes exceed recommended intake levels for vitamins C and E, iron, and zinc across all age groups. Both genotypes displayed similar biomass under W2 and W1, suggesting that exceeding 245 mm of irrigation per season is unnecessary, given the equivalent output of 366 mm. WUE was higher under W2, showing their ability to achieve good yields with limited water.

Keywords: water use, drought, food security, fodder security, human nutrition

AEES-O-9

Elimination of Sugarcane yellow leaf virus (SCYLV) in Sugarcane.

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Sugarcane (*Saccharum officinarum L.*) is a major crop in tropical and sub-tropical regions and a key source of global sugar production. However, its productivity is threatened by various pathogens, notably sugarcane yellow leaf virus (SCYLV), a member of the *Polerovirus* genus, which can cause a yield loss of up to 40% in susceptible cultivars. In South Africa, SCYLV has been detected in several genotypes, including N60, even after meristem tip-culture, highlighting the need for improved virus elimination strategies. This study evaluated the effectiveness of tissue-culture based methods, combining thermotherapy and chemotherapy.

Single budded setts, of cultivar N60, were subjected to hot water treatment at 50°C for 10 minutes, followed by disinfection with 1% calcium hypochlorite and a 0.5ml/L Aria fungicide solution (carbendazim 125g/L and

difenoconazole 62.5g/L), buds were incubated at 35-45°C Selected treatments incorporated salicylic acid (SA) (0.1-0.9mM), enhancing antiviral defence and heat tolerance. Additionally, hydrogen peroxide (0.5-1.5%) soak for 6 and 12 hrs was tested to stimulate host antiviral responses. Bud germination was rated on a scale from 1 (senescent) to 4 (excisable shoot) over a three-week period. Meristems from highly viable buds (rating 3 and 4) were cultured using the standard tissue culture protocol. Tissue blot immunoassay (TBIA) was used to assess viral titre at each node. Results showed optimal germination at 35°C (71%), with reduced viability at higher temperatures. Incorporation of 0.5-1mM SA improved germination, as did hydrogen peroxide treatments at 0.5-1%. TBIA results indicated that viral titre decreased towards the lower stalk nodes, suggesting a gradient of infection. The most promising treatment combination included 0.5-0.9mM SA in hot water treatment, a 6 hour soak in hydrogen peroxide (0.5-1.5%), a 10-min fungicide treatment and incubation at 40°C. Final evaluation of SCYLV elimination efficacy in regenerated plants will be conducted using quantitative real time PCR (RT-qPCR), with conclusions drawn by comparing pre- and post-treatment viral titres.

Keywords: Sugarcane yellow leaf virus, TBIA, chemotherapy, thermotherapy, RT-qPCR.

AEES-O-10

AVOCADO POSTHARVEST DISEASE DETECTION USING NIR SPECTROSCOPY

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Avocado consumption is increasing worldwide. This is primarily driven by its health benefits and consumer preference. A fast, non-destructive, in-line grading system capable of assessing individual avocado fruit for internal quality attributes would greatly benefit the avocado industry. This will provide a more consistent fruit quality to the consumer, optimise market distribution, and ensure maximum yield for the producer and retailer. A portable Innospectra NIR-SG-1 unit was investigated to detect the class 'healthy' against the two important avocado postharvest diseases, Anthracnose and Stem-End Rot, in both 'nearly ripe' and 'ripe' stages. The data was pre-processed using Savitzky-Golay smoothing, and principal components were generated to reduce data dimensionality. The accuracy of a random forest classification model on the test samples was 82% and 91% for the exocarp and mesocarp spectra, respectively. The mean 5-fold cross-validation scores were 76% and 89% for exocarp and mesocarp samples, respectively. The confusion matrix for the exocarp spectra showed that a few samples belonging to the stem-end rot class were misclassified as healthy during the testing phase. The mesocarp spectra confusion matrix shows that most of the misclassifications were between Anthracnose and Stem-end rot. These results suggest that the scans taken through the skin lack specificity, and this could be explained better by the fact that light penetration could not reach the bruised flesh inside the fruit while disease progression is still low.

The misclassification between anthracnose and stem end rot when the spectra were collected directly into the mesocarp could be because the same pathogen can cause both diseases, and since during data collection, pink masses were indeed found on the pedicel end of the stem-end rot, confirming the presence of *Colletotrichum gloeosporioides* on the infection site. However, the high recall score suggests that these two pathogens produce distinguishing compounds. Overall, the performance of the random forest classification model for the three classes: Healthy, Anthracnose, and Stem-End Rot, was satisfying, and it suggests that more in-depth studies should be conducted to distinguish characteristics of the pathogens on avocado fruits so that the model accuracy can be improved.

Keywords: Avocado, Random Forest, Healthy, Anthracnose, Stem-end rot.

AEES-O-11

Effect of municipal wastewater supplementation on growth, leaf gas exchange, and chlorophyll fluorescence of *Lycopersicum solanum* in non-circulating hydroponics

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Hydroponic systems have been proposed as an efficient technique for integrating crop production and wastewater management. Most hydroponic systems are complex, requiring electricity and pumping systems, with less focus on passive systems of growing crops. This study investigated crop response to varied loading rates of inorganic hydroponic fertiliser in anaerobic filter effluent sourced from the decentralised wastewater treatment system (DEWATS). The study was conducted in a glasshouse using a non-circulating hydroponic system design called "Kratky". Two-week-old tomato seedlings (*Lycopersicum solanum L. cv.* Star 9001) were transplanted into the Kratky setup. Treatments include anaerobic filter effluent (AF), AF + 50 % of recommended commercial hydroponic fertiliser mix ($CHFM_{50}$), AF + 75 % ($CHFM_{75}$), and 100 % ($CHFM_{100}$), respectively. The control treatment was tap water + commercial hydroponic fertiliser mix ($CHFM_T$). The experiment was laid out in a completely randomised design (CRD). Growth parameters, leaf gas exchange, and chlorophyll fluorescence were measured biweekly from two weeks after transplanting (WAT). Results showed a significant difference ($P < 0.05$) for all growth parameters, including most leaf gas exchange and chlorophyll fluorescence traits. The $CHFM_{50}$ and $CHFM_T$ recorded comparable results and had marginal differences despite the variation in nutrient concentration. The $CHFM_{75}$ and $CHFM_{100}$ recorded a relatively lower performance compared to AF treatment due to unfavourable pH, electrical conductivity (EC), and luxury consumption. This study demonstrated that moderate supplementation of wastewater in non-circulating hydroponic systems can significantly improve crop growth and physiological performance. This approach can provide a cost-effective means of crop production by reducing the demand for inorganic fertiliser and freshwater usage while contributing to the safe reuse of wastewater.

AEES-O-12

Phenotyping sorghum for maturation period, harvest index, and associated traits

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Sorghum is a climate-resilient crop and a key food, feed, and industrial raw material source. Dwindling yields associated with recurrent drought and short rain seasons necessitate the development of early-maturing and high-harvest index sorghum varieties for sustainable production and livelihoods. This study aimed at phenotyping sorghum for maturity period and harvest index and associated traits to guide production and select complementary parents for breeding population development with desirable product profiles. One hundred and six genetically diverse sorghum genotypes were evaluated during the 2023/24 and 2024/25 growing seasons using a 10 x 11 alpha lattice design. Significant ($p< 0.001$) genotype-by-season interaction and genotype effects were detected for days to 50% anthesis (DTA), grain filling period (GFP), days to 75% maturity (DTM), plant height (PH), above-ground biomass (AGB), number of productive tillers (NPT), grain yield (GY), and

harvest index (HI). The study selected early maturing genotypes such as AS232, AS603, ACCI-S-108, and ACCI-S-118, with 133.2, 136, 136.75, and 137.5 days, respectively. Relatively higher harvest indices were recorded for genotypes AS232, AS352, AS229, and AS619, with mean values of 41.74%, 41.04%, 40.54%, and 38.98%, in that order. Two principal components were identified, explaining the genetic variations of the test genotypes for the maturity period and harvest index component traits. The assessed sorghum genotypes were resolved into three maturity groups: early (16% of the test genotypes, 133 to 142 DTM), intermediate (69%, 143 to 161 DTM), and late (15%, 161 to 183 DTM). Three HI groups were discerned, including high HI (16.98% of the evaluated genotypes with HI 35.63 to 41.74%), intermediate HI (64.15% with 22.27 to 35.16%), and low HI (18.87% with 14.47 to 21.16%). The days to maturity had significant (p<0.001) positive correlations with DTA (r = 0.75), AGB (r = 0.37), and a negative association with HI (r = -0.47). Further, HI exhibited a significant (p<0.001) negative relationship with DTA (r = -0.39) and AGB (r = -0.43). The selected early maturing and high HI genotypes are recommended for grain production and breeding, aiming at low-moisture agro-ecologies.

Keywords: Dry-land agro-ecologies, genetic resources, harvest index, maturity period, sorghum.

ORAL ABSTRACTS

CHEMISTRY AND PHYSICS

CP-O-1

Boron nitride doped graphitic carbon nitride nanocomposites for the photocatalytic degradation of PFAS

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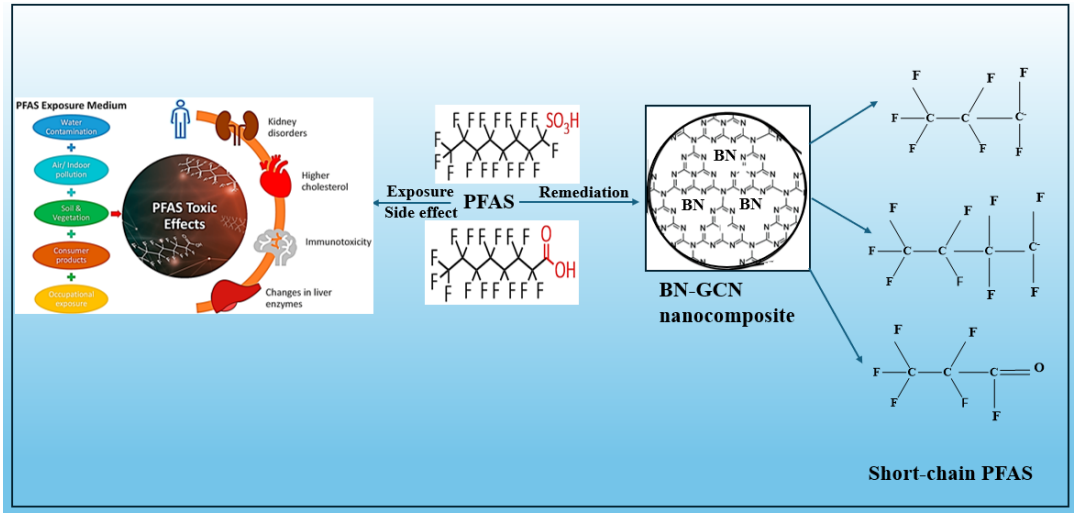
Using non-metal-based semiconductors as photocatalysts for the remediation of environmental pollutants and addressing energy challenges holds plausible advantages owing to low toxicity, high stability, and cost-effectiveness. 2D semiconductor boron nitride (BN) was functionalized with polymeric graphitic carbon nitride (GCN) at different ratios to form BN-GCN nanocomposites. The as-synthesized materials were characterized by UV-Vis- DRS, FT-IR, PXRD, TEM, SEM, BET surface area, CV, and EIS, and used for the photocatalytic degradation of both PFOA and PFOS in aqueous matrices. The hybrid nanocomposites possess an improved surface area, lower band gaps, and low charge transfer resistance, with the BN-GCN (1:3) composite ratio having the highest degradation efficiency due to its highest surface area and lowest charge transfer resistance. The photocatalytic degradation efficiency increases from 81% to 90% for PFOA and 85% to 100% for PFOS as the photocatalyst dosage increases from 30 mg to 50 mg, with a decrease to 87% for PFOA and 97% for PFOS as the dosage increases to 60 mg. The optimum degradation efficiency was achieved at pH 2. Scavenger test shows that holes and superoxide play a significant role in the photocatalytic degradation. In the reusability test, the photocatalyst retains its activity up to 3 application cycles. The phytotoxicity test using *Lactuca Sativa* (lettuce seed) shows the germination of the lettuce seed and elongation of the root in treated water after photocatalytic degradation, which was inhibited before the photocatalytic degradation. Hence, BN-GCN nanocomposites may be used as potential low-cost photocatalysts for the sustainable remediation of micropollutants in wastewater.

Graphical Abstract



CP-O-2

A RAPID, GREENER AND SUSTAINABLE SYNTHESIS OF N-ACYL HYDRAZONES OF ISONIAZID IN A DEEP EUTECTIC SOLVENT

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Developing efficient, green, and environmentally benign methodologies for the synthesis of broadly applicable chemical scaffolds remains a key challenge in synthetic chemistry. Conventional processes often rely on toxic catalysts and hazardous solvents, posing significant environmental and health risks, particularly in the chemical and pharmaceutical industries. In this study, a sustainable and eco-friendly method was developed for the synthesis of N-acyl hydrazone analogues via the condensation of isoniazid with various substituted benzaldehydes. A deep eutectic solvent ($ZnCl_2$/urea) was employed, serving a dual role as both solvent and catalyst. This methodology enabled the synthesis of target compounds within 2–6 minutes, eliminating the need for extensive purification procedures. The protocol is operationally simple and offers several advantages, including short reaction times, good to excellent yields, scalability, and catalyst recyclability and reusability. Green chemistry metrics further confirmed the environmental compatibility of this method. Moreover, Density Functional Theory (DFT) calculations were used to predict the Frontier Molecular Orbitals (FMOs) and global reactivity parameters of the synthesised compounds, providing insights into their electronic properties.

CP-O-3

BSA and DNA binding interactions studies of silver nanoparticles conjugated with an electron-donating porphyrin

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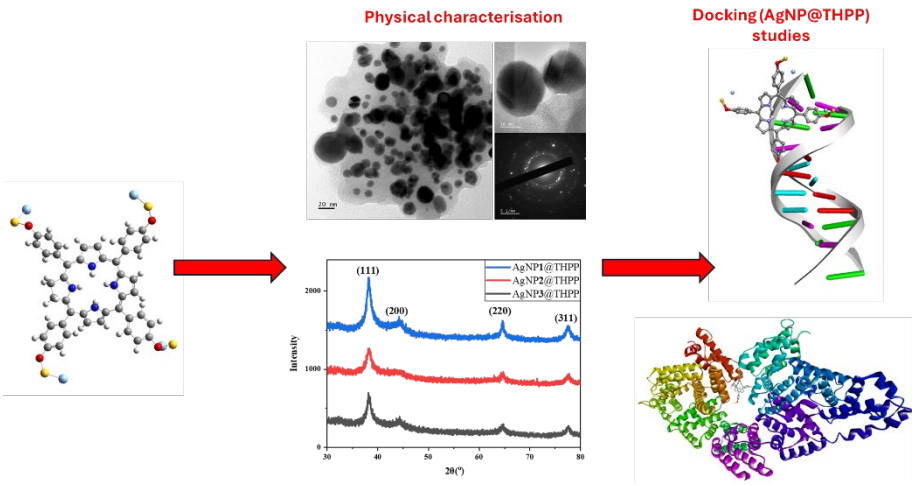
An electron-donating porphyrin, 5,10,15,20-tetrakis(4-hydroxyphenyl)porphyrin (THPP), was successfully conjugated with pure-phase silver nanoparticles (AgNPs), which were synthesised via a green route using *Euphorbia clavarioides* Boiss plant extract [1]. Transmission Electron Microscopy (TEM) revealed spherical silver nanoparticles, with an increase in mean particle size with an increase in precursor concentrations. X-ray diffraction (XRD) patterns confirmed the face-centred cubic crystalline structure of silver in both the pristine nanoparticles and the porphyrin nanoconjugates. AgNP**3**@THPP exhibited potent antioxidant activity, with a DPPH IC_{50} value of 1.410 ± 0.27 µg/mL. Notably, increasing precursor concentrations enhanced the intrinsic binding constants (*Kb*) and Stern–Volmer quenching constants (*Ksv*), indicating strong binding affinity toward bovine serum albumin (BSA) [2]. Fluorescence quenching studies suggested a static quenching mechanism involving a single binding site. Furthermore, UV-Vis spectroscopic titrations revealed evidence of intercalative binding between the nanoconjugates and calf thymus DNA (ct-DNA) [3]. These findings underscore the dual potential of THPP-functionalized AgNPs as stable, bioactive platforms for biomolecular interaction and oxidative stress mitigation. Collectively, this study supports the therapeutic relevance of these nanoconjugates, particularly as promising candidates for photodynamic therapy and related biomedical applications



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CP-O-4

THERMOELECTRIC PROPERTIES OF $Bi_{1-x}Sb_x$ THIN FILMS PREPARED BY PULSED LASER DEPOSITION

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In this study, thin films of bismuth-antimony ($Bi_{1-x}Sb_x$, $0.07 \leq x \leq 0.22$) alloys obtained through pulsed laser deposition (PLD) are of great interest for their tunable band structure and thermoelectric performance near the semimetal-semiconductor transition. $Bi_{1-x}Sb_x$ films will be grown on SiO_2/Si substrates. Achieving

high crystalline quality in thin films is essential, as it directly impacts charge carrier mobility, phase purity, and overall thermoelectric efficiency. PLD offers a route to producing such high-quality crystalline films, but Sb volatility can lead to nonstoichiometric transfer, complicating composition control and property mapping. To address this, we will calibrate PLD parameters (laser fluence, substrate temperature, and background pressure) against reference targets. Structure, phase purity and lattice parameters will be confirmed by X-ray diffraction (XRD), and morphology and grain structure examined by transmission electron microscopy (TEM). Stoichiometry of $Bi_{1-x}Sb_x$ will be validated through energy dispersive X-ray spectroscopy (EDS). Transmittance, reflectance, absorption and optical band gap will be confirmed through UV-VIS spectra, while electrical resistivity and carrier mobility will be measured through four-point probing. The Seebeck coefficient will be obtained using a custom thin film measurement stage. We aim to identify the growth conditions that maximize the thermoelectric power factor ($S^2\sigma$) in $Bi_{1-x}Sb_x$ films.

Keywords: Elements (Bi and Sb), pulsed laser deposition (PLD), Seebeck coefficient (S), Electrical Conductivity (σ), Elemental analysis (EDS)

CP-O-5

Absence of Curvature Singularities in Symmetric Perfect Fluid Spacetimes in Einstein-Gauss-Bonnet Gravity

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We investigate higher-dimensional homogeneous and isotropic perfect fluid spacetimes within the framework of Einstein–Gauss–Bonnet (EGB) gravity. By solving the modified field equations, which include higher-order curvature corrections, we derive evolution equations for the scale factor and show that it admits a strictly positive minimum value. This lower bound depends on the spacetime dimension N, the coupling parameter α, and the chosen equation of state. Crucially, this behaviour eliminates the possibility of curvature singularities that occur when the scale factor vanishes, such as those found in Big Bang or Big Crunch scenarios.

We demonstrate that this regular behaviour is universal across all physically reasonable perfect fluid equations of state, both linear (e.g., radiation or dust-like matter) and nonlinear (e.g., generalised Chaplygin gas). This suggests that singularity theorems can be bypassed in EGB gravity without violating energy conditions. Furthermore, the appearance of a bounce in the collapsing region implies the potential formation of regular black holes, preventing the central singularity via higher-dimensional geometric effects.

In our analysis, we identify N=9 as a critical dimension, where the minimum scale factor reaches its peak for fixed α, indicating maximum repulsive effect from Gauss–Bonnet corrections. Numerical analysis and plots support this claim, emphasising the influence of dimensionality on the avoidance of singularities. These findings underscore EGB gravity as a viable model for constructing non-singular cosmologies and regular gravitational collapse scenarios.

Keywords: FLRW spacetimes, Einstein–Gauss–Bonnet gravity, curvature singularities, bouncing cosmologies, higher dimensions

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CP-O-6

Molecular Hybrids of Quinoline and Indoline-2,3-dione via 1,2,3-triazole linkers: Synthesis and Antimicrobial Evaluation

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The emergence and rapid spread of antimicrobial resistance among pathogenic microorganisms pose a significant global health challenge. Various bacterial strains have developed resistance to many conventional antibiotics, reducing the effectiveness of available treatments. Similarly, opportunistic fungal pathogens have shown increasing resistance to antifungal agents, complicating the management of fungal infections, particularly in immunocompromised patients. To address this crisis, molecular hybridization is used as an effective tool to combat such challenges. In this study, we rationally designed and synthesized a series of novel quinoline–triazole–isatin molecular hybrids **(8a-j)** via molecular hybridization aiming to combine the anti-microbial potential of three pharmacophores into a single molecular framework. The structures of the synthesized hybrids were confirmed by techniques such as nuclear magnetic resonance spectroscopy, mass spectrometry, and infrared spectroscopy.

The antibacterial activity of the synthesized compounds (**8a-j**) was evaluated against *E. coli*, *P. aeruginosa*, *S. aureus*, and *B. subtilis*), while antifungal activity was tested against *A. niger* and *F. oxysporum*. Of the tested compounds, compound **8c** exhibited the most potent antibacterial activity across all bacterial strains, showing particularly strong inhibition against *E. coli* (MIC = 125 µg/mL) and *P. aeruginosa* (MIC = 125 µg/mL). Compound **8e** was the most effective against *S. aureus* (MIC = 62.5 µg/mL), and compound **8f** showed the highest activity against *B. subtilis*. In antifungal assays, compound **8b** demonstrated the highest potency against *A. niger*, with a zone of inhibition measuring 18.87 ± 0.80 mm, and copounds **8h** showing the highest potency against *F. oxysporum* with a zone of inhibition of 26.32±0.38 mm.

This study demonstrates that molecular hybridization, can be an effective strategy for developing new antimicrobial agents. The notable biological activity of these hybrids underscores their potential in combating bacterial resistance and fungal infections, with future structural modifications likely to further enhance their efficacy.

CP-O-7

INTRODUCTION OF HETEROATOM VACANCIES IN BISMUTH TUNGSTATE AND GRAPHITIC CARBON NITRIDE

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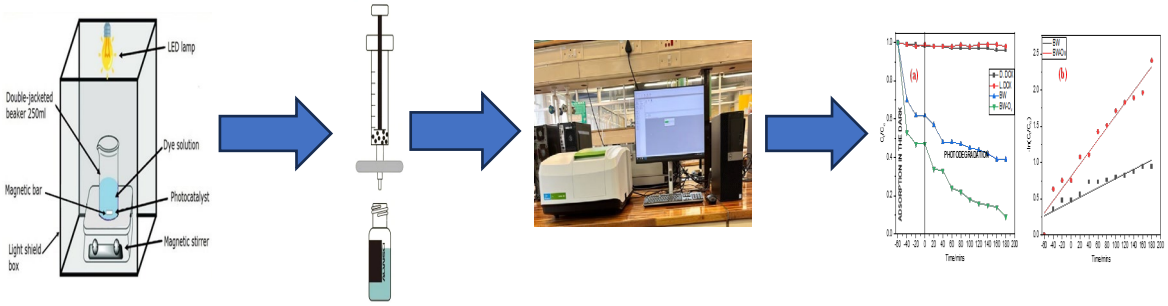
The continuous presence of antibiotics like doxycycline hyclate (DOX) in aquatic habitats poses significant ecological hazards and health risks. Antibiotics have been detected in habitats such as fresh water and soil in concentrations as low as ng L^{-1} using advanced instruments such as HPLC equipped with different detectors. The current challenge is that the existing technology cannot efficiently eliminate these antibiotics in our wastewater treatment plants (WWTPs). Photocatalysis, an advanced oxidation process, has shown promising results as a wastewater treatment technology that employs semiconductor materials. Bismuth tungstate (BW) is a semiconductor material that has gained tremendous attention in photocatalysis due to its intrinsic properties, such as visible light adsorption, thermal and chemical stability, and a suitable band gap. However, a smaller specific surface area and low efficiency of photogenerated electron-hole pair separation hinder the full potential of the BW application as a photocatalyst for pharmaceutical degradation. Introducing oxygen vacancies appears to be the most effective strategy for overcoming the drawbacks of BW. The BW-Ov was synthesised using the alkaline etching method. DOX, as a typical antibiotic pharmaceutical pollutant, was used to evaluate the photocatalytic activity of BW-Ov, as shown in Scheme 1. The BW-Ov had good photocatalytic activity under visible light irradiation. The results showed that introducing vacancies in the structure of BW does not change the chemical structure of BW. When the visible light irradiation lasted for 180 minutes, the degradation rate of DOX reached 91%, displaying a higher degradation rate compared to BW. The pH and point of zero charge (PZC) values play a vital role in the adsorption and photodegradation results. The PZC values for BW-Ov and BW were 4.98 and 5.50, respectively. The BW-Ov showed maximum adsorption and photodegradation in a basic medium, with the highest DOX degradation occurring at pH 7.5 within 180 minutes of irradiation with light. Introducing oxygen vacancies enhanced the efficiency of photogenerated electron-hole pair separation, suggesting and showing great potential for future photodegradation of DOX and other antibiotics in the aquatic bodies.



Scheme 1: Photocatalytic degradation of DOX by BW-Ov

Keywords: Bismuth tungstate, Photocatalysis, Doxycycline hyclate, Oxygen vacancies, Point of zero charge.

CP-O-8

Development of the atmospheric monitoring system for a balloon-borne system.

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Atmospheric monitoring systems are crucial for tracking weather conditions and assessing air quality, which is important not only for climate research but also for public health. While ground-based monitoring systems provide valuable localised data, they have a limitation in collecting atmospheric data at higher altitudes of the atmosphere, and they are expensive. Balloon-borne systems offer a solution to this gap, enabling atmospheric data collection at high altitudes. This is essential for understanding global climate patterns, air quality, and upper atmospheric phenomena.

The proposed atmospheric monitoring system for a balloon-borne system aims to overcome the limitations of the ground-based system (Automatic Weather Stations) by providing a cost-effective method to collect atmospheric data at different vertical levels.

Over the atmospheric conditions, the system is designed to monitor the position and velocity of unmanned vehicles such as rockets, drones, or weather balloons in the atmosphere.

The components used are not on military standard, including sensors, the GPS (Global Positioning System) for tracking the system's position in the atmosphere, and a radio transmitter for real-time data transmission. The collected data is transmitted to the nearest ground station, which through the GSM (Global System for Mobile) can transmit the data globally.

To comply with safety regulations, the payload weight must not be above 2kg. The system is built to withstand harsh environmental conditions during the balloon's flight, including rapid changes in temperature, pressure, and humidity.

CP-O-9

Design and Characterization of Polymer-Coated Mg-Zn Ferrite Nanoparticles: A Glycol-Thermal Approach for Biomedical Application.

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This study aimed to develop and evaluate magnesium-zinc ferrite nanoparticles of $MgFe_2O_4$, $Mg_{0.5}Zn_{0.5}Fe_2O_4$, and $ZnFe_2O_4$ for potential use in drug delivery and cancer treatment. To achieve this, nanoparticles were synthesized using a glycol-thermal method and coated with a biocompatible polymer chitosan (CH), which enhances nanoparticles' stability and reduces toxicity or cytotoxicity. The properties of compounds were characterized using various techniques such as X-ray Diffraction (XRD) and Fourier Transform Infrared Spectroscopy (FTIR) for structural analysis. Transmission and Scanning Electron Microscopy (TEM, SEM) for morphology. Dynamic Light Scattering (DLS) for hydrodynamic size, Mössbauer Spectroscopy (MS), and Vibrating Sample Magnetometry (VSM) for magnetic properties. XRD confirmed a cubic single-phase structure in all samples. The crystallite size was observed to increase from 13 nm to 15 nm after polymer coating and reduction to the lattice parameter, indicating structural compaction. FTIR supported these findings. Furthermore, TEM and SEM revealed spherical nanoparticles with improved uniformity and reduced agglomeration after coating. The hydrodynamic sizes of 2.3 µm (uncoated) and 2.7 µm (coated), which are promising for drug delivery. Magnetic analysis showed that $MgFe_2O_4$ and $Mg_{0.5}Zn_{0.5}Fe_2O_4$ led to ferrimagnetic behaviour, while $ZnFe_2O_4$ resulted in paramagnetism. VSM confirmed superparamagnetic properties in all samples. The highest magnetic performance was observed for $Mg_{0.5}Zn_{0.5}Fe_2O_4$, with a saturation magnetization of 68.49 emu/g. Cytotoxicity tests on CaCo-2, MDA-MB-231, and HEK-293 cell lines revealed that uncoated $ZnFe_2O_4$ was highly toxic to cancer cells, while the biocompatible polymer coating significantly improved biocompatibility and raised cell viability. These results revealed that chitosan-coated Mg-Zn ferrite

nanoparticles demonstrated excellent structural, magnetic, and biocompatible properties, making them strong candidates for drug delivery and anticancer applications.

CP-O-10

Synthesis and structural characterization of O^N^O-donor Zn and Mn complexes as catalysts for the production and depolymerization of PLAs

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Mass production of synthetic plastics remains one of the largest contributors to environmental pollution. Particularly, the prevalence of single-use plastics (SUPs) continues to undermine recycling efforts employed to combat their ubiquity.[1] Approximately 76% of these conventional, petroleum-based plastics end up in landfills or discharged into the natural environment[2] This has prompted research devoted to the production of bio-based and biodegradable polymers, derived from renewable resources. Polylactides (PLAs) have emerged as promising ecofriendly substitutes to fossil-based plastics, owing to their biodegradability, bio-compatibility and renewability[3] Herein, we report the syntheses of mononuclear and multinuclear Zn(II) and Mn(II) complexes supported by imino-phenol Schiff base ligands. Structural characterization of the complexes using spectroscopic techniques, elemental analyses and single crystal X-ray crystallography revealed complexes with diverse coordination modes. All complexes proved to be highly effective as multi-purpose catalysts in the ring-opening polymerization of *rac*-lactide to produce PLA and the degradation of PLA to the green alkyl lactate solvent (**Fig. 1**).

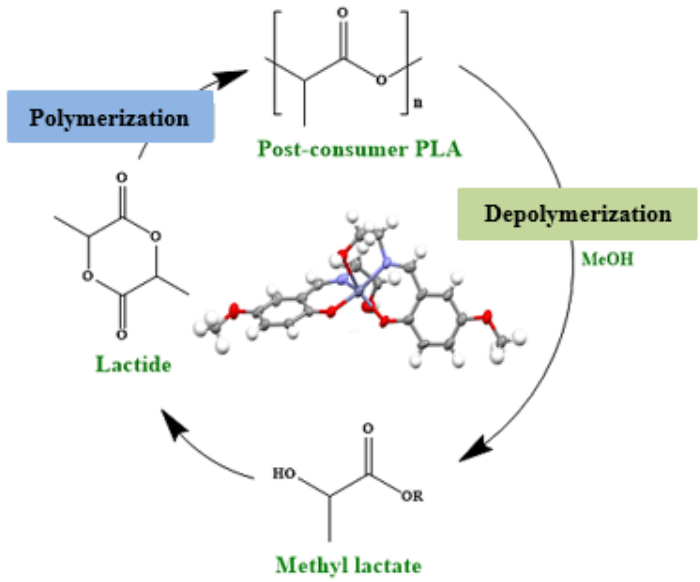

Fig. 1: Zn/Mn catalyzed production and and depolymerization of poly(lactides).

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CP-O-11

SYNTHESIS AND APPLICATION OF MOLECULARLY IMPRINTED POLYMERS-SOLID PHASE EXTRACTION PROCEDURE FOR THE ANALYSIS OF SELECTED PHARMACEUTICALS IN VEGETABLE SAMPLES

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The scope of this study was to synthesise and characterise the multi-template molecularly imprinted polymer (MIP) and to use target compounds, naproxen, ibuprofen, diclofenac, fenoprofen and gemfibrozil as templates so as to achieve all maximum extraction efficiency for all compounds. The synthesis consisted of a bulk polymerisation process at 60 °C by using NSAIDs as multi-templates, ethylene glycol dimethacrylate (EGDMA), 2-vinyl pyridine (2VP) and toluene as cross- linker, functional monomer and porogen, respectively. Nonimprinted polymer (NIP) was synthesised in a similar manner with the omission of the templates. Characteristics of the polymers were analysed using Scanning Electron Microscopy (SEM), Fourier Transformed Infrared Spectroscopy (FTIR), Solid State Nuclear Magnetic Resonance Spectroscopy (NMR) and Thermal Gravimetric Analysis (TGA). The MIP was therefore applied for the analysis of pharmaceuticals in vegetables by means of Molecularly Imprinted - Solid Phase Extraction (MISPE). The extracted compounds were identified both qualitatively and quantitatively using a High-Performance Liquid Phase Chromatographic (HPLC) system coupled with a Photodiode Array detector. This method was effectively implemented on vegetable samples collected from Durban, South Africa (SA), including lettuce, carrot, cucumber, and green pepper. The recovery rates varied from 45 to 103%, with Relative Standard Deviation (%RSD) ranging from 0.9 to 13%. Fenoprofen was the most prevalent compound, exhibiting high concentrations in pepper and cucumber, with maximum concentrations of 6.44 mg kg^{-1} and 4.99 mg kg^{-1}, respectively. The health index (HI) values for the vegetables ranged from 0.27 to 1.25. The pepper sample (1.25) surpassed the HI threshold value of 1, reflecting the health indicator risk associated with the consumption of peppers available within the area. The health risk assessment (HRI) values spanned from 0.00012 to 0.83 for both adults and children, suggesting no health risk associated with the consumption of these vegetables. The selected pharmaceuticals are widely used in SA both by prescription and over the counter, for pain and inflammation management and are anticipated to be existing at high concentrations in the South African environment. In recent years, the presence of selected pharmaceuticals in the environment nave been reported, however, no studies have been conducted on their uptake on vegetables by MISPE.

CP-O-12

Novel piano-stool pyrazolyl-functionalized Ru(II)-NHC complexes: synthesis, characterization, antibacterial and theoretical studies

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Antimicrobial resistance has emerged as a global health threat, and recent estimates indicate a growing trend in antibiotic resistance, with thousands of deaths reported annually [1]. This has necessitated research into

potentially more effective antimicrobial agents [2]. In this study, 10 novel pyrazolyl-functionalized Ru(II)-NHC complexes were synthesized, with varying substituents such as N-wingtips on the azolium moiety, simple imidazolium and benzimidazolium moieties and different carbon chain lengths on the pyrazole moiety. All the compounds were fully characterized by spectroscopic and analytical means. Crystal structures showed the complexes to correspond to the proposed structures of piano-stool style, with the azolium ligand being bidentate.

In vitro studies showed the Ru(II)-NHC complexes to have moderate antibacterial activity in the range of 88-403 μM, which was comparable to some complexes of the same nature reported in literature [3][4]. Computational DFT predictions complemented with the experimental findings. Both the HOMO and LUMO were found to be lying on the p-cymene, metal centre and chloride ligands. Molecular electrostatic potential maps showed the complexes to be more electron acceptors than donors, with the regions around the chloride ligand and metal centre having some electron donating ability. The benzimidazolium-based Ru(II)-NHC complexes with ethyl substituents on the pyrazolyl moiety exhibited the highest antibacterial activity. This might be due to the presence of long carbon chains which are known to enhance lipophilicity which ultimately improves antibacterial activity [5].

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ORAL ABSTRACTS

ENGINEERING

ENG-O-1

Modelling and Simulation of the Control of Turbulent Flow in Pipes Using Ansys Fluent & Machine Learning Tools.

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Pipes and ducts are the most common means to distribute fluids throughout the world, with applications ranging from the oil & gas industry to domestic uses. Most often these flows are turbulent, and a lot of Transport Energy is required to meet the large associated frictional losses. It is estimated that around 20% of the global electric power consumption is spent by pumping systems to overcome frictional drag. This figure could be reduced to a great deal if flows in these systems were smooth and laminar rather than turbulent, with consequent huge cuts in pumping costs and carbon emissions. Turbulent-flow control aims to develop strategies that effectively manipulate fluid systems, such reduction in drag in the petroleum and natural gas transportation and improving energy efficiency both critical steps aim to reduce global CO_2 emissions. Computational Fluid Dynamics and Machine learning tools offer novel approach to discover flow-controls strategies[1], which will be combine to the knowledge of the physics of turbulence. The trained model targets the most relevant regions in the flow to sustain turbulence and produces a drag reduction which is higher than that of a model specifically trained to reduce the drag, while using half of its power consumption. One of the viable solutions is the drag reduction which may reduce the cost of pipe transportation. This project thus aims to investigate efficient control strategies to completely suppress turbulence in pipe flow. This would drastically improve energy efficiency and reduce cost. The problem will be tackled using advanced mathematical tools combined with state-of-the-art numerical simulations and modern data-driven/machine-learning techniques. Different re-laminarization (i.e. the process of transition from turbulent to laminar flow) scenarios will be analyzed to gain a unified fundamental understanding of the physical mechanisms underlying this process. Such knowledge will then be exploited to develop new control techniques that are applicable in practice. Implementing mechanical devices that alter flow parameters can influence turbulence characteristics significantly. Injecting secondary fluids into the main flow can disrupt turbulence structures and promote re-laminarization[2]. Controlling skin-friction drag is essential in applications such as pipeline transport and aerodynamics. Strategies includes using riblet textures or specific surface coatings can reduce drag by influencing the near-wall turbulence structure. Also, employing buoyancy forces or localized heating can dynamically alter flow characteristics to achieve drag reduction. By directly applying the advance simulation method that sustain turbulence, current approach offers a powerful pathway towards its efficient control, which is a long-standing challenge in physics with profound implications for energy systems, climate modelling aerodynamics and future energy targets and meeting policy targeting of the worlds specifically south Africa [1]

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ENG-O-2

CHARACTERIZATION AND VALORIZATION OF FAECAL SLUDGE FROM THE LOOWATT SANITATION SYSTEM FOR SUSTAINABLE RESOURCE RECOVERY

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Proper management of sanitation waste is essential to ensure public health, protecting the environment and promoting sustainable development. However, the infrastructure required for effective sanitation management is costly to assemble and maintain, particularly in developing nations where water and sanitation systems are inadequate. Resource recovery from sanitation systems presents a sustainable solution, enabling the extraction of water, energy, and nutrients from waste streams. The LOOWATT (Kaloola) waterless toilet system, introduced in Durban, South Africa, captures and stores human waste in sealed liners to minimize bacterial exposure and odour. However, effective treatment and valorisation of the sludge remain a challenge. This study evaluated the physio-chemical characteristics of faecal sludge and the plastic liner collected from the Kaloola/Loowatt sanitation systems in Durban, along with investigations into potential treatment and valorization pathways that aligned with circular economy principles. Critical parameters that were subject to analysis included Chemical Oxygen Demand (COD), pH, nutrient concentrations such as phosphorous and nitrogen, microbial content, moisture content, total and volatile solids, ash content, viscosity, calorific value and electrical conductivity. The results indicated sludge with high moisture content (88%), moderate organic load and significant nutrient levels for resource recovery. Through the utilization of structured decision-making tools such as RAG analysis and a decision matrix table, anaerobic digestion and co-composting emerged as the most viable treatment options for the sludge based on the results. The low sludge production rates (around 100-150 kg/day) currently limits economic viability, hence co-processing with municipal organic waste could enhance feasibility. A techno-economic analysis, inclusive of capital costs, operational expenses, and revenue potential from valorised products is recommended for further assessment.

ENG-O-3

ADVANCING CROP MONITORING: A SYSTEMATIC REVIEW OF SATELLITE AND UAV REMOTE SENSING, DATA FUSION, AND AI/ML TECHNIQUES

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The increasing challenges posed by climate change, resource limitations, and global food insecurity necessitated advancements in crop monitoring through innovative technologies. The study conducted a systematic review to examine the integration of satellite and unmanned aerial vehicle (UAV) remote sensing

with data fusion, artificial intelligence (AI), and machine learning (ML) techniques aimed at enhancing precision agriculture, particularly in the context of smallholder farms.

A total of 137 peer-reviewed articles published between 2015 and 2025 were selected from Scopus and Web of Science, following PRISMA guidelines. These articles were analyzed to assess technological advancements in crop monitoring. The study focused on evaluating progress in technical capabilities, sensor types, and vegetation indices used for crop health assessment, stress detection, and yield prediction.

The comparative analysis of UAV and satellite platforms revealed their respective strengths and limitations, highlighting the potential of multi-platform data fusion strategies such as pixel-level, feature-level, decision-level, and deep-learning-level fusion to bridge spatial and temporal resolution gaps. AI/ML models including convolutional neural networks (CNN), support vector machines (SVM), random forests (RF), and hybrid approaches were evaluated for their performance in processing remote sensing data. Among these, CNNs and ensemble models demonstrated notably higher accuracy. This combined approach holds strong potential to bridge the spatial scale divide between ground-based and satellite observations, improving both qualitative and quantitative crop monitoring analyses

Despite promising developments, the review identified persistent challenges, including regulatory restrictions, substantial computational demands, and limited adoption of advanced technologies in smallholder farming systems. Key research trends and knowledge gaps were also identified. The study suggested future directions such as the development of AI models, the expansion of open-access datasets, and the creation of user-centered decision support systems to support scalable and sustainable crop monitoring solutions.

Keywords: Crop Monitoring, Remote Sensing, UAV, Satellite, Data Fusion, AI, Machine Learning, Precision Agriculture

ENG-O-4

DESIGN AND DEVELOPMENT OF A METAMATERIAL-BASED MIMO ANTENNA FOR UWB APPLICATIONS

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Ultrawideband (UWB) technology is essential in high-speed wireless communication systems due to its wide bandwidth, low power consumption, and resistance to multipath interference. Microstrip patch antennas are widely adopted in such systems for their compactness, low cost, and favorable radiation characteristics. However, in compact UWB-MIMO systems, challenges such as mutual coupling and limited isolation reduce performance. In this study, a compact two-port UWB-MIMO antenna is presented, featuring a Minkowski fractal slot embedded in the radiating patch and a triple-T-shaped double-negative (DNG) metamaterial wall to improve isolation. The fractal slot increases the effective current path, supporting wideband operation without increasing antenna size. The antenna is fabricated on an FR-4 substrate ($\varepsilon r = 4.4$) and operates from 3.15 to 13.6 GHz, achieving a simulated impedance bandwidth of 109.03%, peak gain of 5.65 dB, and isolation better than –19 dB. Diversity metrics including an ECC below 0.001, diversity gain of ~9.95 dB, and MEG under –3 dB confirm excellent MIMO behavior.

The antenna was fabricated and experimentally validated using a Rohde & Schwarz vector network analyzer and horn antennas in an anechoic chamber. Measured results closely align with simulations, showing a slightly wider bandwidth of 109.97% (3.95–13.6 GHz), strong isolation, and high radiation efficiency above 70%. The antenna exhibits stable omnidirectional radiation and reliable impedance matching across the band. The metamaterial wall effectively suppresses mutual coupling without increasing antenna size. These results

demonstrate that the proposed antenna is highly suitable for compact, high-performance UWB-MIMO systems in advanced wireless communication applications.

ENG-O-5

Pioneering Native Research: Optimization and Analytical Analysis of Bio-wax Extracted from Indigenous South African Plants Using Established Methods for Potential Industrial Use

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The growing environmental concerns associated with fossil fuel extraction, coupled with the non-renewable nature and ecological impact of mineral-based waxes, have necessitated the transition toward greener, biodegradable, and renewable raw materials. This study focuses on the extraction and characterization of bio waxes from selected South African indigenous plants, with the aim of contributing to the development of sustainable, plant-based alternatives to fossil- and mineral-derived waxes. Plant-based bio waxes offer a promising solution due to their natural origin, lower toxicity, and potential for reduced carbon footprint. These bio waxes may have applications in sectors such as cosmetics, sustainable packaging, and lubricants. Despite this potential, many indigenous plant species remain underexplored for their wax-producing capabilities, especially in the South African context.

The selection of the four indigenous plant species was informed by a preliminary qualitative research phase, which evaluated criteria such as natural availability, ease or difficulty of cultivation, and potential competition with other traditional or commercial uses of the plants that might impact their viability for bio wax extraction. Following this selection, the chosen species will undergo phytochemical screening to identify the presence of bioactive compounds. Soxhlet extraction will then be performed using two polar and two non-polar solvents to assess extraction efficiency across different solvent polarities.

To optimize wax yield, extraction parameters including drying temperatures (T1 and T2), solvent type and concentration, extraction temperature, and time will be systematically evaluated using Design of Experiments (DoE). The extracted bio waxes will subsequently be characterized using analytical techniques to assess their physicochemical properties and determine their potential for industrial application. Analytical methods such as Fourier Transform Infrared Spectroscopy (FTIR), Gas Chromatography–Mass Spectrometry (GC-MS), and Thermal Gravimetric Analysis (TGA) will be employed to characterize the extracted waxes.

The research include consultation with stakeholders such as local communities, botanists, and industry partners interested in sustainable materials. Expected findings include the identification of the most promising plant–solvent combinations and optimized extraction conditions for high-yield, high-quality bio waxes. The outcomes of this research will benefit future scientific investigations, green chemistry initiatives, and industries seeking to replace conventional waxes with sustainable, plant-based alternatives. While the study focuses on laboratory-scale extraction and characterization, it lays the groundwork for future research into large-scale processing and commercialization.

ENG-O-6

EXTRACTION AND CHARACTERIZATION OF CHITIN BIOPOLYMER FROM MOPANE WORM (*IMBRASIA BELINA*)

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Chitin is the second most important natural biopolymer after cellulose, a major constituent of fungus, insect exoskeletons, and crustacean shells. There is a rise in the demand for new areas of chitin application and finding new sources of chitin. This study aimed to extract and characterize chitin from matured mopane worm (MW) (*imbrasia belina*) namely (MW_1, MW_2, and MW_3) by treatment with the chemical method. The physicochemical properties of chitin from mopane worms were compared with shrimp chitin. In addition, mopane worm chitin was analyzed for structural properties using Fourier-transformed infrared, X-ray diffraction, and scanning electron microscopy. The yield of unbleached chitin from mopane worm for all different samples (MW_1, MW_2, and MW_3) was reported as 10.97 %, 10.30 %, and 9.04 %. The yield of bleached chitin decreased slightly for all different samples and was reported as 8.50 %, 7.95 %, and 6.72 % respectively. The results revealed a significant difference between MW_1, which had the highest yield for unbleached and bleached chitin, and MW_2, and MW_3. The percentage of ash and nitrogen content indicated the effectiveness of the extraction method used to extract chitin from mopane worms with values lower than 1 % for ash and lower than 6.89 % for nitrogen content. The ash content of shrimp chitin was higher than that obtained from mopane worm chitin. The lower values of ash and nitrogen content revealed that the chitin from the mopane worm was pure and of better quality. The Degree of Acetylation (DA) values of all mopane worm chitin samples were within the range of DA reported for insect-derived and shrimp chitin (80-100 %). These results show that mopane worms and shrimp chitin have the same degree of acetylation. Therefore, mopane worm is a promising alternative source of chitin biopolymer.

Keywords: Chitin, characterization, FTIR, SEM, XRD, mopane worm

ENG-O-7

STATUS OF INTEGRATED TOOLS FOR APPRAISING IRRIGATED AGRICULTURE: A SYSTEMATIC ANALYSIS

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Irrigated agriculture has increasingly come under scrutiny as the competition for water and energy intensifies - driven by population growth, economic development, urbanization, climate change and cultural and technological changes. The need for sustainability has triggered an urgent need to quantify synergies and trade-offs among water, energy and food sub-systems for different activities particularly irrigation. However, irrigation has been planned and appraised from silo-based performance assessment approaches which tend to optimize one resource while ignoring the feedback mechanisms and interdependencies with other resources. The complexity of irrigated agriculture demands evaluation approaches that move beyond conventional performance metrics to embrace integrated, multi-dimensional frameworks. This study systematically analyses

the status of existing tools developed to appraise irrigated agriculture, with particular attention to their capacity to incorporate the Water–Energy–Food–Environment–Livelihood (WEF+) nexus perspective. Using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) protocol, peer-reviewed literature published between 2013 and 2025 was screened from major databases. Each tool was evaluated against criteria including scope of WEF dimension coverage, indicator comprehensiveness, data requirements, methodological transparency, and applicability at different scales. Results reveal that while most tools address water and food dimensions adequately, integration of energy, environmental, and livelihood aspects remains partial and inconsistent. Only a minority of tools generate composite indices that enable holistic system-scale appraisal, and these often face limitations in data availability and conversion factor standardisation. Furthermore, gaps persist in linking field-scale irrigation performance metrics with broader sustainability and nexus-based outcomes. The review highlights the need for harmonised indicator frameworks, interoperable datasets, and cross-disciplinary modelling approaches to support evidence-based irrigation policy and management. Findings provide a foundation for developing a minimum set of core indicators and conversion factors for WEF+ aligned irrigation appraisal, offering a pathway towards more integrated and sustainable water–food–energy–environment management in agricultural systems.

Keywords: Irrigated agriculture, Water-Energy-Food nexus, Irrigation performance appraisal, sustainable irrigation, indicators

ENG-O-8

SOLAR PV ARRAY FIXED ORIENTATION ASSESSMENT USING THE OSM-MEPS MODEL

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This study presents an energy assessment of fixed-orientation solar PV arrays using the OSM-MEPS (Open-Source Modeling Method for Energy and Power Systems) model, which was developed by the authors. A novel contribution of the model, distinguishing it from existing benchmarking frameworks, is the incorporation of cloud opacity as an explicit modifier and humidity correction, enabling more accurate real-world performance prediction. The model systematically simulates different tilt and azimuth configurations to quantify their impact on annual and seasonal energy yield, identifying optimal fixed orientations for maximum production. Derived from key steps in modeling literature, the OSM-MEPS method integrates first-principles thinking, the scientific method and the engineering design process frameworks to ensure rigor, empirical validation and geographical adaptability. Applied to a PV system at the Serres-C site in Greece with high-resolution 2024 weather data (Solcast-DNV), the model achieved a strong fit with actual PV energy output (R^2: 0.887), outperforming PVLIB (R^2: 0.232). Seasonal validation further confirmed robustness: in May 2024, OSM-MEPS reached an R^2 of 0.917 versus PVLIB's –0.039; and in December, 0.873 versus 0.638, respectively. Geographical validation showed better generalization to Pretoria and Adelaide. These results highlight the value of a systematic, open-source method—developed in this study—and its resultant model, which are empirically grounded, modular and iteratively data-driven, for optimizing fixed PV array orientation in both rooftop and utility-scale applications.

ENG-O-9

MODELLING THE POST-HARVEST LOSSES OF UNDERUTILISED CROPS: A LITERATURE REVIEW

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Food insecurity remains a global challenge, with Sub-Saharan Africa experiencing the highest rates of food loss and hunger. One of the key contributors to food insecurity is post-harvest losses (PHL). PHL significantly reduces food availability, nutrient content, economic value, and contributes to environmental degradation. The long-term impacts of food insecurity are malnutrition, resulting in significant health problems that affect human and economic development. Underutilised crops such as orange-fleshed sweet potato (OFSP) offer a promising solution due to their climate-resilient and high nutritional value (particularly in vitamin A) qualities. However, they remain vulnerable to PHL due to poor post-harvest handling practices. This study explores recent literature on the practical applications of modern modelling technologies, including sensor-based monitoring systems, image analysis, artificial intelligence, and digital twins, to assess and reduce post-harvest losses. A critical literature review was conducted to evaluate the performance, limitations, and integration potential of these technologies across the agricultural supply chain. The findings highlight the significant advantage over traditional methods presented by these systems in reducing PHL, the growing success of multimodal systems in reducing food losses by up to 30% and enhancing decision-making through real-time data. Despite their potential, challenges such as cost, data compatibility, infrastructure gaps, and limited digital literacy hinder their widespread adoption, especially in developing countries. This study fills a critical gap by highlighting the potential of modelling technologies to address PHL in underutilised crops, enabling data-driven, and sustainable food systems in developing regions.

ENG-O-10

Fry Drying of Faecal Sludge for Briquette Production

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In South Africa, current sludge treatment methods are inefficient, expensive, and hinder resource recovery. This coupled with inadequate faecal sludge management, contributes to pressing issues such as unhygienic emptying practices and illegal dumping, all of which pose significant risks to public health and the environment. Fry-drying process is an emerging technology that presents an opportunity to effectively address these issues as well as treat sludge and recover valuable resources. This study investigates the development of a novel fry-drying process for sludge treatment. By using waste oil as the heating medium, this process enhances the calorific value of the resulting sludge-derived briquettes, transforming waste into a renewable biofuel , reducing key challenges in sludge disposal while also reducing dependence on fossil fuels, helping to minimize environmental impact. Samples were collected from DWS from VIPs in the KwaMashu located in the eThewkini municipality. The samples were then formed into pellets of a diameter of 14mm and underwent the fry drying process . Experiments were conducted at three target temperatures: 130 °C, 150 °C, and 170 °C

. At each temperature, samples were fried at time intervals of 30 seconds up to 4 minutes, followed by 60-second intervals, yielding total residence times of 0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4, and 5 minutes. The results indicated that increasing the temperature led to a reduction in moisture content, which correspondingly enhanced the calorific value of the sludge. At 170 °C, sludge samples with a thickness of 10 mm achieved complete moisture removal within 3 minutes, reaching a calorific value of 20.00–24.00 MJ/kg. This effect results from the hydrophobic interactions between the waste oil and water in the sludge, where elevated temperatures facilitate rapid steam generation and evaporation. In this context fry-drying emerges as a promising thermal treatment option, capable of significantly reducing pathogens and the potential for producing energy-rich solid fuels with significantly reduced drying times compared to conventional techniques.

ENG-O-11

CURRENT SHARING IMBALANCE IN PARALLEL HTS TAPES: THE CRITICAL ROLE OF CONTACT RESISTANCE FOR BUSBAR APPLICATIONS

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The development of high-current superconducting busbars using High-Temperature Superconducting (HTS) tapes necessitates the parallel connection of multiple tapes stacked to

meet the demanding current ratings (hundreds to thousands of amperes) typical of electrical grid feeder lines. A significant challenge is that the current does not always split evenly between the tapes. If one tape carries too much current, it can overheat and stop superconducting (Quench) before the whole superconducting cable reaches its full capacity. This work investigates the hypothesis that variations in the contact resistance at the current terminals are a primary driver of current imbalance in parallel HTS tape conductors. The experimental study on a three HTS tape parallel arrangement, measuring the individual contact resistances and critical currents using V-I characterization of each tape was presented. Results demonstrate a clear inverse correlation between a tape's contact resistance and its share of the total current. Due to equipment current limitations, a follow-on study using two tapes in parallel is conducted, pushing the pair to its collective critical current to observe the impact of imbalance under near-critical conditions. The key finding is simple: even small differences in contact resistance cause uneven current sharing. This uneven sharing becomes a serious problem when the cable is operating near its maximum current. For building reliable, high-current superconducting power cables, it is crucial to make connections with very low contact resistance and more importantly consistent contact resistances.

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ENG-O-12

Governance Fragmentation and Implementation Deficits in Durban's Sustainable Transportation Transition

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Durban, South Africa's third-largest metropolitan economy, faces a critical sustainability impasse where rapid urbanization intersects with three compounding transportation crises: Transportation constitutes 28% of metropolitan GHG emissions due to entrenched fossil fuel dependence, low-density spatial development perpetuates automobile-centric mobility patterns while undermining public transport viability, and institutional fragmentation across 34 municipal entities creates governance paralysis in implementing integrated solutions. These systemic failures manifest in worsening traffic congestion, deteriorating air quality, and mobility poverty affecting 65% of low-income households.

Despite extensive policy frameworks, e.g. Green Transport Strategy 2020-2050 and technological innovations, critical knowledge gaps persist regarding the governance-infrastructure-behaviour nexus in complex African urban contexts, implementation barriers causing the "planning-implementation gap" in low-carbon transitions, and scalable solutions for secondary Global South cities where institutional capacity constraints differ fundamentally from primary cities. Current literature inadequately addresses how polycentric governance systems can overcome path dependencies to deliver transformative change.

This systematic review diagnoses these interconnected failures through political ecology and sustainability transitions frameworks. We critically synthesise empirical evidence to establish how institutional misalignment, funding discontinuities, and uncoordinated land use-transport planning perpetuate unsustainable mobility patterns.

This analysis reveals that catalytic interventions require simultaneous advancement across four dimensions namely: 1)Metropolitan-scale governance integration enabling cross-departmental coordination, 2) Strategic infrastructure prioritization targeting network effects (e.g., BRT optimization increasing throughput 22%, cycling corridors capturing 15-30% mode share), 3) Behaviour change programs leveraging modal choice elasticities, and 4) Standardized monitoring frameworks tracking decarbonization metrics. The Buffelsdraai reforestation project exemplifies how nature-based solutions can complement but not substitute systemic reforms. This research establishes that Durban's transition requires dismantling institutional siloes through metropolitan transport authorities with statutory powers. It provides diagnostic frameworks applicable to secondary cities confronting similar governance fragmentation and implementation deficits across the Global South.

Keywords: Transportation governance, Implementation deficit, Sustainable mobility transitions, Institutional barriers, Climate-responsive infrastructure, Decarbonization pathways, Urban political ecology, Global South secondary cities

ORAL ABSTRACTS

LIFE SCIENCES

LS-O-1

Chaetomorpha linum EXTRACT ENHANCES GLUCOSE UPTAKE, MODULATES POLYOL PATHWAY AND GLUCOSE METABOLIC ENZYMES IN GLUCOTOXIC ADIPOSE TISSUE *EX VIVO*

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The growing interest in marine-based therapies has brought seaweeds into focus for their potential to improve glucose regulation and reduce metabolic syndrome. This study investigated the effects of *Chaetomorpha linum*, a green seaweed on glucose uptake and key enzymes involved in the polyol pathway and glucose metabolism in adipose tissue. The adipose tissues from normal rats were exposed to glucose with or without *C. linum* extract *ex vivo*. Exposure of adipose tissue to glucose resulted in elevated activities of aldose reductase, sorbitol dehydrogenase, glycogen phosphorylase, glucose-6-phosphatase, and fructose-1,6-bisphosphatase, along with decreased glyoxalase-1 activity, glucose uptake, and impaired glutathione metabolism (reduced glutathione, glutathione reductase, glutathione peroxidase). Notably, treatment with *C. linum* extract significantly reversed these abnormalities, while improving glucose uptake, restoring antioxidant enzyme levels, and normalizing carbohydrate metabolic enzyme activities. LC-MS analysis identified the bioactive compounds including but not limited to proanthocyanidin A2, kurarinol, rutaevin, caryoptin, and glyoxalase-1 modulator isolobinine, which are also known for their antioxidant, antiglycation, and insulin-sensitizing properties. These findings suggest that *C. linum* possesses potent bioactive constituents capable of ameliorating glucose-induced metabolic disturbances in adipose tissue. Further studies in experimental animals and human subjects are warranted to ascertain the results of this study.

LS-O-2

Cervicovaginal Microbiota and Immune Profiles Associated with HPV Genotypes in South African Women

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Human papillomavirus (HPV) is the most prevalent sexually transmitted infection globally and is implicated in over 90% of cervical cancer (CC) cases. However, the interactions between HPV genotypes, vaginal microbiota, and local immune responses remain poorly understood, particularly in African populations. In this study, we analysed cervicovaginal samples from 33 South African women aged 18–35 to investigate microbial community composition and inflammation profiles across different HPV genotypes and Community State Types (CSTs). HPV prevalence was high, with 97% of participants testing positive for at least one HPV genotype. Low-risk (LR) and high-risk (HR) HPV types were detected in 90.9% and 69.7% of samples, respectively. The most common HR types included HPV 56 (31.3%), 18 and 45 (18.8% each), and 16 (15.6%), while the most prevalent LR types were HPV 6 (37.5%) and 44/55 (34.4%). Microbial profiling revealed distinct genotype-associated signatures. LR HPV genotypes were generally associated with *Lactobacillus iners* and *L. crispatus*, indicating a more stable and health-associated microbiome. In contrast, HR genotypes were linked to greater microbial diversity and increased abundance of dysbiosis-associated taxa, including *Gardnerella vaginalis*, *Prevotella*, *Fannyhessea vaginae*, and *Sneathia vaginalis*. CST IV-B and IV-C, dominated by anaerobic bacteria, exhibited significantly elevated pro-inflammatory cytokines (IL-1β, IL-6, IL-8, MIP-1α, IP-10; all $p < 0.05$). In contrast, CST I and III, dominated by *L. crispatus* and *L. iners,* respectively, were associated with lower levels of these cytokines, suggesting a less inflammatory environment. While inflammation varied significantly across CSTs, a direct association between HPV genotypes and cytokine levels was also observed. These findings highlight potential links between vaginal microbiota composition and the presence of HR HPV types, particularly HPV 16, 18, and 45, and suggest that CST-associated inflammation may influence cervical health.

Keywords: Human papillomavirus (HPV), Vaginal microbiome, Community State Types (CSTs), Cytokines, Inflammation, *Lactobacillus* species, *Gardnerella vaginalis*, High-risk HPV, Low-risk HPV, Vaginal dysbiosis

LS-O-3

Characterisation, Yield Optimisation, and Anti-Inflammatory Potential of Vaginal *Lactobacillus*-Derived Extracellular Vesicles

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The vaginal microbiome is a critical factor in reproductive health. *Lactobacillus*-dominant communities are associated with reduced inflammation and lower infection risk, whereas non-*Lactobacillus*-dominant profiles common among women in sub-Saharan Africa are linked to increased genital inflammation. This inflammation is of particular concern, as it is associated with a threefold increased risk of HIV acquisition.

Extracellular vesicles (EVs) are nanoscale, membrane-bound particles released by most cell types. They facilitate intercellular communication by transporting proteins, nucleic acids and metabolites, and their small size allows them to cross biological barriers while protecting their cargo from degradation. These features make them promising tools for therapeutic applications. While EVs from mammalian cells are well-studied, less is known about bacterial EVs, particularly those from vaginal *Lactobacillus* species. These EVs may carry bioactive molecules that contribute to the anti-inflammatory effects associated with *Lactobacillus*-dominant vaginal microbiomes. This study aims to optimise the isolation of EVs from vaginal Lactobacillus strains by applying stress conditions to enhance their release and enable further functional characterisation.

EVs were isolated using polyethylene glycol (PEG) precipitation and characterised using nanoparticle tracking analysis (NTA) for size and concentration, transmission electron microscopy (TEM) for morphology, and

RNA quantification. Additional analyses, including membrane staining and cargo characterisation, are currently underway.

To increase EV yield, *Lactobacillus* cultures were subjected to various stressors: (i) altered pH conditions (3.5, 5.5, and 7.5), (ii) mechanical agitation at 180 rpm during growth, (iii) post-growth heat shock, and (iv) sublethal antibiotic exposure (ongoing). So far, growth at pH 7.5 increased EV yield ~7-fold, and agitation resulted in a ~10-fold increase compared to standard conditions.

We are currently evaluating the anti-inflammatory potential of these EVs by assessing cytokine profiles in inflamed vaginal epithelial cells.

These findings will improve our understanding of *Lactobacillus*-derived EVs and their cargo and may inform future probiotic-based interventions to reduce genital inflammation and associated HIV risk.

LS-O-4

Potential use of epinecrotic bacterial community succession for estimating post-mortem interval in decomposing pig carcasses – an experimental study

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The decomposition process of human and animal cadavers involves breaking down of the body through the interaction of abiotic and biotic factors. The primary contributors consist of microbiota populations, including archaea, bacteria, and viruses, which are imperative in the body's decomposition. Two adult pigs, were used in this study to simulate human carcass decomposition due to the close resemblance of their anatomy and physiology to humans. The aim of the study was to identify the epinecrotic bacterial communities associated with different decomposition stages of pig carcasses and soil underneath carcasses and to further assess their importance in estimating the post-mortem interval (PMI) using both culture dependent and independent analysis in the warm season. The sampling methods used included swabbing the oral cavity and scraping the skin surface. Results obtained from the experiments revealed similar bacterial species which were dominant across different stages. Four phyla: Proteobacteria, Firmicutes, Actinobacteria, and Bacteroidetes, were observed to be dominant in both skin and oral cavities. However, varied microbial community compositions were noticed in distinct stages of decomposition. The skin surface microbiome exhibited an early increase in Proteobacteria, which later declined, while Firmicutes followed the opposite trend. In contrast, the oral cavity showed a peak in Proteobacteria until the active stage, followed by Firmicutes dominance in later decomposition stages. Abundance of Actinobacteria and Bacteroidetes declined as decomposition progressed. The trend of microbial succession during decomposition in this current study illustrated a shift from indigenous aerobic microorganisms to gut-associated putrefactive Firmicutes, eventually leading to bacterial communities resembling those found in the environment and soil. This study revealed that the succession pattern of microorganisms can be a vital tool for estimating PMI in KwaZulu-Natal using both culture-dependent and sequencing results which showed a strong correlation throughout decomposition.

Keywords: Post-mortem Interval, Decomposition, Microbial Succession Pattern, Epinecrotic bacteria, PacBio sequencing

LS-O-5

Genome-wide Single Nucleotide Polymorphism (SNP) Discovery, Genetic Variation, and Population Structure of South African and Eswatini *Cannabis sativa* L. Varieties

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Cannabis sativa is a wind-dispersed plant in which the genetic diversity, population structure and gene flow are crucial for future plant breeding and conservation efforts [1, 2]. South Africa and Eswatini have a favourable environment and possess traditional knowledge of *Cannabis* cultivation techniques, which are perfect for *Cannabis* farming [3-5]. The two countries probably have developed new *Cannabis* varieties with unique single-nucleotide polymorphism (SNP) markers that remain unexplored. Using Genotyping-by-sequencing, 293 *Cannabis* samples from 9 populations in South Africa and 4 populations in Eswatini were sequenced and analysed to assess genetic diversity and population structure through phylogenetic analysis, principal component analysis (PCA), Structure clustering using ADMIXTURE, and calculation of genetic diversity indices including expected heterozygosity (H_E), observed heterozygosity (H_O), and fixation index (F_{ST}). Approximately 4.6 million high-quality SNPs were detected for genetic diversity analysis, while 777,000 SNPs were used to investigate population structure analysis. Results showed that *Cannabis* have moderate genetic diversity and high gene flow between populations. The observed heterozygosity was higher than the expected heterozygosity, resulting in a negative FIS, which suggests a trend toward outbreeding in the South African and Eswatini samples. The PCA revealed two distinct genetic clusters. The optimal K value identified was K = 12, indicating that the *Cannabis* landraces from South Africa and Eswatini can be categorised into twelve unique populations. Each of the populations showed significant genetic admixture, while the KwaZulu-Natal, Eastern Cape, and Eswatini populations maintained their distinct clusters. The results show that the South African and Eswatini *Cannabis* have promising genetic pools to enrich genetic diversity in breeding programs and could be used for developing new varieties for medicinal, industry and agricultural use.

Keywords: *Cannabis*, Single-nucleotide polymorphism, Genetic diversity, population genetic structure

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LS-O-6

The Role of Histidine 382 on the Stability and Ligand Binding of the E2 Domain of Amyloid Precursor Protein

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Amyloid precursor protein (APP) is a type-I transmembrane protein ubiquitously expressed in almost all neuronal and non-neuronal tissues. It is mostly studied for its role in neuronal and peripheral tissues, where it has been implicated in the pathogenesis of various diseases, including Alzheimer's disease and obesity. The E2 domain of APP has been reported to contribute to APP's interaction with heparin and metal ions. Additionally, it has been identified as a ligandable domain of APP where small molecules may bind with implications for drug development. The amino acid histidine 382 (H382) of the E2 domain has been identified as a possible critical residue required for heparin, metal ion, and small molecule binding. This study investigated the role of H382 on the stability and ligand binding of the E2 domain of APP. We designed a mutant of the E2 domain, where H382 was mutated to leucine. We subsequently analysed the stability of, and binding of heparin, copper, zinc, and small APP binding ligands to the wild-type E2 domain as compared to the mutant E2 domain (APP_E2 ΔH382L) through thermal shift assay. The APP_E2 ΔH382L mutant exhibited a significant reduction in thermal stability when compared to wild-type APP_E2 domain. We also demonstrated that the mutation weakened the binding of heparin and metal ions to the E2 domain of APP, but not the small APP binding ligands. We also demonstrated that the mutation weakened the binding of heparin and metal ions to the E2 domain of APP, but not the small APP binding ligands. We further compared the binding affinity of heparin to wild-type APP_E2 and APP_E2 ΔH382L mutant through a pull-down assay using heparin Sepharose CL-6B resin, where we demonstrated that heparin binds to wild-type APP_E2 with higher affinity when compared to APP_E2 ΔH382L mutant. These findings suggest a potential role of H382 in stabilising the E2 domain of APP and confirms the important role H382 has in the interaction of heparin and metal ions with the E2 domain, but not necessary for the interaction of small APP binding ligands with the E2 domain.

LS-O-7

Molecular Epidemiology and Genetic Diversity based on *pCS20* Gene of *Ehrlichia ruminantium* in Indigenous Goats and *Amblyomma hebraeum* ticks

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Heartwater is an infectious tick-borne disease of major economic importance in sub-Saharan Africa, caused by the intracellular bacterium *Ehrlichia ruminantium*. It affects both domestic and wild ruminants, leading to significant mortality and reduced livestock productivity. The disease is primarily transmitted by *Amblyomma hebraeum* ticks and remains a persistent challenge to animal health, despite ongoing control efforts. Variability in disease severity across host species, breeds, and age groups, coupled with the genetic diversity of *E. ruminantium* strains complicates effective disease management and vaccine development. This study

investigated the molecular prevalence, infection dynamics, and genetic diversity of *E. ruminantium* in South African indigenous goats and *A. hebraeum* ticks collected from selected heartwater-endemic regions. A total of 381 goat blood and 70 tick samples were screened using a TaqMan qPCR assay targeting the conserved *pCS20* gene region. Samples were categorized as blood-only positive, tick-only positive, both positive (typical infection), or both negative. A cycle threshold (Ct) value of ≤35 was used to define qPCR positivity. Positive samples (n=25) were subjected to Sanger sequencing for genetic characterization and phylogenetic analysis. The molecular prevalence of *E. ruminantium* was 14.7% (56/381) in goats and 44.3% (31/70) in *A. hebraeum* ticks, emphasizing the tick's role as a key reservoir and transmitter of the pathogen. Breed-specific differences in infection were observed, with speckled goats showing the highest infection rate (28%) and Kalahari Red the lowest (9.2%). Boer goats exhibited the highest combined blood-tick positivity and tick burden. A statistically significant association was found between tick infestation and infection status (p=0.003), suggesting host-vector interactions influenced by breed susceptibility. Ticks carried significantly higher bacterial loads than goats (p=0.00034), and an inverse correlation (ρ=-0.53) between tick burden and bacterial load in goats was observed, possibly indicating immunological adaptation or resistance mechanisms. However, regression models did not identify strong predictors of infection status or bacterial load, likely due to limited variability among covariates. Sequence analysis revealed five distinct *pCS20* haplotypes (ER-H1 to ER-H5), including three novel variants (ER-H3, ER-H4, ER-H5) defined by unique SNPs and indels patterns. Phylogenetic reconstruction showed that these novel haplotypes clustered separately from known West African and Caribbean reference strains, indicating localized evolutionary divergence. Co-circulation of multiple *E. ruminantium* haplotypes within individual farms suggests complex transmission dynamics between host and vector. This study confirms the persistence of *E. ruminantium* spread within indigenous goat populations and high infection rates in *A. hebraeum* ticks, with the *pCS20* qPCR assay proving effective for early detection. The identification of novel haplotypes highlights the importance of considering regional genetic diversity in diagnostics, vaccine development, and integrated control strategies.

Keywords: *E. ruminantium*, Heartwater, Indigenous goats, *A. hebraeum*, *pCS20* qPCR, Molecular epidemiology, Genetic diversity

LS-O-8

Improving the nutritional composition of bread through supplementation with edible insects

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Food insecurity is a major global problem which is one of the main causes of malnutrition. Malnutrition is a worldwide health problem that is particularly prevalent in developing countries. Many individuals in developing countries lack essential nutrients such as protein, zinc, and iron in their diets as they consume monotonous plant-based diets that are high in carbohydrates, mainly starch, and low in animal protein, dairy products, and fruits and vegetables. Bread is a popular staple food globally but deficient in several nutrients, including protein and the essential amino acids lysine and tryptophan, vitamins, and minerals. In regions prone to nutrient deficiencies, edible insects are abundant and readily accessible and most of the insect species are high in several nutrients including protein and minerals. Therefore, this study aims to improve the nutritional content of white and brown bread using edible insects. Edible insects were milled into insect meal and experimental bread was prepared where wheat flour was partially substituted with different proportions of termite and mopane worm meal: 5% and 10% separately.

White or brown bread with no insect meal (0%) served as the control. There was a significant difference ($p < 0.05$) in the proximate and mineral composition of white and brown bread supplemented with mopane worm and termite meal. The proximate and mineral element content of white and brown bread significantly increased

with increasing concentrations of edible insects. A significant increase in protein content was observed in white bread containing 5% and 10% mopane worm and termite meal. Similarly, a substantial increase was observed in the mineral content of white and brown bread supplemented with mopane worm and termite meals. These findings indicate that supplementing bread with mopane worm and termite meals improves the nutritional composition of bread. A higher nutritional content of white supplemented with 10% termite and brown bread with 10% mopane worm meal suggests that both insect types are suitable for incorporation in the two bread types to improve the nutrient content of starchy staple foods.

LS-O-9

EV-PEI-AuNPs as a Hybrid Nanocarrier for siRNA Delivery: Synthesis, Characterisation, Binding, Cellular Uptake and Cytotoxicity *in vitro*

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Nanocarriers with the ability to deliver both genetic material and therapeutic drugs are vital for the advancement of nanomedicine. Hence, combining biologically derived extracellular vesicles (EVs) with synthetic polyethyleneimine-coated gold nanoparticles (PEI-AuNPs) is a promising novel hybrid nanocarrier system for efficient gene and drug delivery. EVs are naturally biocompatible with intrinsic targeting features that reduce immunogenicity and support cellular uptake [1]. PEI enhances siRNA complexation and promotes endosomal release via the proton sponge mechanism, while AuNPs offer structural and colloidal stability, and the potential for imaging [2,3].

Characterisation of EV-PEI-AuNPs was carried out using UV-Visible spectroscopy (which confirmed plasmonic shift upon functionalization), nanoparticle tracking analysis (EV-PEI-AuNPs have a size of approximately 119.9 nm and a zeta potential of -36 mV), transmission electron microscopy (showing vesicle morphology and nanoparticle association) and Fourier-transform infrared spectroscopy (for chemical bonding verification). Gel retardation and nuclease protection assays showed effective binding and nuclease resistance of non-targeting siRNA. Fluorescent-based cellular uptake studies confirmed strong internalisation of the nanocomplex in the human embryonic kidney (HEK293) and cervical cancer (HeLa) cells. Furthermore, MTT and apoptosis assays confirmed that the nanocomplexes were well tolerated in both cell lines.

These results support the potential of EV-PEI-AuNPs as a biohybrid delivery vehicle capable of siRNA encapsulation, protection and cellular delivery with the prospect of being a delivery vehicle for targeted therapeutic delivery or gene-drug co-delivery.

Keywords: extracellular vesicle, polyethyleneimine, gold nanoparticles, hybrid nanocarrier, gene therapy.

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LS-O-10

Influence of Biostimulants and Elevated Carbon Dioxide on Germination, Growth, and Medicinal Properties of *Lippia javanica* (Burm.f.) Spreng.

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Lippia javanica, a South African medicinal plant, is known for its medicinal properties. There is currently limited data on the germination and post-germination behavior of this species, as well as on efforts to optimize seed germination and the effects of elevated atmospheric carbon dioxide (CO_2) on growth and medicinal properties. This study aimed to investigate the optimal concentration of biostimulants to enhance seed germination and early seedling development. It also examined how ambient and elevated CO_2 levels influence various plant growth parameters of *L. javanica*. Additionally, the study analyzed the total phenolic content (TPC), total flavonoid content (TFC), condensed tannin content (CTC), antioxidant activity, antidiabetic activity, and antibacterial activity of methanol, hexane, and aqueous extracts of *L. javanica* harvested under both ambient and elevated CO_2 conditions.

Seeds were germinated in distilled water, smoke-water (SW), and gibberellic acid (GA_3) solutions. *Lippia javanica* plants were grown under ambient (472 ± 28 ppm) and elevated (695 ± 47 ppm) CO_2 levels in controlled environments. Growth parameters (shoot length, root length, and biomass accumulation) and chlorophyll fluorescence were recorded. Methanol, hexane, and aqueous extracts from leaves and roots were analyzed for TPC, TFC, CTC, antioxidant activity (DPPH assay), antidiabetic activity (α-Glucosidase and α-Amylase assays), and antibacterial activity (MIC against four bacterial strains).

Lower concentrations of SW (SW1:2000 v/v) and GA_3 ($GA_3 10^{-9}$ M) significantly enhanced germination performance, resulting in lower mean germination time, higher germination percentage, mean germination rate, coefficient of velocity of germination, seedling vigour index, and germination index. Elevated CO_2 increased plant height and biomass accumulation; however, there was a reduction in leaf foliage, and ambient CO_2 increased fluorescence. Ambient CO_2 extracts exhibited higher TFC and TPC than those of elevated CO_2. Antibacterial activity varied with solvent and strain, with MIC values ranging from 0.006 to <2.5 mg/ml; *E. faecalis* was the most susceptible, while *E. coli* and *P. aeruginosa* were more resistant.

LS-O-11

Green synthesis of metallic nanoparticles from plant extracts for biotechnological applications

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Extensive research has been done on metallic nanoparticles for antimicrobial applications [1]. The conventional chemical and physical techniques of synthesis are unfavourable as they promote high energy consumption, discharge of pollutant chemicals, toxic intermediates and waste [2]. A more all-round sustainable alternative has been green biogenic synthesis mediated by bacteria, fungi, algae or plants using their natural stabilising agents [3]. The misuse of conventional antibacterial, antifungal, and antiviral agents has led to an

increased threat of the antimicrobial resistance crisis [4]. This has necessitated a dual solution to this clinical and global public health challenge. In response, the main aim of this study has been to investigate the green synthesis of metallic nanoparticles using the plant extract from local ethnomedicinal species, *Siphonochilus aethiopicus,* for various biotechnological applications. The methodology involved using leaf extract from *S. aethiopicus* to synthesise metallic nanoparticles. Techniques used for screening in this study included UV-VIS spectroscopy to confirm nanoparticle synthesis, High Resolution Transmission Electron Microscopy to establish size and shape of the nanoparticles, Energy Dispersive X-ray Spectroscopy for elemental composition determination, and Dynamic Light Scattering for poly dispersive index, zeta potential and hydrodynamic size determination. The successful synthesis of silver and gold nanoparticles from the *S. aethiopicus* extract was exhibited by UV-VIS spectroscopy at 460 nm and 560 nm respectively. The elemental composition was shown by strong peaks characteristic of silver at 2.98 keV and gold 2.12 keV. The silver nanoparticles had triangular and spherical shapes with sizes ranging between 14 – 108 nm; and the gold nanoparticles had triangular, trapezoid and hexagonal shapes with sizes ranging between 30 – 85 nm. The silver and gold nanoparticles had low and moderately uniform size, respectively. The zeta potential of the silver nanoparticles was -39,27 ± 1,80 mV and for the gold nanoparticles it was -40,57 ± 1,29 mV making both highly stable. This synthesis is novel because the *S. aethiopicus* leaf extract has never been used for the synthesis of silver or gold nanoparticles. Preliminary testing of the silver and gold nanoparticles have shown good activity against various species; however, further testing is required for final conclusions.

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LS-O-12

Expression, Purification and Characterisation of Cysteine and Serine Protease Inhibitors from *Trypanosoma congolense* as Diagnostic and Drug Targets for Nagana

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Animal African Trypanosomiasis (AAT) or nagana, caused by *Trypanosoma congolense*, *T. vivax* and *T. brucei brucei*, remains a major constraint to livestock production across sub-Saharan Africa. The need for improved diagnostics and therapeutics has directed attention toward parasite-derived molecules with diagnostic and drug target potential. This study focuses on the expression, purification, and characterisation of recombinant cysteine and serine protease inhibitors from *T. congolense*. These inhibitors play key roles in parasite survival, immune evasion, and host-pathogen interactions, making them attractive targets for intervention.

Genes encoding the *T. congolense* inhibitor of cysteine protease (TcoICP) and serine protease (TcoISP) were retrieved from TriTrypDB, synthesised, and cloned for expression in *E. coli*. Both proteins were recombinantly expressed and purified using His-select/Ni-NTA affinity chromatography. Immunogenic peptides were

identified in the primary structures of the two inhibitors, and anti-peptide antibodies were produced to identify the recombinantly expressed proteins.

Western blotting confirmed the identities of the proteins using anti-His antibodies and affinity-purified anti-peptide IgY antibodies. These peptide-specific IgY antibodies were raised in chickens following epitope mapping and peptide-carrier conjugation with rabbit serum albumin via glutaraldehyde. Antibody production was monitored over 15 weeks using an indirect ELISA with peptide as coating antigen. Affinity-purified IgY, using a peptide-affinity chromatography column, detected the recombinant proteins in both ELISA and western blotting. Functional characterisation through enzyme inhibition assays demonstrated that rTcoICP inhibited papain (cysteine protease) with an IC_{50} of 72.91 nM, achieving 99% inhibition at 2 µM. rTcoISP inhibited both host trypsin (IC_{50} = 0.3595 µM; 93% inhibition at 2 µM) and the parasite protease *T. congolense* oligopeptidase B [TcoOpdB] (IC_{50} = 0.435 µM; 97.4% inhibition at 1 µM).

These findings establish recombinant TcoICP and TcoISP as potent inhibitors and promising candidates for affordable, locally produced diagnostic tools and novel therapeutic strategies for the effective control of AAT.

ORAL ABSTRACTS

MATHEMATICS, STATISTICS AND COMPUTER SCIENCE

MSCS-O-1

On Cohesive Locales

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In this talk we introduce the notion of cohesiveness in frames (locales). We give some properties of cohesive frame. We show that every cohesive frame is not zero-dimensional. We also give an example of connected frames that are not cohesive and those of connected frames that are cohesive. We talk about the relationship between cohesive and strongly cohesive frames. We conclude by showing that both cohesive and strongly cohesive frames are open hereditary.

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MSCS-O-2

Causal modelling of COVID-19 relative vaccine effectiveness of Ad26.COV2.S and mRNA-1273 boosters

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BACKGROUND

Causal inference modeling is a statistical concept developed for estimating treatment effects with nonrandomized data, and for drawing causal inferences from observational data. In this research project, we aim to use causal inference methodology to evaluate the effectiveness of boosting the mRNA-1273 vaccine against SARS-CoV-2 infection.

METHODS

We used data from the SHERPA (Sisonke Heterologous mRNA-1273 Boost after Prime with Ad26.COV2.S) trial, where healthcare workers in SA received one or two doses of Ad26.COV2.S and later an mRNA-1273 booster. Causal inference models suitable for cross-sectional exposure were applied.

Cross-sectional comparisons between boosted and unboosted individuals:

Participants were classified into two groups (boosted with mRNA-1273 vs unboosted), propensity score matching was used to create subgroup with balanced covariates. Matching was conducted using nearest neighbour method at 1:1 ratio and caliper of 0,2. Cox proportional hazards model was applied to the matched dataset to estimate the causal effect of mRNA-1273 boosting on SARS-CoV-2 infection.

RESULTS

Among 424409 participants, including 11248 (2.65%) who received the mRNA-1273 booster. Majority of participants were females 85.24%. HIV prevalence was 8.55% among boosted and 91.45% among unboosted participants, pointing to the rationale for need to balance covariates. Boosting was associated with a significant 58% reduction in the risk of SARS-CoV-2 infection (HR: 0.42; 95% CI: 0.22 to 0.80; p = 0.0085) compared to those unboosted.

CONCLUSION

Our findings support the effectiveness of mRNA-1273 boosting after Ad26.COV2.S priming in reducing SARS-CoV-2 infection. The application of causal inference methods enhanced the validity of these estimates despite the observational design.

MSCS-O-3

DYNAMIC BILEVEL OPTIMISATION FOR CARBON EMISSION REDUCTION

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Designing effective carbon pricing policies presents a significant challenge due to the strategic interplay between regulators seeking to minimize emissions and producers aiming to maximize profits. This paper introduces a dynamic bilevel optimisation framework to navigate this conflict, modeling it as a Stackelberg game, which we solve using a bespoke Adaptive Genetic Algorithm that captures the co-evolutionary dynamics between the leader and follower. Within this framework, the leader optimizes the parameters of nonlinear, time-dependent tax and subsidy functions. At the same time, the follower provides a profit-maximizing production response calculated via a nested numerical solver. Our findings reveal that the algorithm consistently converges to a sophisticated and effective policy strategy characterized by an aggressive, exponentially increasing tax on high carbon sources to ensure their rapid phase-out; a stable, lower level tax on medium-carbon sources for ongoing management; and a front-loaded, decaying subsidy for low-carbon sources that adapts as the technology matures. Ultimately, this work demonstrates a robust computational framework that provides policymakers with a powerful tool to design, test, and validate nuanced, data-driven environmental policies for a sustainable energy transition.

MSCS-O-4

Macroeconomic Drivers of Economic and Industrial Growth in Africa: A Panel Econometric Study

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This study investigates the macroeconomic drivers of economic and industrial growth in ten African countries over the period 1980–2023, using an unbalanced panel comprising 440 country-year observations. The primary objective is to examine the joint effects of trade openness, foreign direct investment (FDI), government expenditure, inflation, and tariffs on two dependent variables: GDP growth and industrial output (manufacturing value added).

A multivariate Seemingly Unrelated Regression (SUREG) model is employed to simultaneously estimate GDP growth and industrial output equations, accounting for cross-equation error correlations. Preliminary diagnostics confirm data quality: average VIF = 5.6 (suggesting moderate multicollinearity), and panel unit root tests (Levin-Lin-Chu and Fisher-ADF) identify trade openness as non-stationary, necessitating first differencing. To address multicollinearity, Principal Component Analysis (PCA) is applied; the first two components explain 84.3% of the total variance among the regressors. The results indicate that a one percentage point increase in the FDI-to-GDP ratio raises GDP growth by 0.22 percentage points ($p < 0.01$), while a similar increase in trade openness increases GDP growth by 0.15 percentage points ($p < 0.05$). For industrial output, a one percentage point rise in tariffs is associated with a 0.18 percentage point increase ($p < 0.05$), suggesting strategic protection may benefit local manufacturing. Inflation and government expenditure show mixed and statistically insignificant effects. The integration of PCA with SUREG enhances model efficiency and mitigates multicollinearity.

These findings support evidence-based macroeconomic policy reforms aimed at attracting FDI and balancing liberalisation with selective tariff protection to foster industrial development in Africa.

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MSCS-O-5

A Block Hybrid Method for Nonlinear Boundary Value Problems: Application to Casson Fluid

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In this study, we solve the Casson fluid flow problem using the newly developed block hybrid method for boundary value problems. The Casson fluid flow is defined on a semi-infinite domain. The mathematical model is formulated to derive partial differential equations for this problem. The obtained are transformed into ordinary differential equations using dimensionless variables. The block hybrid method is then applied to solve the transformed equations. The results are validated by comparing them to those obtained using the spectral quasi-linearisation and overlapping grid spectral quasi-linearisation methods. The study reveals that the block hybrid method performs better than these methods in terms of accuracy, error norms, and convergence. However, the block hybrid method takes more time in some cases than these methods to find the solution due to the computational work required. Furthermore, increasing the number of intra-step points results in increased accuracy of the block hybrid method. In a study where precision and accuracy are critical, the block hybrid method is recommended for conducting such studies.

MSCS-O-6

A COMPARATIVE ANALYSIS OF IMPUTATION TECHNIQUES FOR HIGH-DIMENSIONAL LONGITUDINAL BIOMARKERS: UTILIZING THE COX-SHARED FRAILTY MODEL TO ESTIMATE TIME-VARYING EFFECTS IN HIV INCIDENCE

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Missing data is a persistent challenge in clinical research, especially in high-dimensional datasets with repeated biomarker measurements that introduce unobserved heterogeneity and inherent dependencies. Imputation methods, such as missForest and Multiple Imputation by Chained Equations (MICE), offer viable alternatives to complete case analysis, mitigating information loss, biased estimates, and reduced statistical power. Despite their widespread use, their comparative application in high-dimensional, time-varying biomarker data remains underexplored. This study evaluates and compares the performance of missForest and MICE in handling missing data for predicting HIV incidence.

We assess the impact of these imputation methods on the estimation of time-dependent effects within the shared frailty time-dependent Cox proportional hazards (PH) model, which accounts for unobserved

heterogeneity, and compare it to the time-dependent Cox PH model without a frailty term. The time-varying cytokines, alongside baseline covariates, were incorporated as predictors, with stepwise regression employed for covariate selection.

Our results demonstrate that both imputation methods enhance the statistical and predictive power of the Cox PH models, with specific strengths and weaknesses in each technique. After imputation, several cytokines, including SCF, GM_CSF, and SCGF_B, lost statistical significance, while others, IL_7, IL_13, IL_12P40, IL_2RA, LIF, and SDF_1A, emerged as significant predictors of HIV incidence. Notably, missForest achieved superior discriminative performance (AUC = 0.919) compared to MICE (AUC = 0.894). Furthermore, the shared frailty Cox PH model consistently outperformed its non-frailty counterpart, as evidenced by lower Akaike Information Criterion (AIC) values both before (AIC = 395.3) and after imputation (MICE: AIC = 1189.8; missForest: AIC = 1082.4).

These results underscore the critical role of selecting an optimal imputation technique and model specification for robust prediction in high-dimensional clinical data settings, particularly when addressing unobserved heterogeneity and dynamic covariate effects.

MSCS-O-7

MODELING HEALTH INEQUITIES THROUGH PREDICTIVE ANALYTICS: A MULTILEVEL AND MACHINE LEARNING APPROACH

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The rising burden of chronic diseases—alongside persistent inequities in healthcare access—necessitates advanced, data-driven approaches capable of distilling actionable insights from complex, population-level data. This study utilizes nationally representative data from the U.S. National Health Interview Survey (NHIS) to investigate the structural, behavioural, and socioeconomic drivers of chronic disease risk.

We implement a comprehensive analytic pipeline that integrates Generalized Linear Mixed Models (GLMMs), Bayesian GLMMs (BGLMMs), Structural Equation Modelling (SEM), and ensemble machine learning algorithms including Random Forests, XGBoost, and Support Vector Machines (SVMs). These methods are used to model the risk and distribution of hypertension, diabetes, cardiovascular disease, and respiratory illness across diverse U.S. population subgroups.

The workflow incorporates multiple imputation, dimensionality reduction, cross-validation, and fairness auditing, ensuring methodological robustness, reproducibility, and ethical accountability. Outputs—visualized via forest plots, predicted risk surfaces, and subgroup analyses—highlight patterns of systemic disparity by race, income, education, and access to care.

By demonstrating the value of interpretable, scalable predictive modelling in exposing hidden structures of health inequity, this work contributes to both the data science and public health domains. While focused on the U.S. context, the analytic framework and equity-oriented insights presented here offer transferable value to other health systems—such as South Africa—facing analogous demographic and structural challenges. These findings reinforce the importance of algorithmically informed, justice-centred public health strategies.

MSCS-O-8

A Hybrid Interpretable Machine Learning Model for Culturally-Attuned African Traditional Food Recommendations

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Poor dietary habits significantly contribute to chronic diseases including obesity, diabetes, and cardiovascular conditions, with culturally inappropriate nutrition recommendations often failing to achieve sustained behavioural change. While AI-driven personalized nutrition systems show promise, existing approaches predominantly use black-box models that lack transparency and fail to incorporate cultural food practices, limiting adoption in diverse communities. This research develops a hybrid interpretable machine learning framework for recommending traditional African foods that balances nutritional optimization with cultural appropriateness. The system integrates structured health data (BMI, dietary restrictions, health goals) with culturally informed features derived from traditional food ontologies spanning West, East, and Southern African cuisines. We developed a two-stage hybrid architecture combining rule-based cultural filters with interpretable machine learning models (Random Forest, Gradient Boosting) enhanced by SHAP explanations. The cultural component incorporates food preparation methods, ceremonial significance, and regional availability to ensure recommendations align with users' cultural contexts. Evaluation on a dataset of 2,847 traditional African recipes and 450 user profiles from three regions demonstrated 87.3% recommendation accuracy and 0.82 cultural appropriateness score (validated through expert review). User studies with 120 participants showed 73% higher acceptance rates compared to generic nutrition apps, with explanation quality rated 4.2/5.0 for clarity and cultural sensitivity. The interpretable framework enables users to understand why specific foods are recommended while respecting traditional dietary practices. This work contributes a novel approach to culturally sensitive nutrition AI, demonstrating that interpretable machine learning can effectively bridge algorithmic performance with cultural authenticity in health applications.

Keywords: Interpretable Machine Learning, Hybrid Models, Personalized Nutrition, Explainable AI (XAI), Dietary Recommendations.

MSCS-O-9

Development of a Pointing offset Measurement System for HIRAX

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The Hydrogen Intensity and Real-time eXperiment (HIRAX) is a cutting-edge radio interferometer array consisting of 1024 six-meter dishes at the South African Radio Astronomy Observatory (SARAO) site in the Karoo desert. Designed to survey 15,000 square degrees of the Southern sky in the 400–800 MHz frequency range, HIRAX will complement major Southern Hemisphere surveys such as DESI, SPT, and ACT. The main scientific objectives are to monitor Fast Radio Bursts (FRBs), identify the faint Baryon Acoustic Oscillations (BAO), and constrain the dark energy equation of state. Separating the BAO signal from brighter galactic and point source foregrounds is a significant issue for HIRAX, requiring careful mitigation of instrumental and

systematic factors, such as pointing error. We developed an inclinometer monitoring system to improve the accuracy of HIRAX's cosmological measurements by minimizing pointing errors in the interferometric data. This system was deployed on a HIRAX prototype dish at the Hartebeesthoek Radio Astronomy Observatory (HartRAO) to monitor dish stability under real-world conditions. We gathered and analysed data from the inclinometer sensor alongside wind sensor measurements. Clear correlations between inclinometer readings and wind conditions: we observed distinct spikes during wind gusts and consistent fluctuations on days with sustained wind speeds, indicating that the inclinometer effectively captures dish vibrations induced by wind. These results provide valuable insights into the wind-induced pointing errors in the HIRAX system. Future work includes deploying the inclinometer system on HIRAX dishes at Klerefontein to improve further pointing stability across the array.

MSCS-O-10

RFI detection in interferometric data using Machine learning algorithms

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Radio frequency interference (RFI) is a contaminating signal from the telescope's terrestrial, external, and internal sources. With large datasets coming from telescopes like Hydrogen Intensity and Real-time Analysis eXperiment (HIRAX), MeerKAT and other new-generation telescopes, It is essential to detect and excise the RFI at the early stages to avoid losing data credibility and sensitivity and having to extend the duration in which the observations are made. In this research, we employ discriminative Autoencoders, unsupervised anomaly detection learning that can distinguish RFI signals from noise. This includes even the faintest RFI signals. This learning type enhances RFI detection compared to other supervised learning algorithms and general autoencoders.

We employ AOflagger tagged simulations for validation after testing the models on gaussian simulations with mock RFI and training them on RFI-free gaussian simulations (RFI clean) across 50 epochs. The flagging of these Aoflagger simulations is flawless. In order to assess the model's performance, we also look at the Receiver Operating Character (ROC), Precision Recall, and Area Under the Curve curves.

MSCS-O-11

Transformer Models for Ontology Vocabulary Construction from Texts

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Ontologies serve as foundational frameworks for organizing knowledge, enabling information sharing and structured representation of domain-specific terms. Manual ontology construction is labor intensive, costly, and inadequate for handling ever-growing web data. The exponential growth of web-based data necessitates automated ontology construction to organize and manage knowledge effectively. This process involves building a vocabulary from various sources by extracting terms, concepts, relations, and axioms. Traditional

machine learning methods struggle with scalability, ambiguity, and domain-specific challenges. Early deep learning models such as RNNs, CNNs, and LSTM faced limitations like vanishing gradients and sequential processing inefficiencies. In contrast, transformer models have revolutionized the field of Natural Language Processing by enabling contextual understanding and parallel processing. However, challenges persist, including handling domain-specific terminology, disambiguating complex relationships, and integrating global and local contexts. To address these gaps, this study optimizes transformers to automate ontology vocabulary construction and improves the accuracy of term/relation extraction from texts. The study follows five systematic steps: (i) A critical review of deep learning methods for ontology construction, (ii) Design of an attention- based BERT model integrated with WordNet for domain-specific terms extraction, (iii) Development of a Centrality-weighted BERT model (CenBERT-SEQ) for key phrase extraction from texts, (iv) Development of a Multimodal Transformer-based Fusion (MTF) model for relation classification, and (v) Error analysis in transformer models for relation extraction from texts. Various state-of-the-art transformer models were adopted in the development of our proposed models including BERT, DistilBERT, RoBERTa, LUKE and mLUKE. Experiments spanned diverse datasets, including horticulture do main texts, computer science article datasets (SemEval-2010, WWW, KDD) and benchmark datasets (Conll04, NYT). The performance of the transformer-based models developed was evaluated using various metrics, including accuracy, precision, recall, and F1-score. The attention-based BERT model integrated with WordNet for domain-specific term extraction achieved an accuracy of 73% a precision of 89%, a recall of 79%, and F1-Score of 84%. The CenBERT-SEQ model performed well in keyphrase extraction and achieved a higher accuracy, precision, recall, and F1-score of 95%, 97%, 91%, and 94%, respectively. The best performance was achieved by the MTF model in relationship classification with 96.86%, 96.89%, 96.86%, 96.87%, accuracy, precision, recall, and F1-score, respectively. The errors analysis reveals that, despite these successes, transformers struggle with unseen data due to semantic challenges such as semantic overlap (47%), boundary errors (28%), ambiguous cases (20%) and outliers (5%). For future directions of research, this study recommends the adoption of hybrid frameworks that combine transformer models with structured domain knowledge, to address semantic ambiguity and boundary detection. The study also recommends the adoption of dynamic ensemble models that fuse task-specific transformer-based models such as our proposed CenBERT-SEQ and MTF models with graph-based alignment techniques such as graph neural networks (GNNs), to mitigate generalization gaps.

MSCS-O-12

Perfect Compactifications of Frames

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In this talk, perfect compactifications of frames will be discussed. The Stone-Čech compactification of a completely regular frame and the Freudenthal compactification of a rim-compact frame are examples of perfect compactifications. We will examine the perfectness of the least compactification of a regular continuous frame.

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FLASH ABSTRACTS

AGRICULTURAL, EARTH AND ENVIRONMENTAL SCIENCES

AEES-F-1

ASSESSMENT OF THE IMPACT OF PESTICIDES ON THE AQUATIC ENVIRONMENT OF THE KOUGA RIVER

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The increasing use of pesticides in agriculture poses significant threats to freshwater ecosystems, particularly in developing regions with limited environmental monitoring. This study aims to assess the impact of pesticide contamination on the aquatic environment of the Kouga River in South Africa, which is a key water source that is bordered by intensive farming. Through a combination of field sampling, bioassessment using the South African Scoring System (SASS5), and hydrological modelling with the SWAT+ tool, the research will evaluate pesticide presence, ecological effects on aquatic macroinvertebrates, and water quality degradation across various sites along the river. Preliminary insights indicate significant ecological stress linked to land use and seasonal variability. The outcomes are expected to enhance understanding of pesticide transport and toxicity in tropical river systems and support improved catchment management and regulatory frameworks. Also, to inform sustainable water resource management and improve monitoring strategies for pesticide pollution in vulnerable river systems.

AEES-F-3

AN EVALUATION OF THE STATE OF CITIZEN SCIENCE FOR WATER QUALITY MONITORING IN SOUTHERN AFRICA

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South Africa faces critical water security issues including water quality decline in river systems, posing threats to river health. However, South African water authorities face a dearth of capacity to monitor water quality and river health, thus face limitations in meeting reporting requirements at both national (State of Rivers reporting) and international (Sustainable Development Goal – specifically SDG 6.3.2 – reporting) scales. In light of these challenges, this research sought to investigate the potential of citizen science (CS) to aid water quality monitoring (WQM) in the South African context, with the main aim to evaluate the potential of CS for WQM which included the following objectives: determination of how CS can assist in South African and international water resources monitoring and reporting;

consolidation of CS for WQM efforts across South Africa during 2023/2024; and, the generation of a State of Rivers (SoR) report from a CS perspective over localities across South Africa.

Through national collaborative efforts, CS data was collected across river systems using biological observations of macroinvertebrates (mini Stream Assessment Scoring System – miniSASS), the determination of the turbidity levels of a stream (by use of a clarity tube) and the determination of the levels of certain chemicals present. Over 2700 data observations were used in the generation of the CS SoR report, representing monitoring efforts across South Africa. Challenges included the variability in data collection frequency and potential biases in site selection. However, the report demonstrated the feasibility of gaining valuable insights into river health based on CS data at considerable temporal and spatial scales. Notably, biomonitoring, turbidity monitoring, and *E. coli* CS monitoring techniques can be reliably used for water quality monitoring, and/or tracking key contaminants. However, recommendations suggest further research into physico-chemical monitoring techniques specifically for nitrate and phosphate monitoring, which, once refined, can be used to inform national and SDG 6.3.2 reporting.

Additionally, this research revealed significant qualitative insights into the potential and reality of CS applications with support for applications at large-scale to support WQM, but concerns raised included varying data collection methodologies, data ownership, and sustainable funding systems for CS efforts.

Overall, CS has demonstrated great potential in this evaluation research, not only for producing sound datasets for WQM but also for its value beyond data, including as an educational tool, a promoter of environmental conservation, and a tool for advocacy. The data generated through CS can be used to increase the temporal and spatial frequencies of both national-scale and international-scale reporting on the local rivers of South Africa. CS Physico-chemical and biological monitoring techniques are also recognised data sources for reporting on SDG 6.3.2, demonstrating the potential for CS to contribute to detailing South Africa's progress towards achieving SDG 6.3.2.

AEES-F-4

FOLIAR APPLICATION OF SEAWEED EXTRACT TO MITIGATE NEGATIVE EFFECTS OF SIMULATED SALINITY STRESS ON PRODUCTION OF POTATOES

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Abiotic stresses negatively affect various stages of growth and development of crops resulting in the loss of yield and quality. Amongst abiotic stresses, salinity is known to be more devastating. This abiotic plant stress disrupts the production of economic crops such as potato. This necessitates the need for scientists to conduct more research that focus on modern innovative approaches that can support sustainable production of potatoes. One of these methods is the use of plant derived biostimulants to attempt to produce this crop in a sustainable manner, while counteracting the negative effect caused by abiotic stress such as salinity. This study was, therefore, carried out to find the ideal concentration of seaweed extract that can be applied to assist crops to cope and produce high quality produce despite the occurrence of salinity stress on the open field. Crops were simulated with salinity ($3dSm^{-1}$) using sodium chloride. The treatment levels were seaweed extract (SWE), at the following concentrations: 0 control, 1 L: 0.02 kg (v/w), 1 L: 0.03 kg (v/w), 1 L: 0.04 kg (v/w), 1 L: 0.05 kg (v/w) and 1 L: 0.06 kg (v/w). The study indicated that SWE extract at 1 L: 0.03 kg (v/w) can improve plant vegetative growth, physiological processes, and nutritional quality of potato tubers. These beneficial effects were achieved as a result of nutrients and phytohormones such as auxins, gibberellin and cytokinins present in the applied biostimulants. Seaweed extract at a concentration of 1 L: 0.03 kg (v/w) is an ideal concentration of biostimulant that can be employed in the agricultural industry to improve potato performance under salinity stress and still produce optimum yield and quality potatoes while sustaining environmental health.

Keywords: Abiotic stress, eco-friendly farming, phytohormones, plant growth regulators, Solanaceae crops

AEES-F-5

Empowering Smallholder Farmers: Leveraging South African Weather Services Seasonal Climate Information for Climate Adaptation and Enhanced Food Security in KwaZulu-Natal

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Smallholder farmers in KwaZulu-Natal face increasing climate variability and extreme weather events that threaten food security and agricultural productivity. This study explores how seasonal climate information provided by the South African Weather Services (SAWS) can be leveraged to empower smallholder farmers in the province to enhance their adaptive capacity and resilience. Using a mixed-methods approach involving surveys, interviews, and focus group discussions with farmers, extension officers, and climate service providers, the research examines farmers' access to, understanding of, and use of seasonal forecasts for decision-making. The findings reveal that while seasonal climate information is available, its accessibility, relevance, and interpretation remain significant challenges for smallholder farmers. Many farmers lack awareness, training, and localized advisories necessary for practical application. However, those who effectively utilize seasonal forecasts are better able to plan planting schedules, manage risks, and improve yields. The study underscores the importance of strengthening the climate services value chain through targeted training, participatory forecast dissemination, and collaboration among SAWS, agricultural stakeholders, and local communities. Enhancing the usability of climate information can play a pivotal role in improving food security, reducing vulnerability, and promoting sustainable farming practices among smallholder farmers in KwaZulu-Natal.

AEES-F-7

LAND AND MARKET ACCESS AMONG URBAN FARMERS IN SOBANTU AND MPOPHOMENI: IMPLICATIONS ON HOUSEHOLD FOOD SECURITY

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Across the world, many communities rely on agriculture to generate income and sustain their livelihoods. Urban farmers are locked out because they cannot participate in lucrative activities and have limited land to grow their produce. The rapid growth in urban areas is putting pressure on food systems. South Africa is recognized as a country that is food secure at a national level; however, it faces food insecurity at the household level. Food insecurity is still a significant challenge for many South African households, mainly urban households. Sustainable Development Goal 2, Zero Hunger, aims to create an environment free of hunger by 2030. The significance of farming production is closely tied to access to land and markets. The overall perception is that households participating in urban farming have improved nutritional status. This study argues that land access directly affects urban farmers' market opportunities, as having more land enables farmers to grow larger quantities of produce, which can lead to sales in lucrative markets and increased profits. The study examines how land and market access influence household food security among urban farmers. Data were collected through structured surveys of 172 purposively selected households

with gardens and focus group discussions involving farmers' cooperatives. The data were analysed using descriptive statistics, PESTLE analysis and Tobit regression in conjunction with the Household Food Insecurity Access Scale and Household Dietary Diversity Score (HFIAS and HDDS). The Tobit regression results indicated that food security primarily influenced marital status, education level, household size, land access and total household income. These findings highlight the importance of enhancing access to markets and land in conjunction with educational support, offering valuable insights for government and other agencies aiming to improve household food security.

AEES-F-8

THE HEALTH STATUS OF HEMP: INSIGHTS INTO THE SEROLOGICAL AND MOLECULAR CHARACTERIZATION OF VIRUS AND VIRIOD INFECTIONS

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Hemp (*Cannabis sativa* L.) is an emerging industrial and medicinal crop in South Africa. Hemp produces two cannabinoids (tetrahydrocannabinol and cannabidiol) that are widely used in medical and pharmaceutical industries. This crop is susceptible to a variety of plant pathogens including viruses and viroids. There is a need to develop optimum and reliable detection techniques for viruses and viroids infecting hemp in South Africa. This study was conducted with the aim to use serological and molecular methods to characterize viral and viroid infections of hemp. Field surveys were conducted in the Eastern Cape, Gauteng and Limpopo provinces to collect symptomatic and asymptomatic leaf material of hemp. DNA and RNA were extracted from leaves using the cetrimethylamonium bromide and TRIZOL, respectively. Polymerase chain reaction (PCR) and reverse-transcription PCR were used to detect the presence of alfalfa mosaic virus (AMV), arabis mosaic virus (ArMV), beet curly top virus (BCTV), cannabis sativa motivirus1 (CasaMV1), cucumber mosaic virus (CMV), hibiscus chlorotic stunt virus (HCRSV), hop latent viroid (HLVd), tobacco streak virus (TSV), tobacco mosaic virus (TMV), and tomato spotted wilt virus (TSWV). The double antibody sandwich enzyme-linked immunosorbent assay (DAS-ELISA) was used for the detection of AMV, ArMV, CMV, TSV and TMV in Eastern Cape and Gauteng provinces. PCR amplicons for samples that tested positive for viral infections were sent for Sanger sequencing to confirm infection. The identity of viruses was confirmed through Basic Local Alignment Search Tool (BLAST). DAS-ELISA detected the presence of the ArMV, CMV and TSV samples collected in the Eastern Cape province and none of the tested viruses were detected in the Gauteng province. RT-PCR detected the presence of CMV and TMV with the band sizes of 678 and 422bp respectively. Sequence data confirmed that isolates belonged to the cucumovirus and tobomovirus genera. PCR results revealed the absence of AMV, HLVd and TSWV in all provinces. There is still a need to optimize PCR conditions for the detection of ArMV, BCTV, CasaMV1, HCRSV and TSV and to confirm the presence or absence of HLVd in the areas surveyed. The presence of TMV was a concern as this virus spreads easily, has a wide host range and has led to yield losses of up to 25% on tobacco in Holland. Results obtained in this study can be used in the development of integrated disease management strategies for hemp and cannabis diseases. Future studies need to investigate the impact of viral and viroid infections on the content of cannabinoids and the strength of fiber.

Keywords: Cannabis virology, viroids, molecular characterization, BLAST, Sanger sequencing

AEES-F-9

THE MORPHO-PHYSIOLOGICAL RESPONSES OF SELECTED CITRON MELON GENOTYPES EVALUATED UNDER LOW NITROGEN CONDITIONS

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Citron melon (*Citrullus lanatus var. citroides*), an emerging underutilised crop, widely known for its tolerance to various abiotic stress factors particularly poor soil fertility due to low nitrogen content. This study investigated the morpho-physiological responses of selected citron melon genotypes. Four genetically diverse citron melon genotypes were evaluated under greenhouse and rainout shelter environments using a RCBD with three replications. Two nitrogen application regimes i.e. low nitrogen (LN) and optimum nitrogen (ON) were investigated using polyethylene pots. The morphological (nitrogen use efficiency (NUE), fruit length (FL), fruit diameter (FD), and fruit mass (FM), leaf area (LA), vine length (VL)) and physiological (i.e., photosynthetic rate (A), stomatal conductance (g_s), Intercellular carbon dioxide concentration (Ci), transpiration rate (E)) were recorded. The analysis of variance revealed significant ($p \leq 0.05$) genotype effect for LA, FL, FM, RT, SPF and NUE. Significant site effect was recorded for all study traits except RM and SPF. Nitrogen application effect was significant ($p \leq 0.05$) for LA, VL, SPF, NUE, g_s and E. High means values were recorded for the studied morpho-physiological traits under low nitrogen conditions i.e., LA (137 cm ^{2}), VL (2.980 m), FM (1433g), FL (15.13 cm), FD (14.47 cm), RT (2.33 cm) NUE (895.8), A (54.54 μmol m^{-2} s^{-1}), g_s (0.2914 mol m^{-2} s^{-1}) and E (4.771 mmol m^{-2} s^{-1}). For the studied morphological traits, genotypes G58 recorded the highest values of 137 cm^2 (LA), 15 cm (FL), 1433.3 g (FM) and 895.8 (NUE), while G16 excelled with 2.980 m (VL), 14.47 cm (FD) and 2.33 (RT). For physiological attributes, G16 showed the highest performance for 54.54 mol m^{-2} s^{-1} (A), 0.2914 mol m^{-2} s^{-1} (gs) and 4.771 mol m^{-2} s^{-1} (E). Regarding the fruit related traits, G58 identified with the highest FL (15.13 cm) and FM (1433 g). These citron melon genotypes (i.e., G16 and G58) could be key to aid cultivar design and development for enhanced productivity under low nitrogen availability.

AEES-F-10

Food Insecurity Among Tertiary Students: A Comparative Study of Mangosuthu University of Technology and University of KwaZulu-Natal

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Food insecurity remains a growing concern in South Africa's higher education sector, disproportionately affecting students from low-income backgrounds. This study conducts a comparative analysis of food insecurity at Mangosuthu University of Technology (MUT) and the University of KwaZulu-Natal (UKZN), with a focus on prevalence, socio-economic determinants, academic and psychological consequences, and coping strategies. KwaZulu-Natal presents unique socio-economic challenges, and universities in this region draw a large proportion of students from financially disadvantaged communities.

A mixed-methods design integrates quantitative surveys (n=300) and qualitative interviews and focus group discussions, enabling a comprehensive understanding of statistical patterns and personal experiences. Stratified random sampling and purposive selection capture diverse perspectives across campuses and residences. Quantitative data will

be analysed using descriptive statistics and logistic regression models, while qualitative data will be coded using thematic analysis. Preliminary literature suggests food insecurity correlates with poor academic performance, mental health distress and stigma, while institutional support remains unevenly accessed due to barriers such as limited resources and social perceptions.

This research aims to inform equity-focused policies and expand interventions tailored to vulnerable student populations. Through cross-institutional analysis, the findings will contribute toward improving food access initiatives, strengthening support networks, and reinforcing student wellness within South Africa's tertiary education sector.

AEES-F-11

AGRO-PROCESSING BARRIERS AND OPPORTUNITIES: INSIGHTS FROM UMSHWATHI LOCAL MUNICIPALITY, SOUTH AFRICA

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Despite agro-processing's potential to enhance rural livelihoods, reduce post-harvest losses, and drive inclusive economic growth, current research and policies fail to address the persistent disconnect between smallholder crop farmers and their participation in agro-processing industries, particularly in underdeveloped rural contexts like the uMshwathi local municipality, KwaZulu-Natal. These frameworks often overlook the complex, multidimensional barriers smallholders face, including poor access to capital, knowledge, and infrastructure, resulting in their continued marginalisation from value-added agricultural opportunities. This thesis investigates the factors influencing smallholder crop farmers' participation in agro-processing industries within the uMshwathi local municipality. It aims to identify key agro-processing activities practiced by smallholders, assess their level of knowledge and awareness of agro-processing, examine the accessibility of critical resources, and explore the decision-making processes driving engagement in value-adding practices. The study is situated within the Sustainable Livelihoods Framework (SLF) and the Innovation Diffusion Theory (IDT), providing a dual lens through which smallholders' adaptive capacity, resource utilisation, and innovation uptake are analysed.

The research employed semi-structured surveys, focus group discussions, and key informant interviews with 30 purposively selected smallholder farmers using a mixed-methods design. Quantitative data were analysed using IBM SPSS to derive statistical trends, while qualitative responses were thematically coded and analysed using NVivo 15. Data triangulation ensured robust and context-sensitive insights. Findings reveal that 73.33% of smallholder farmers engage in home-based agro-processing activities such as baking, juice-making, and mushroom drying. However, their participation remains hindered by high levels of credit inaccessibility (86.7%), poor access to processing equipment (90% with no or uncertain access), and inadequate infrastructure. Additionally, formal training remains irregular, and many farmers rely on informal knowledge systems and peer learning. While most farmers recognise the economic and food security benefits of agro-processing, their ability to act on this awareness is severely constrained by limited human, physical, financial, and institutional capital.

The research contributes new knowledge by revealing how livelihood assets, innovation characteristics, and contextual barriers influence smallholder participation in agro-processing. It suggests policymakers should provide targeted credit schemes, capacity-building initiatives, and promote cooperatives to integrate smallholders into agro-processing value chains. This will help align agricultural development strategies with national goals and the UN Sustainable Development Goals, focusing on zero hunger, decent work, and economic growth.

AEES-F-12

Animal manure extracts as a source of nutrients on growth, yield, and quality of hydroponically grown tomatoes (*Solanum lycopersicum* L.)

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Tomatoes rank as the second most vital vegetable crop in the world, they are grown globally except Antarctica. They are highly nutritional as they contain vitamins and antioxidants that benefit human health. The cultivation of these fruits is, however, costly due to the overuse of chemical fertilizers since their nutrient formulations are very expensive. Thus, this study assessed the potential of animal manure extracts on the growth of tomatoes under hydroponic production system. This experiment investigated how extracts from animal manure influenced growth, leaf gas exchange, chlorophyll fluorescence, yield, physiochemical and nutritional quality of tomatoes (cv. CLX 532) grown in the soilless hydroponic system.

The findings for growth, photosynthesis and chlorophyll fluorescence experiments showed that applying GME and CHME boosts plant height, stem diameter, fruit number, Ci, WUEi, Fm and qN while CME increased gs, Fv/Fv and ETR. On the other hand, the results for yield and quality experiments showed that the application of CHME enhanced the number of fruits, shoot mass, TSS, TA, TSS/TA, BrimA, colour index and firmness, CME affected shoot mass, while GME affected TSS/TA, BrimA, firmness and phenolics concentration. Furthermore, fruits fertigated with the commercial fertilizer were rich in macronutrients, whereas those fertigated with AME had elevated levels of micronutrients. Based on these findings, animal manure extracts could serve as an alternative source of nutrients in the soilless production of tomatoes, especially CHME and GME. They improved growth, yield, leaf gas exchange, chlorophyll fluorescence and overall fruit quality.

AEES-F-13

SEVERE PRE-FLOWERING DROUGHT STRESS DISTORTS CORRELATIONS BETWEEN YIELD COMPONENTS IN GRAIN SORGHUM

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Due to climate change, drought stress is increasingly becoming a serious threat to agriculture, including the production systems of hardy crops such as sorghum (*Sorghum bicolor* L. Moench). Breeding for drought tolerance is often cumbersome due to the diminishing heritability of key traits under severe stress; breeders must rely on yield components and secondary traits highly and genetically correlated to grain yield. A study examined the correlations between sorghum secondary traits and yield components under severe drought stress and well-watered conditions in the open field at Ukulinga Research Farm in the 2023/24 season. The study comprised 260 grain sorghum genotypes planted in a 0.1-alpha-lattice design, in two replications, each with 13 blocks in each of the two watering regimes. All experimental plots received the same irrigation until five weeks after crop emergence. However, the severe drought stress plots were allowed to deplete to 9-11% soil moisture content in four weeks before flowering. The 260 genotypes

elicited significant differences in leaf rolling, tillering, senescence, plant height and other phenological traits in the two soil moisture environments, and apparent drought stress-induced yield reductions. The study recorded many non-significant correlations between yield and grain yield components in the severe drought stress environment. The study recorded significant, but weak correlations between grain yield and seed size ($p < 0,01$; $r = 0,14$), grain yield and number of grains per panicle ($p < 0,05$; $r = 0,12$), and panicle size and panicle harvest index ($p < 0,05$; $r = 0,10$). Panicle length, diameter, and peduncle girth all returned non-significant and weak correlations. This study now challenges the use of some secondary traits in accurately screening for drought stress; instead, it calls for the development of relevant and panel-specific indices for accuracy.

AEES-F-14

THE EFFECT OF SEAWEED-EXTRACT AS A BIOSTIMULANT ENHANCING GROWTH AND DEVELOPMENT OF COWPEA (*VIGNA UNGUICULATA*)

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Cowpea (*Vigna unguiculata*) is a nutrient-rich Indigenous African leafy vegetable, holding a promise to alleviate food and nutrition insecurity in sub-Saharan Africa [1]. However, its cultivation is constrained by environmental and agronomic stresses. This study employed 3 × 2 factorial experiment arranged in a completely randomized design to evaluate the effect of seaweed extract applied through soil feeding (SF) and foliar spray (S) at different application rates: reduced (C1), recommended (C2), and twice the recommendation rate (C3) on growth, development and yield of cowpea. Physiological and morphological parameters were measured, including photosynthetic gas exchange, chlorophyll fluorescence parameters, stem diameter, plant height, and root and leaf growth. Results showed that the SF (C2) significantly ($p \leq 0,05$) produced higher dry biomass (15g) and moderate nodules (31) with stable photosynthetic traits, similar findings were observed on cowpea, soil-applied seaweed at recommended rates enhanced its growth and symbiotic efficiency [2]. Soil feeding (C3) improved steam diameter (2.9cm), root length (40.3), and recorded highest values of photosynthetic efficiency including higher steady-state fluorescence, effective quantum yield of photosystem II, and non-photochemical quenching. Interestingly, SF (C1) promoted longer roots (40.63cm) while control recorded the shortest (31.6cm), though differences were not significant. Despite the control showing more root nodules (38), tallest plant (130cm), and most leaves (99.3), treated plants exhibited better overall vegetative performance. The results suggest that SF (C2) is optimal for promoting cowpea's physiological vigour and growth, offering a sustainable strategy to enhance productivity of cowpea under low-input farming conditions.

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AEES-F-15

Reimagining Curriculum for Food Security: A Complexity-Informed SDG-Aligned Framework for Higher Education

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Persistent food insecurity and fragmented curriculum structures in higher education demand innovative pedagogical responses. Conventional approaches often overlook the interconnectedness of socio-ecological systems, disciplinary silos, and the transformative potential of education. This study develops and evaluates a complexity-informed curriculum design model to enhance SDG integration, contextual relevance, and interdisciplinary coherence within Consumer Science and Food and Nutrition education. Grounded in Complexity Theory, the model employs constructs such as emergence, non-linearity, and self-organisation to reconceptualise curriculum as a dynamic, adaptive system. Quantum metaphors, entanglement, and uncertainty further enrich pedagogical strategies and foster transdisciplinary engagement. Using a constructivist-interpretivist paradigm and qualitative case study design, the research focuses on curriculum modules at X University. Data were collected via semi-structured interviews, document analysis, and reflective expert journals. Thematic analysis using ATLAS.ti revealed five dimensions: curriculum fragmentation and disciplinary silos; limited SDG integration and contextual misalignment; underutilised experiential learning; disconnection from local food security realities; and opportunities for quantum-informed pedagogical innovation. The study proposes a framework for embedding SDG competencies through system-based learning outcomes and advocates for experiential and work-integrated learning to promote learner agency. Complexity-informed assessments are recommended to support adaptability, reflection, and co-creation. Transdisciplinary collaboration among curriculum teams is emphasised to foster holistic understanding and innovative practice. This theoretically grounded, practice-oriented model offers actionable insights for educators, curriculum designers, and policymakers seeking to embed sustainability, equity, and complexity into higher education systems, ultimately contributing to more responsive and transformative educational environments.

Keywords: *Complexity-Informed Curriculum Design, Food Security Education, SDG Integration, Transdisciplinary Pedagogy, Experiential and System-Based Learning*

AEES-F-16

Development of maize lethal necrosis disease (MLND) resistant maize using CRISPR/Cas9 technology

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Maize lethal necrosis disease (MLND) is a viral disease caused by the co-infection of maize chlorotic mottle virus (MCMV) and a maize-infecting potyvirus. The disease poses a significant threat to maize production in sub-Saharan Africa and has been reported to cause yield losses of up to 100% in infected fields. Although the disease is not currently present in South Africa, its introduction is considered imminent. To safeguard national maize production, it is crucial to develop resistant cultivars. Potyviruses, including those in the MLND complex exploit host metabolic machinery such as the eukaryotic initiation factor (eIF) proteins for their replication and translation during infection. This study aims to develop MLND-resistant maize lines by targeting susceptibility genes (eIF4G, eIF4E1 and eIF4E2) using

CRISPR/Cas9 genome editing. Candidate genes were identified through literature review. *In silico* analysis was conducted to identify sites of interaction between plant and the viral pathogen. A web tool, CRISPOR, was used to design guide RNAs (gRNAs) targeting potential interaction sites on the candidate genes. Plasmid vectors containing gRNA arrays, Cas9, and a selectable marker were combined via Golden Gate cloning to form transformation vectors. The resulting transformation vectors were incorporated into Agrobacterium strain*s* via electroporation. Preliminary results suggest that among MCMV proteins, only p50 interacts directly with the eIF4E. The designed gRNAs target these interaction sites to disrupt virus-host binding, thus interfering with the infection cycle. Transformation vectors were successfully electroporated into Agrobacterium as confirmed by colony PCR. The efficacy of the transformation vectors will first be tested in maize protoplasts before proceeding to transforming using immature embryos. This work is expected to yield MLND-resistant maize lines contributing to sustainable maize production and national food security.

Keywords: Maize lethal necrosis disease, CRISPR/Cas9, *in silico*, protein interactions, Golden Gate cloning

AEES-F-17

Improving Germination Rates of *Moringa oleifera* Seeds Using Different Priming Methods

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Although moringa is regarded as a fast-growing plant, its germination and establishment rates remain a significant challenge, especially under field conditions. Factors such as seed coat thickness, and environmental conditions contribute to irregular germination and weak seedling establishment, ultimately affecting biomass yield and quality. Therefore, there is a need for low-cost solutions to address these limitations and promote successful moringa production. A 5 seed priming treatments (control, 5 g of KNO_3, distilled water, warm water, and mechanical scarification) were tested under laboratory conditions to evaluate their effects on moringa seed germination and seedling growth. Radicle growth and shoot growth data were collected every day for a total of 13 days. Results show that seed priming had a significant effect on radicle length ($p < 0.001$) and shoot length ($p = 0.0011$), however it had no significant effect on the number of days to germination ($p = 0.4129$). KNO_3 had significantly higher average shoot length (6.95 mm) and average radicle length (14.43), compared to the control average shoot length (0.63 mm) and average radicle length (4.59 mm). Germination percentage of KNO_3 (80%), distilled water (70%), warm water (69%), mechanical scarification (61.6%) showed significantly higher percentage, compared to the control (16.67%). These findings show that KNO_3 priming, at 5 g for 12 hrs, is a promising strategy to enhance moringa seedling establishment under South African conditions, potentially improving productivity for smallholder farmers.

Keywords: *Moringa oleifera,* seed priming, radicle length, shoot length, germination rate

AEES-F-18

A Critical Review on the Applications of Sentinel Satellite Datasets for Soil Moisture Assessment in Crop Production

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Understanding soil moisture dynamics in crop production is critical for optimising water resource management. The Sentinel satellite missions have significantly contributed to soil moisture monitoring by providing high-resolution, multi-sensor data. This review examines advancements in soil moisture assessment using Sentinel datasets, particularly in crop production. It highlights key challenges, evaluates their impact on monitoring accuracy, and explores potential methodological improvements. Findings indicate that Sentinel-1's synthetic aperture radar (SAR) data, particularly VV and VH polarizations, and Sentinel-2's multispectral indices, such as NDVI and NDMI, are widely integrated with machine learning algorithms to enhance soil moisture estimation. However, dense vegetation and complex topography reduce retrieval accuracy, necessitating sensor fusion and calibration for improved reliability. Sentinel-3 provides valuable surface temperature and land condition data for indirect soil moisture estimation, but its application remains limited due to higher uncertainty compared to SAR and multispectral approaches. Emerging trends suggest that machine and deep learning techniques, such as RF, SVR, and CNN, can enhance data fusion across Sentinel missions. Additionally, preprocessing steps such as RTC, speckle filtering, and the integration of multipolar and polarimetric data with physical backscattering models show promise in mitigating radar backscatter interference. Further development of robust retrieval models that incorporate topography, soil roughness, and texture are essential for improving soil moisture accuracy in diverse agricultural landscapes. This review underscores the need for continued methodological advancements to maximise the potential of Sentinel datasets for soil moisture monitoring in precision agriculture and water resource management.

Keywords: Soil moisture, Sentinel-1, Sentinel-2, Data fusion, Sentinel-3

AEES-F-19

Monitoring bush encroachment in Bisley Nature Reserve using RapidEye and PlanetScope data

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The woody vegetation encroachment into natural grasslands is a significant global concern in nature reserves and other protected and conserved landscapes. Bush encroachment remains one of the major contributors of land degradation and landscape alterations. The phenomenon adversely affects biodiversity, conservation efforts, landscape productivity and recreational value. To understand the progression and threat of woody vegetation invasion into nature reserves, this study aimed to monitor bush encroachment and associated land use-land cover types in a nature reserve using high spatial resolution multi-temporal data within the Google Earth Engine (GEE) platform. The study employed RapidEye and PlanetScope data spanning the period from 2009 to 2023 to estimate the changing extent of woody vegetation, grassland cover and bare areas, providing a comprehensive analysis of their dynamics over the 14-year study period. The results indicated that over the study period, approximately 130.69 hectares of grassland underwent a transition to woody vegetation, while approximately 2.78 hectares of woody vegetation was converted to grassland. The study revealed a net increase of 127.91 hectares in the total area covered by woody vegetation. The analysis revealed a notable upward trend in woody vegetation expansion during the 14 years of study, with percentage coverage of 37.69%, 51.18%, 64.52% and 74.02% in 2009, 2014, 2019 and 2023, respectively.

AEES-F-20

Comparative profiling of bioactive compounds and antioxidant activity of extracts from selected medicinal plants: Implications for mitigating obesity-related inflammation

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Obesity is a metabolic disorder that contributes to various health complications, including diabetes, hypertension, and cardiovascular dysfunction. Increased use of plant extracts to reduce obesity risk reflects consumer preference for natural remedies and scientific validation for their safety and efficacy. This study profiled bioactive compounds in methanolic extracts from the leaves and roots of *Merwilla plumbea* (Lindl.) Speta, *Hypoxis hemerocallidea* Fisch, *Eucomis autumnalis* (Mill.) Chitt, and *Pentanisia prunelloides* (Klotzsch) Walp. The objective was to explore and compare the medicinal properties of distinct plant parts for their potential to mitigate obesity-induced inflammation. *P. prunelloides* leaves and roots had higher concentrations of phenolics (123.92 mg/mL and 110.01 mg/mL) and flavonoids (44.4 mg/mL and 55.05 mg/mL), respectively. Gallotannins were significantly higher in *H. hemerocallidea* roots (5.19 mg/mL) while proanthocyanidins were predominantly found in *P. prunelloides* roots (35.77 mg/mL). The antioxidant activity was assessed by ferric reducing antioxidant potential (FRAP) and DPPH radical scavenging activity (RSA) assays. *P. prunelloides* roots had higher FRAP (2.97 mg/mL) and moderate DPPH (RSA) (52.89 %), while *M. plumbea* roots had the highest DPPH RSA (80.86 %) and lower FRAP (2.25 mg/mL). *E. autumnalis* roots and leaves showed FRAP values of 2.78 and 2.13 mg/mL, and DPPH RSA of 80.72 and 74.54 %, respectively. The results revealed that all plants investigated had considerable amounts of bioactive compounds, with *P. prunelloides* showing the highest concentration, highlighting its potential for further pharmaceutical and nutraceutical exploration. Further research validating the bioactivity of key compounds in vivo, exploring seasonal variations, and assessing optimal harvesting practices is paramount for the sustainable utilization of these medicinal plants.

AEES-F-21

Host-Plant Mediated Selection of Beneficial Microbes in the Presence of Plant Resistance Inducers

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Introduction:

The widespread use of chemical fungicides in crop protection has led to several challenges, including environmental and human health hazards, and reduced efficacy due to resistant pathogen strains. Priming plants with resistance inducers is considered a more sustainable approach, which offers a longer-lasting, broad-spectrum protection against fungal pathogens. Resistance inducers are also known to influence plants' recruitment of beneficial microorganisms.

Methods:

This novel approach involved assessing various plant resistance inducers to determine their effects on sugarcane plantlet survival and growth and their direct impact on the sugarcane pathogens *Sporisorium scitamineum* and *Fusarium verticillioides in vitro*. Host-plant mediated selection of beneficial microbiomes from diverse environmental samples was conducted in the presence of resistance inducers. Plantlets were grown in a synthetic medium, specifically

designed to kill the plantlets in the absence of beneficial bacteria. After one month of exposure, the "best grown" plantlets were considered to have recruited beneficial microbial communities, and representatives thereof were isolated on a wide range of selective media and assessed for PGP traits and direct biocontrol activity against pathogens.

Results:

Certain resistance inducers, which were compatible with plantlet growth and survival *in vitro* (e.g. Fluopyram at 250 µM and Imidacloprid at 300 µM), also exhibited antifungal activity against S. *scitamineum* and *F. verticillioides*. Host-plant mediated microbial selection in the presence of resistance inducers yielded bacteria with plant growth-promoting properties, including phosphate solubilisation, IAA production and ACC (1-aminocyclopropane-1-carboxylate) deaminase activity. Many isolates showed varying inhibitory activity against *S. scitamineum* teliospore germination, the sexual mating of bipolar sporida, and growth inhibition of *F. verticillioides* mycelium.

Conclusion:

This approach increases the likelihood of compatibility between the plant, resistance inducer, and the recruited microbiome. Ultimately, synthetic microbial communities can be designed for further experimentation in the presence of resistance inducers.

Keywords: *Fusarium, Sporisorium,* SynComs, PGPR, Biocontrol

AEES-F-22

Developing a Coupled Groundwater and Surface Water Interactions Model for the Umgeni Catchment, KwaZulu-Natal, South Africa.

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The contribution of groundwater to river basin hydrology and its role in sustaining streamflow remains poorly understood in South Africa. Previous studies have mainly focused on quantifying and modeling surface water. Recent policies in South Africa emphasize the need for conjunctive water resource use, advocating for the inclusion of groundwater in the national water security framework and water balance accounting. Stream networks sustained by groundwater have been proven to be resilient against global climate change, supporting biodiversity and ecological functions. This study investigates the groundwater recharge processes and their connection to the stream network in the Umgeni Catchment of KwaZulu-Natal, with a specific emphasis on groundwater-surface water interactions and their implications for long-term hydrological monitoring. Between March 2022 and July 2025, approximately 300 rainfall samples have been collected from Durban, Pietermaritzburg and Howick at daily to monthly intervals. In addition, 220 water samples have been collected from streams (105), springs (18), wetlands (15), and boreholes (83), covering both wet and dry seasons.

A multi-method approach combining stable isotopes ($\delta^{18}O$, $\delta^{2}H$), Radon-222 (^{222}Rn), piezometric data, electrical conductivity and baseflow separation is used to assess recharge processes and groundwater contributions to streams. Radon-222 data indicated substantial groundwater inflow into headwater streams, with limited contributions downstream, suggesting shallow, local groundwater and surface water interactions. There was no significant indication of intermediate or regional groundwater flows, raising critical questions about how and where deeper groundwater discharges. Building on these findings, the study aims to further characterize the regional groundwater flow system of the Umgeni Catchment using a MODFLOW-based numerical model. The catchment have a complex geologic setting, Karoo sedimentary formation intruded by swarms of dolerite dykes, which influence recharge, flow paths and discharge zones. Groundwater models in geologically complex settings often carry significant uncertainty due to heterogeneity in subsurface properties and limited direct observations. Therefore, field investigation of environmental

age tracers will be incorporated to validate the model. This multi-evidence approach is essential for integrated water resources management, supporting the sustainable use and protection of groundwater systems.

Keywords: Stable isotopes, radioactive isotopes, groundwater and surface water interactions, groundwater modelling, Umgeni Catchment.

AEES-F-23

Identification and characterization of viruses infecting potato (*Solanum tuberosum L.*) in KwaZulu-Natal

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Accurate detection and characterization of plant viruses is important for effective disease management, especially as new virus strains and variants continue to emerge and challenge existing control strategies. In KwaZulu-Natal (KZN), virus infections cause serious yield losses, reduced tuber quality, and higher production costs for both small-scale and commercial farmers. This study aimed to identify and characterize viruses infecting potato in KZN using serological (ELISA) and molecular RT-PCR, SDS-PAGE, and next-generation sequencing (NGS) methods. Leaf samples with typical virus symptoms, such as mosaic patterns, leaf curling, and stunting, were collected from small-scale and commercial farms. Primers targeting the coat protein genes of potato virus Y (PVY), potato virus A (PVA), potato virus S (PVS), potato virus M (PVM), potato virus X (PVX), and potato leafroll virus (PLRV) were used to confirm the presence of these viruses. Strain-specific primers were then used to differentiate PVY strains present in the sampled locations. The results confirmed the presence of potyviruses (PVY and PVA) in all locations and identified PVY^{o} and PVY^{n} strains in Msinga and Howick. PVY was further characterized using SDS-PAGE, which revealed a viral coat protein band of approximately 33 kDa. Sequencing of PCR products for PVY showed evidence of recombination between strains. These results highlight the prevalence of different viruses infecting potato crops in KZN, with a particular widespread occurrence of PVY in potato crops. The results indicate a need for early detection of these viruses as a basis for developing appropriate measures to control/manage the diseases they cause on both small and large-scale farms.

Keywords: Detection; Potato; PVY; NGS; recombination

AEES-F-25

DECADAL CHANGES IN BLUE CARBON: HIGH-RESOLUTION MULTI-SENSOR MONITORING OF MANGROVE TOTAL CARBON STOCKS IN COASTAL KENYA

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Mangrove forests are critical blue carbon ecosystems. These ecosystems are vital climate solutions, sequestering up to 70% of their carbon in belowground biomass (BGB) and soil organic carbon methodological gaps persist in scalable quantification. However, their long-term carbon dynamics remain underexplored, especially in regions facing both conservation efforts and anthropogenic pressures.

This study investigates decadal changes in total carbon stocks across an 8,000-hectare mangrove forest in Kenya's South Coast, comparing REDD+ project zones with adjacent non-REDD+ areas. Although all sites are designated protected reserves, illegal logging persists, potentially influencing carbon stock trends.

This study also demonstrates the use of various satellites images with different spatial and spectral properties in estimating the totla carbon quantity. The fusion was from high-resolution PlanetScope, RapidEye, and Sentinel-1 satellite data, we appleid machine learning models ; Random Forest, XGBoost, and Support Vector Machines to estimate aboveground biomass and soil carbon.

Model performance was evaluated to identify the most suitable approach for long-term monitoring. The analysis reveals spatial differences in carbon retention between REDD+ and non-REDD+ zones, highlighting the impact of targeted conservation interventions.This research contributes to the understanding of blue carbon dynamics under REDD+ frameworks. It also supports evidence-based strategies for climate mitigation and sustainable coastal ecosystem management.

AEES-F-26

Understanding factors influencing the adoption of digital marketing: A behavioural analysis of smallholder farmers in Limpopo, South Africa

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The 4th industrial revolution has led to numerous developments in the agricultural sector, including growth in marketing fresh produce. The introduction of digital marketing enables smallholder farmers to attract a wider range of potential buyers from various established markets. This can ensure their profitability and sustainability while improving local economic development and improving the livelihood of rural societies. The Waterberg district, situated in the Limpopo province, was found to be a red meat zone with greater potential for improving its agronomy. The study employed a multistage and purposive sampling technique to find the appropriate study sample in this area. The study then analyzed the decision process of smallholder farmers towards adopting new marketing technologies based on the Unified Theory of Acceptance and Use of Technology (UTAUT2) model. It also analyzed the effect of psychological factors such as a positive psychological capital endowment and entrepreneurial spirit on the adoption of digital marketing. Descriptive analysis and Principal Component Analysis were performed using SPSS, and the study found that hedonic motivation, performance expectation, effort expectation, social influence, and the price value of marketing technologies were among the major influences of marketing technologies adoption. Furthermore, psychological capital and entrepreneurial spirit positively influenced the adoption of digital marketing. It is therefore crucial for policymakers and extension officers to consider these factors in their task of redirecting smallholder farmers to use the 4th industrialised marketing technology to curb market access challenges and ensure profitability.

Keywords: Digital marketing, Adoption, Psychological capital, Entrepreneurial spirit

AEES-F-27

An Assessment of Radon (^{222}Rn) Levels in Aquifers Along the Umgeni Catchment: Health and Geohydrological Significance

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Radon (^{222}Rn) is a naturally occurring radioactive gas used as a tracer for understanding surface water, groundwater interactions, and subsurface geology. However, high concentrations in drinking water pose health risks, including cancer. This study investigates the seasonal variation of radon levels in 13 active boreholes within the Umgeni Catchment, KwaZulu-Natal, South Africa. Groundwater samples were collected in both the wet (summer) and dry (winter) seasons using the RAD7 Big Bottle system, alongside measurements of pH, temperature, and electrical conductivity. Results show significantly higher radon concentrations during the wet season, likely due to increased aquifer recharge mobilizing radon from uranium-rich geological formations. These findings highlight the importance of considering seasonal influences in radon monitoring. Long-term surveys without seasonal resolution may misrepresent radon variability, emphasizing the need for more frequent, seasonally sensitive measurements. This study also contributes to the development of a radon surveillance protocol, supporting improved groundwater quality monitoring and public health protection in regions dependent on groundwater.

Keywords: Radon (^{222}Rn), Groundwater, Aquifer Recharge, Seasonal Variation, Geology.

AEES-F-28

Modelling Land Use and Land Cover Change, and its Impact on Human-Wildlife Conflict in Hluhluwe-iMfolozi Park, KwaZulu-Natal

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Human-wildlife conflict (HWC) presents a growing threat to biodiversity, human livelihoods, and sustainable development, particularly in sub-Saharan Africa. As land use and land cover (LULC) change due to agricultural expansion, urbanization, and infrastructure development, the spatial overlap between wildlife and human settlements intensifies, increasing the frequency of conflict. In South Africa's Hluhluwe-iMfolozi Park (HiP), such interactions are exacerbated by socioeconomic pressures, habitat fragmentation, and inadequate mitigation infrastructure. Despite the severity of these challenges, limited research has explored the spatial relationship between LULC changes and HWC using advanced geospatial technologies.

This study aims to fill this gap by developing a spatially explicit model that maps LULC changes over time and predicts future conflict scenarios. Using Sentinel-2 satellite imagery, remote sensing, machine learning algorithms (Random Forest, Support Vector Machine), and conflict incident data, the study quantifies LULC changes from 2017 to 2025 and correlates them with HWC hotspots in and around HiP. It further assesses how changes in habitat structure influence wildlife movement and conflict intensity. The findings are expected to support land-use planning, conservation strategies, and sustainable coexistence between humans and wildlife. By identifying high-risk zones and modelling future scenarios, this research provides actionable insights for policymakers, conservation practitioners, and local communities working to mitigate HWC in dynamic landscapes.

AEES-F-29

Associations Between Demographic Factors, Glycemic Markers, and Dietary Habits Among Individuals with Diabetes Mellitus.

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Background: The globalisation of Western culture in Africa has contributed to significant risk factors for diabetes, such as sedentary lifestyles and physical inactivity. These factors have also altered African dietary patterns with high ultra-processed foods, resulting in a nutritional transition from traditional dietary patterns to high carbohydrate consumption and prepackaged foods, which affects their blood glucose profile. There is a lack of comprehensive research on the specific impact of demographic factors among people living with diabetes, despite the country's diversity in socioeconomic status, cultural practices, and educational levels.

Objectives: This research examines the impact of demographic factors, Glycemic Markers, and Dietary Habits Among Individuals with Diabetes Mellitus.

Method: The research used convenience sampling to recruit 101 people living with diabetes. Data on demographics and dietary habits were collected using the structured questionnaire, while biochemical information was obtained from the patient's files. Data analysis used descriptive, bivariate, and linear regression analyses to explore the relationship between variables.

Result: The result reveals a relationship between gender, age groups, living arrangements, professional rank and duration of diagnosis with fasting blood sugar ($p < 0.05$). The bivariate analyses revealed statistically significant associations between diabetes type and several predictor variables, including age group, marital status, living environment, occupation, and duration of diabetes management ($p < 0.05$). The results indicate that 63.0% of participants who reported skipping meals had elevated FBS levels.

Conclusion: Several demographic factors and dietary habits (Fast-food consumption) interfere with diabetes therapy and increase the risk of medical complications. There is a need for comprehensive management strategies that address demographic factors in people with diabetes.

AEES-F-30

THE EFFECT OF MOISTURE CONTENT ON THE SENSORY PROPERTIES OF RABBIT BILTONG: ADVANCING SUSTAINABLE MEAT INNOVATION

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The development of value-added meat products has become an increasingly important strategy in promoting sustainable protein sources and enhancing the use of underexploited livestock species. Rabbit meat which is characterised by its favourable nutritional profile and production efficiency remains underutilised in South Africa. This is due to limited product development and low consumer exposure. Henceforth, the integration

of rabbit meat into familiar presentations such as biltong may offer a pathway to improving its market acceptability.

This study investigates the effect of moisture content on the sensory properties of rabbit biltong, with the objective of optimizing product quality for consumer acceptance. Rabbit biltong was produced at three target moisture levels, low (25%), medium (35%) and high (50%), and is being evaluated by a trained sensory panel based on aroma, flavour, texture, and overall acceptability using a structured hedonic scale.

Currently, data collection and statistical analysis are ongoing. However, initial observations suggest that moisture content plays a significant role in determining the textural and flavour profile of biltong, these are vital to consumer appeal and market potential.

Through the contextualization of rabbit meat within the ready-to-eat category, this study contributes to protein diversification, agro-processing innovation and the development if emerging livestock value chains. The findings from this study will support processors and stakeholders in recognising process optimization parameters that improve product quality, support rural enterprises and promote inclusive livestock systems.

AEES-F-31

FORAGE YIELD, WATER USE EFFICIENCY AND ECONOMIC ANALYSIS OF KENAF UNDER CONTROLLED AND FIELD CONDITIONS.

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Introduction: Kenaf (*Hibiscus cannabinus L.*) is herbaceous annual, multi-purpose crop, which was traditionally cultivated for fiber [1]. Kenaf has been recognized to have the potential to be grown as alternate forage crop, due to the high protein content in the leaves [2]. Even though there are several studies that investigated irrigation and harvesting effects on kenaf for fiber, there is still limited research on the performance of kenaf as a forage crop under varying water availability and harvesting intervals.

Aim: To evaluate the impact of water availability and harvesting intervals on forage yield, water use efficiency, and economic returns of two kenaf varieties grown under controlled and field conditions.

Materials and Methods: The research will be conducted in two phases: a pot trial under controlled environment, and a field trial under rainfed and supplemental irrigation conditions. Two kenaf varieties (*Tainung 1* and *Tainung 2*) will be grown in both trials. The pot trial will use a 2 × 3 factorial randomized complete block design, where plants will be subjected to three plant available water (PAW) depletion levels levels (25–30%, 45–50%, and 65–70%) to assess biomass yield and water use efficiency. The field trial will use a split-plot, with kenaf variety as the main plot and harvesting interval (4, 6, and 12 weeks) as the sub-plot factor. Biomass yield and water use will be measured. Water use efficiency will be calculated as the ratio of dry matter yield and total water applied. Cost-benefit analysis will be conducted to identify the treatment combination that was most cost-effective and improved resource efficiency.

Expected outcomes: Although the trial have not yet begun, the study is expected to offer production guidelines for sustainable feed production and improving water use efficiency. The outcomes will provide irrigation and harvesting strategies to promote resource management and optimize kenaf yield, and the profits that can come from economic production of kenaf.

Keywords: kenaf, forage yield, water use efficiency, harvesting interval, economic analysis, variety

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AEES-F-32

DRIVERS OF EUTROPHICATION AND ALGAL PROIFERANCE IN THE UMNGENI- MIDMAR, ALBERT FALLS, NAGLE AND INANDA

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The Umgeni system dams Midmar, Albert Falls, Nagle, and Inanda are key freshwater Dams in KwaZulu-Natal, supplying water to millions and supporting a range of economic and ecological activities. However, increasing occurrences of eutrophication and algal bloom proliferation threaten the integrity of these dams. This study aims to investigate the environmental and anthropogenic drivers behind eutrophication and algal bloom proliferation in these waterbodies.

Historical water quality data will be analysed using R programming, GIS tools, and statistical modelling to identify spatial and temporal trends in nutrient levels (nitrogen and phosphorus), chlorophyll-a, temperature, rainfall, and land use patterns. The study will explore the relationships between these variables and bloom events across the four dams. In addition, it will assess the financial implications of eutrophication, particularly the increased operational costs related not only to the clogging of filtration systems but also to the chemical treatment required to process nutrient-rich, contaminated water for safe human use.

Findings from this research are expected to deepen understanding of bloom dynamics and inform catchment-level interventions and water quality management strategies. The outcomes will contribute to the development of sustainable policies for protecting KwaZulu-Natal's critical water infrastructure under growing urbanisation and climate pressures.

Keywords: Eutrophication, algal blooms, Umgeni dams, water treatment, nutrient loading, GIS, KwaZulu-Natal

FLASH ABSTRACTS

CHEMISTRY AND PHYSICS

CP-F-1

Carbamazepine adsorption onto biochar/graphene oxide composites

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The presence of pharmaceutical compounds in water bodies has emerged as an increasing concern because of their potential harmful impacts on both ecosystems and human health. Carbamazepine (CBZ), a common anticonvulsant, has been found in aquatic ecosystems owing to its resistance to conventional wastewater treatment processes. Its discharge causes ecological and human health problems; hence, novel and economical technologies for its removal from waterbodies are needed. Adsorption is one method that has been identified as a fast, simple, cost-effective, and reusable method. This study investigates the effectiveness of a novel biochar/graphene oxide composite as a low-cost adsorbent for the removal of CBZ from aqueous solutions. The biochar was obtained from the pyrolysis of pine pallets (PPB) and exotic plant material (EPB). The two biochar samples, PPB and EPB, and graphene oxide (GO) were studied as adsorbents, including their composites with graphene oxide (PPB/GO and EPB/GO, respectively). The adsorption isotherms, kinetics, and thermodynamic studies for removing CBZ from aqueous solutions with the various adsorbents are described in this study (Fig. 1). The degree of adsorption was monitored as a function of solution pH, contact time, adsorbent mass, initial adsorbate concentration, and solution temperature. The adsorption of CBZ onto the biochar/GO composites was optimal at a pH of 2.5 under a constant temperature of 25 °C. Four kinetics models, including the pseudo-first order, pseudo-second order, Elovich, and intraparticle diffusion models, were employed to evaluate the sorption kinetics of CBZ onto the biochar/GO composites and to identify the possible rate-determining step. The kinetics data generated for the adsorption of CBZ onto the biochar/GO composites were best described by the pseudo-second-order model, indicating chemisorption, which implies a bimolecular process. The equilibrium data obtained were fitted into eight isotherm models: Freundlich, Langmuir, Temkin, Redlich-Peterson, Dubinin–Radushkevich, Sips, Toth, and Khan, and the best-fit model for each adsorbent was selected based on the model with the lowest sum of squared residuals (SSR). The Freundlich isotherm model was found to be the best fit for the removal of CBZ from aqueous media onto biochar/GO composites. This finding suggests that the biochar/GO composites can be used as a sustainable, effective, and low-cost adsorbent for the removal of CBZ from an aqueous solution.

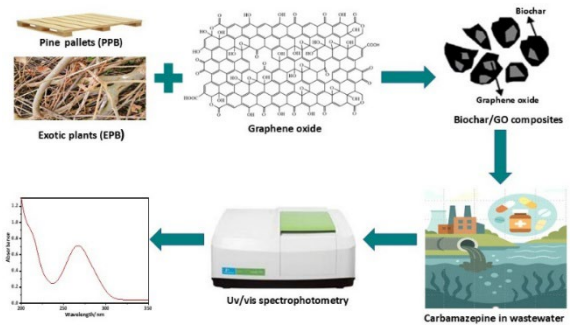

Fig. 1: Removal of CMZ onto biochar/graphene oxide composite in aqueous solution

CP-F-2

THIAZOLES AND THEIR MOLECULAR HYBRIDS AS POTENT ANTICANCER AGENTS

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Thiazoles have emerged critical scaffolds for anticancer agents, with prominent examples being Dasatinib, a 2-Aminothiazole core -Pyrimidine hybrid agent which targets Src, BCR-ABL (leukemia), and Tiazofurin**,** a thiazole-nucleoside hybrid targeting IMPDH, which induces apoptosis by inhibiting nucleotides synthesis. The planar aromatic structure of the thiazole-core affords pi-pi stacking, hydrogen bonding and hydrophobic interactions, essential for interactions with active sites on cancer-related kinases and tubulin, causing apoptosis. Molecular hybridization is one of the new approaches to drug design. Molecular hybridization of thiazoles with other pharmacophores enhance potency, selectivity, and pharmacokinetic properties, thereby addressing challenges of efficacy, toxicity and drug resistance in cancer therapy. Examples of thiazole molecular hybrids are the thiazole-pyrimidine, dasatinib, the thiazole-triazole hybrid, 2-amino-4-aryl-5-(1,2,3-triazol-1-yl)-thiazole, with added solubility and stability properties of triazoles, and the thiazole-triazole-chalcone hybrid, 2-amino-4-phenyl-5-(chloromethyl)-thiazole, with the chalcone acting additionally as a Michael acceptor. Globally, cancer is responsible for the second highest mortality rate after cardiovascular diseases. In South Africa, with an increase in incidence and mortality rates, cancer is increasingly recognized as a major public health issue, after Tuberculosis and HIV. The search for more efficacious cancer chemotherapeutics therefore continues. A large diversity of molecular-hybrids of thiazoles are possible, due to the various possibilities of substitutions at positions 4 and 5 of thiazole.

CP-F-3

DEVELOPMENT OF A GC-MS SCREENING METHOD FOR EMERGING CONTAMINANTS IN SOUTH AFRICAN WASTEWATER

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South Africa's status as one of the world's driest countries, along with its growing population, industrial expansion and ageing infrastructure have contributed to climate- and demand-driven water scarcity. In response, South Africa has steadily integrated wastewater reuse as an essential approach to managing water deficiency. Thus, thorough wastewater treatment practices are crucial to ensuring that reused water standards are met. However, conventional treatment plants in South Africa are inadequate in the removal of emerging contaminants (ECs), a diverse group of unregulated substances, such as pharmaceuticals (e.g., antibiotics and antiretrovirals), personal care products (e.g., triclosan), pesticides (e.g., atrazine), and disinfection by-products (e.g., haloacetonitriles). Therefore, these contaminants often pass through these systems with intact active moieties, contributing to their environmental persistence and posing potential physiological and environmental risks. Though global standardised methods for EC monitoring exist – mostly developed in the global North – these are often impractical for South African application due to distinct wastewater characteristics. Therefore, there is a clear need to develop context-specific protocols. South Africa currently lacks foundational data and standardised procedures for EC monitoring in relation to its unique socio-economic trends. This project addresses this gap by contributing to the development of a standardised screening

protocol for ECs in South African wastewater using gas chromatography-mass spectrometry (GC-MS). This study aims to develop a sensitive, robust, and multi-residue method that can handle the complexity of local wastewater matrices.

CP-F-4

Effects of Molecular Composition and Chain Length on the Interfacial and Thermodynamic Properties of Cyclic and Linear Polymer Blends

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Understanding how polymer architecture and composition influence interfacial and thermodynamic properties is critical for advancing sustainable materials. We employed molecular dynamics simulations using the Kremer-Grest bead-spring model to systematically

investigate the effects of chain length and blend composition on the adsorption, heat capacity, energy partitioning, and Fourier transform infrared spectroscopy of cyclic and linear polymer blends at solid interfaces. By varying chain lengths (10, 20, 40, and 60 monomers) and cyclic polymer concentrations (10% and 90%), I quantified how these parameters modulate local composition profiles, thermal stability, and interfacial behavior. I found that longer cyclic chains preferentially localize near interfaces, heat capacity exhibits non-linear dependence on chain length and blend ratio, and energy partitioning highlights the dominance of pairwise interactions in short-chain blends. These results provide qualitative insight into the structure–property relationships underpinning polymer blends and may potentially provide directions on how to improve performance and degradability of polimeric materials, informing the design of environmentally friendly polymers with optimized lifecycle characteristics.

CP-F-5

Plug-and-play QKD architecture with a self-optical pulse train generator

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Quantum key distribution (QKD) allows distant parties Alice (sender) and Bob (receiver) to remotely share secret keys via the laws of quantum physics [1]. Plug-and-Play (PnP) QKD has garnered considerable attention for its ability to ensure a provably secure communication, particularly characterised by the precise controls of quantum signals and long-term operational stability. However, a conventional PnP QKD has some limitations on miniaturization because of the inclusion of a bulky storage line (SL). In addition, the secure key rate is relatively low since signal pulses from Bob's system are transmitted only at dedicated time slots to overcome backscattering [2]. This work is a review of an innovative architecture that removes the SL by employing an optical cavity made of two Faraday mirrors for pulse train generation. This approach allows Alice to duplicate the seed pulse sent by Bob to generate optical pulse trains herself that overcome miniaturization limitation and the slow secure key rate since the SL is no longer necessary.

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CP-F-6

QUANTIFICATION OF TEXTILE DYES USING HPLC IN KZN SURFACE WATERS, AND STUDYING THEIR TOXICOLOGICAL EFFECTS ON THE ENVIRONMENT.

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The severity of the environmental pollution caused by synthetic dyes has raised a great concern owing to their toxic nature, unfavourable health effects and bioaccumulation potential; as they have been found to be major water pollutants globally. Over the past couple of decades, studies have covered the increased use of reversed phase HPLC, coupled with UV-VIS or diode array detectors.

This literature review explores recent advances in the quantification of textile dyes in surface water, with the focus greatly placed on High Performance Liquid Chromatography (HPLC) as an analytic tool for the detection and quantification of dyes. In terms of compatibility, cost and efficiency towards chromatographic methods; sample preparation techniques such as liquid-liquid phase extraction (LLE), solid phase extraction (SPE) and membrane filtration have been covered extensively. In addition, interrelated techniques such as mass spectrometry, UV-VIS spectrometry and capillary electrophoresis have also been reviewed. Great attention has been given to method selectivity and sensitivity, detection limits and also compliance with the environmental regulations in parts of Africa, Asia and South Africa; not excluding KZN. Furthermore, toxicological effects of textile dyes have been explored in this work and the ecotoxicity data, in-vitro and in-vivo assays, and cytotoxicity have been discussed.

Moreso, the complexity of analytical chemistry combined with toxicological assessments in a critical approach for evaluating and contributing in environmental studies have been highlighted. Thus, by providing an overview of existing methodologies, gaps have been identified in which areas require in depth work, such as chronic toxicity, dye metabolites and green dye chemistry.

CP-F-7

Coherent control of atomic states using photons and applications

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A control technique in [1] is used to prepare an atom trapped in a Fabry-Perot cavity [2] in a desired state using a sequence of interactions with single photons. The trapped atom has a lambda configuration i.e. it is a 3-level atom

which has 2 ground states and 1 excited state, for example, a Rubidium-87 atom. The photon is first prepared in a superposition of it's polarisation states which is swapped into a superposition of the ground states of the lambda system by a sequence of operations. The prepared atom-cavity system can then be used to generate Schrodinger cat states, which are particles that are in a superposition of their macroscopic states. Entanglement can be generated between different cavity modes, the atoms and the photons. This talk will explore the utility of such phenomena.

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CP-F-8

EXTRACTION, GC-MS ANALYSIS AND EVALUATION OF BIOLOGICAL ACTIVITIES OF THE ESSENTIAL OILS FROM *M. SIAMENSIS* AND *M. KOENIGII*

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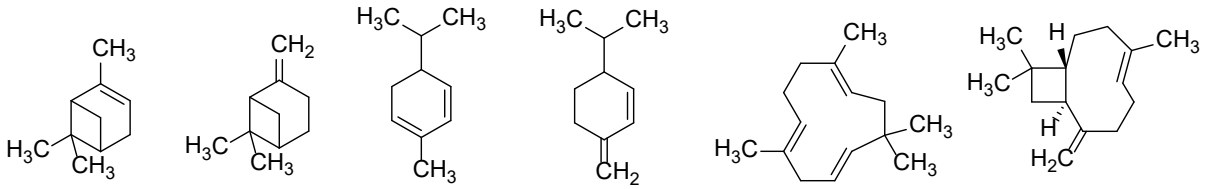
The increase in bacterial and cancer infections have become a major concern around the world. In many countries, including South Africa, treatment is complicated by limited access to new and effective medicines. This emphasises the need for new therapeutic agents that can overcome this problem. Several studies have been undertaken to investigate the antioxidant, anticancer and neuroprotective properties [1] of *M. koenigii* (L.) Spreng, which belongs to the genus *Murraya*. However, another species, *M. siamensis* Craib [2] remains understudied, with limited knowledge on its phytochemical composition and its medicinal properties. This study aims to address this gap by investigating the bioactive constituents and biological activities, such as anticancer and antibacterial activities, of *M. siamensis* to support its potential as a source of medicinal compounds.

In this research study, essential oils from the milled leaves of *M. Koenigii* and *M. siamensis* will be extracted using different extraction techniques such as solvent extraction, Soxhlet extraction, steam distillation and the solvent-free extraction technique, headspace analysis. The chemical composition of the essential oil will be analysed using Gas Chromatography-Mass Spectrometry. The terpenoid compounds, α-pinene, β-pinene, α-phellandrene, β-phellandrene, α-caryophyllene and β-caryophyllene shown in **Figure 1** will be quantified using GC-MS standards. The extracted oils will also be analysed and compared for their antibacterial and anticancer activities.



α-pinene β-pinene α-phellandrene β-phellandrene α-caryophyllene β-caryophyllene

Figure 1: Chemical structures of terpenoids

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CP-F-9

Quantification of Endocrine Disrupting Chemicals (EDCs) using HPLC-UV-Vis in the Influents and Effluent of Durban Wastewater Treatment Plants

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The quality of effluent produced by wastewater treatment works (WWTW) is of utmost importance to the natural resources located downstream of the WWTW which include aquatic animals. In this study an analytical method was developed and validated to quantify steroid hormone concentrations in wastewater. The analytes of interest were estriol, bisphenol A, ethynylestradiol (EE2), levonorgestrel, progesterone, medroxy progesterone (DEPO) and mestranol which are found in contraceptives. Validation parameters were linearity through calibration curve which yielded a R^2 value of 0.997- 0.9998, LOD between 0.03-0.215 mg L^{-1}, and LOQ between 0.082-0.351 mg L^{-1}, accuracy by recoveries of 97-112% and precision <15% RSD. Sampling sites were WWTWs in the North, Central, South, and outer West areas of Durban. The samples were collected in amber bottles once a month and transported to the laboratory at a temperature of 4ºC. Solid phase extraction (SPE) was used for the preconcentration and clean-up technique. SPE parameters that were optimized were volume of elution, SPE packing material, elution solvent composition, drying time, and pH to obtain optimum conditions for recovery. The concentrations obtained for raw influents were between <LOD - 0.286 mg L^{-1} and effluent was <LOD - 0.0329 mg L^{-1} for the month of February. March results ranged from <LOD - 0.0105 mg L^{-1} for final effluent and <LOD-0.740 mg L^{-1} for influent. DEPO and progesterone were the analytes in highest concentration in both February and March influent and was directly proportional to the WWTW that services the most populated area of Durban. Progesterone and EE2 had the highest concentration in the February effluent and progesterone was the highest for March effluent. The presence of these compounds is threatening the abstraction of river water for drinking water treatment and the well-being of aquatic animals in rivers receiving the effluent.

CP-F-10

Kinetics of chloramine-mediated oxidation of tyrosine and antimicrobial effect of chloramines on *Escherichia coli* and *Staphylococcus aureus*

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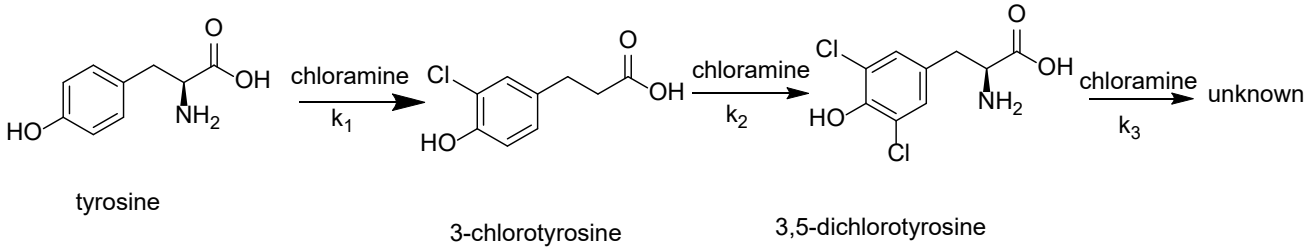
Keywords: Tyrosine, chloramines, *E. coli,* and *S. aureus*

HOCl produced in phagosomes reacts with amine groups on neutrophil proteins to form unstable dichloramines that liberate cytotoxic gases, ammonia monochloramine (NH_2Cl), and ammonia dichloramine ($NHCl_2$) [1]. Excessive HOCl can cause host tissue damage, which can be linked to numerous diseases such as cystic fibrosis, arthritis, atherosclerosis, and kidney disease [2]. Due to their instability, little attention has been focused on the contribution that dichloramines may have on oxidative killing by neutrophils [1]. Herein, we report the synthesis of taurine dichloramine, lysine dichloramine, ammonia monochloramine, and ammonium dichloramine. The formation and stability of synthesized chloramines were confirmed by a UV-Visible spectrophotometer. The kinetics of chloramine-mediated oxidation of tyrosine (Scheme 1) were studied on the Stopped Flow spectrophotometer and characterized with UV-Visible spectrophotometer, ^{1}H NMR, and mass spectrometry. The biological activities of both $NHCl_2$ and NH_2Cl against strains of *Escherichia coli* and *Staphylococcus aureus* bacteria were determined by zone of inhibition plate tests and traditional optical density (OD) measurements. NH_2Cl and $NHCl_2$ at various concentrations showed inhibition against both Gram-positive (*S. aureus)* and Gram-negative (*E coli*) strains of bacteria.



Scheme 1: Reaction of tyrosine with chloramine to form different products.

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CP-F-11

NEW QUINAZOLINE ANALOGUES AS MTB DNA GYRASE INHIBITORS: DESIGN, SYNTHESIS, AND ANTIMYCOBACTERIAL EVALUATION

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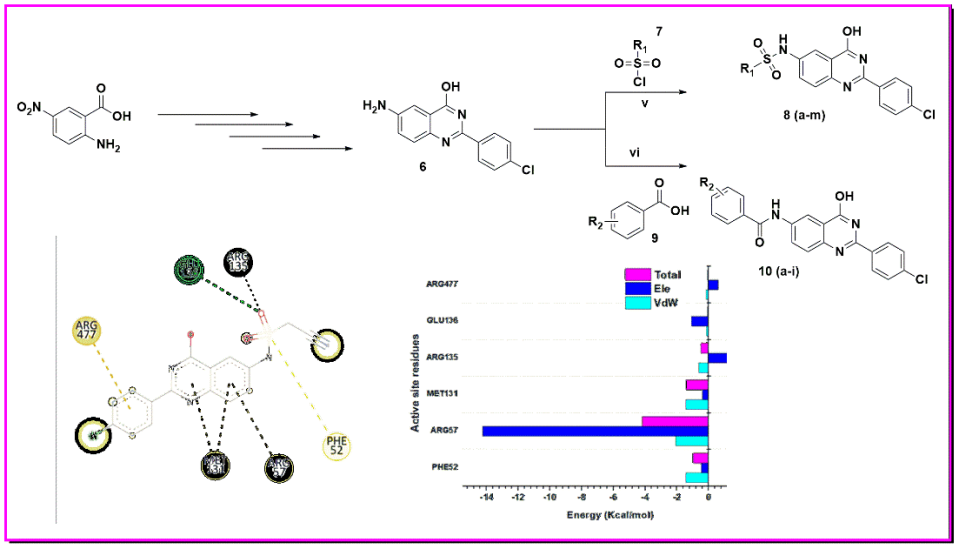
Tuberculosis (TB) is an airborne disease that has a disproportionate number of South Africans, particularly within KwaZulu Natal. With the rise of drug-resistant strains of TB it is imperative that novel drugs active against these strains of TB are developed.

A series of new quinazoline analogues (**8a-m** & **10a-i**) were designed, synthesized, and evaluated for their antitubercular activity, scheme shown below (**Scheme 1**). The final compounds were evaluated *in vitro* for their antitubercular and antimicrobial activity against a panel of pathogenic strains with Moxifloxacin, Rifampicin, Isoniazid, Ofloxacin and Levofloxacin as the standards. The compounds showing the highest inhibitory activity against *Mtb* H37Rv were compounds **8k** and **8m** with both having a minimum inhibitory concentration (MIC) of 3.9 µg/mL, the highest MIC thereafter came from compounds **8a**, **8l**, and **10h**.

Compounds **8a** and **8k** activity against MDR-TB and XDR-TB strains with MIC values of 7.81µg/mL and 15.62 µg/mL, respectively. When tested against select pathogenic fungi (*A. fumigatus*, *A. flavus*, *A. niger*) it was noted that compounds **8a**, **8b**, **8k** and **10h**, also exhibited significant activity with MIC values ranging from 3.9 to 15.62 µg/mL. In addition, DNA gyrase enzyme inhibition studies showed that **8l**, **8m**, and **10h** could inhibit at low micromolar levels (IC_{50} = 1.08–3.49 µM), indicating *Mtb* gyrase as the probable drug target.



CP-F-12

SYNTHESIS OF REDUCED GRAPHENE OXIDE AND GRAPHITIC CARBON NITRIDE FOR SOLAR ENERGY APPLICATIONS

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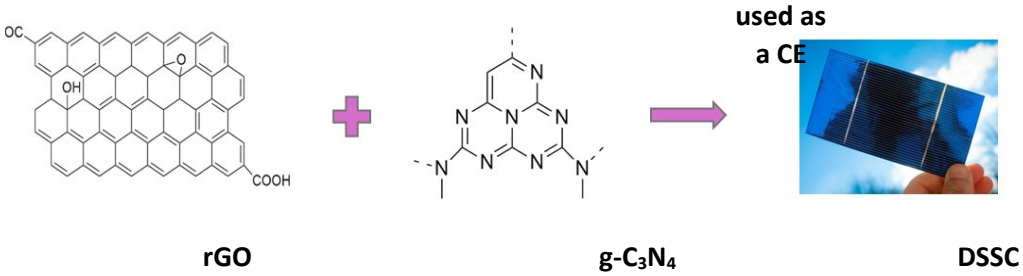
Rapid urbanisation and industrialisation have led to an unprecedented increase in the global energy demand, with the reliance on fossil fuels, a non-renewable and environmentally destructive resource, highlighting the urgent need for sustainable energy alternatives. One such way is through dye-sensitised solar cells (DSSCs), a class of third-generation solar cells, which have gained increasing attention due to their low cost, environmental friendliness, and simple fabrication procedure. A DSSC consists of a photoanode, a dye, an electrolyte, and a counter electrode (CE). Traditionally, platinum, a rare and precious group metal, is used as a CE material due to its excellent electrocatalytic activity; however, its limited availability, high cost and susceptibility to degrade in iodine-based electrolytes limit its practical application [1]. As a result, carbon-based materials such as reduced graphene oxide (rGO) and graphitic carbon nitride (g-C_3N_4), as seen in Scheme 1, have been sought after due to their cost-effectiveness, chemical and thermal stability, excellent catalytic activity, and electrical conductivity. In this work, graphene oxide was synthesised by Tour's method and reduced with ascorbic acid, a green reducing agent, to rGO. g-C_3N_4 was prepared through a

thermal polycondensation technique. Fourier-transform infrared spectroscopy and powder X-ray diffraction confirmed the successful synthesis and crystallinity of the materials, respectively. Ultraviolet-visible spectroscopy and photoluminescence spectroscopy displayed strong visible light absorption and reduced charge recombination, respectively. Lastly, electrochemical analyses, such as cyclic voltammetry and electrochemical impedance spectroscopy, showed low charge transfer resistance, indicating good electrocatalytic activity. The outcomes of this study will contribute to the ongoing development of cost-effective and sustainable materials to improve the performance of DSSCs.



Scheme 1: rGO and g-C_3N_4 used as materials for solar cell applications

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CP-F-13

Synthesis, Characterization, and Evaluation of Pt(II) Carboxamide Complexes as Potential Anticancer Agents: DNA Binding and Cytotoxicity Studies

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The use of Platinum based drugs in cancer treatment gained significant interest since the discovery of Cisplatin in 1969 by Bernett Rosenberg [1]. Cisplatin is used to treat cancer of ovaries, testicles, lungs, head, neck, just to mention a few. Studies have shown that the bonds formed between Pt(II) complexes and *N*-donor ligands are thermodynamically stable when they reach the DNA helix where they covalently bind to the structure, resulting in the hinderance of DNA replication, ultimately leading to cancer cell death [2]. Even though Cisplatin is one of the most potent chemotherapy drugs widely used to treat cancer, it has shown several disadvantages, namely: severe side effects such as hearing loss, nausea, nephrotoxicity, allergy, elevated blood pressure, etc. Moreover, this drug has a limited spectrum of tumor types that it can act on, and some cells are resistant to it [3]. These disadvantages indicate a scope for improvement to increase clinical effectiveness by broadening the spectrum of action and reducing toxicity by eliminating side effects.

In our study we explore the kinetics and mechanistic behavior of *N,N'*-pyridine and pyrazine Pt(II) complexes in hopes of providing an insight as to how these complexes would behave in biological media. The pyridine and pyrazine ligands **L1** to **L4** were prepared *via* a modified condensation reaction of equivalent acid and amine to produce moderate to good yields [4]. Equivalent amounts of the ligands were reacted with K_2PtCl_2 to give platinum (II) complexes **PtL1** to **PtL4**. The compounds were characterized using NMR, mass spectroscopy, FT-IR, and elemental analysis.

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CP-F-14

Porous Carbon Material Derived from Coffee Biomass for Application in Capacitive Deionization Technology

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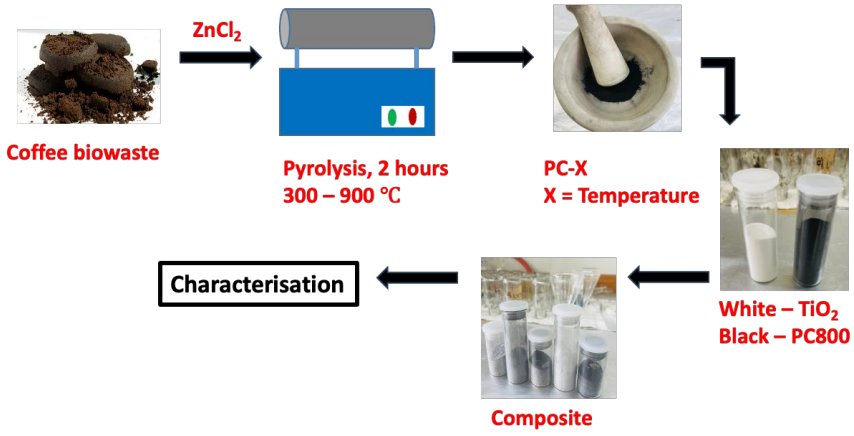
Access to clean water at affordable prices is one of the most critical technological, social, and economic challenges of the 21st century. The increasing extraction of groundwater globally is causing the gradual encroachment of saline water into water sources and aquifers. To make this water suitable for industrial, agricultural, or drinking purposes, it must be purified and desalinated. Consequently, methods for desalinating water with varying salinity levels, from brackish to seawater, are receiving much attention. The ongoing research is to enhance the energy efficiency and cost-effectiveness of water desalination technologies. Capacitive deionization (CDI) is one promising technology that aligns with these goals. Although CDI has been known for over 30 years, substantial advancements in CDI research have only been realized in recent years, particularly in the development of CDI cell architectures and carbon materials, as well as addressing the challenges of commercializing this technology. This research focuses on synthesizing a carbon-based material from coffee waste, an inexpensive and readily available resource, for use as electrode material in CDI cells. The carbon material was prepared via pyrolysis at various temperatures (300 – 900 °C) under inert atmosphere to observe the temperature that gives optimal properties. The material that possessed the better properties was incorporated with TiO_2 for further enhancement. The prepared carbon material was characterised using Brunauer-Emmet Teller (BET), Fourier-transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), Raman spectroscopy, X-ray diffraction (XRD), cyclic voltammetry (CV), impedance electrochemical spectroscopy (EIS) and galvanostatic charge-discharge (GCD). The prepared porous carbon material exhibit improved electrochemical properties due to the presence of TiO_2, showing that it can be used as an electrode for CDI.

Graphical abstract



CP-F-15

COMPARISON OF GRAPHENE AND REDUCED GRAPHENE OXIDE-CHITOSAN COMPOSITES FOR THE ELECTROCHEMICAL DETECTION OF LAMIVUDINE

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The high prevalence of HIV/AIDs in South Africa has resulted in the extensive use of antiretroviral drugs (ARVDs) such as lamivudine. This has given rise to the prevalence of these drugs in water bodies. Various analytical techniques, such as HPLC and GC, have been widely used for the detection and quantification of pharmaceuticals; however, these techniques are costly and time-consuming. Therefore, an alternative rapid, accurate, simple, and in-situ measurement technique is needed to detect and quantify ARVDs in the environment. Electrochemical sensing is considered a cheaper and simpler technique for detecting and quantifying pharmaceuticals in the environment. In this work, graphene oxide-chitosan (GO-CS) and reduced graphene oxide-chitosan (rGO-CS) composites synthesised in a 2:1 mass ratio by a simple reflux method were used to modify a glassy carbon electrode (GCE) for the detection of lamivudine in aqueous systems (Figure 1). The nanocomposites were characterised by SEM, TEM, XRD, Raman spectroscopy, CV, and EIS to investigate their physicochemical and electrochemical properties. The composites were used as a potential electrode modifier by drop casting on a GCE and tested for the detection of lamivudine in wastewater. Differential pulse voltammetry studies showed that the rGO-CS/GCE produced sharper and more well-defined peaks than the GO-CS/GCE. Lamivudine undergoes an electrochemical reduction process at an optimum pH of 2 in a modified Britton-Robinson buffer as the supporting electrolyte. The process was determined to be irreversible and dominated by diffusion mass transport, with the presence of some adsorption mass transport. Two protons and two electrons were involved in the electrochemical process. The limits of detection (LOD) and quantitation (LOQ) for each electrode were determined, with the LOD and LOQ of the GO-CS/GCE being 0.06452 μM and 0.2151 μM, respectively. The LOD and LOQ of the rGO-CS/GCE were 0.07838 μM and 0.2613 μM, respectively. The percentage recoveries obtained with the rGO-CS/GCE were larger than those obtained with the GO-CS/GCE, therefore suggesting that the rGO-CS/GCE performed better in the electrochemical detection of lamivudine.

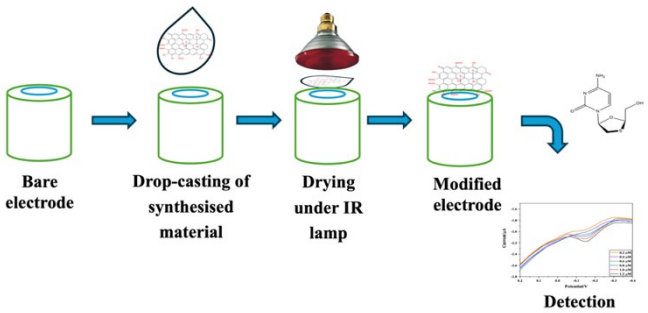

Figure 1: Preparation of the modified electrode.

CP-F-16

A COMPARATIVE MATERIAL-PERFORMANCE STUDY OF HETEROATOM-DOPED REDUCED GRAPHENE OXIDES FOR BIOSENSING OF PESTICIDES

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Electrochemical biosensors represent a transformative advancement in analytical sensing, integrating biological recognition elements with nanostructured materials to enable real-time, ultra-sensitive detection of pesticides and environmental contaminants. This research compares the material innovations and application landscapes of biosensors, with a focus on their potential applications in food safety and pollution monitoring.

Graphene oxide (GO) was synthesized by the modified Hummers' method, and the precursor used for reducing and doping of the GO with S was NaS_2. This was compared to Phosphorus doped GO and the precursor, the reductant and dopant was triphenylphosphine (TPP), resulting in PrGO. The characterization of the heteroatom-doped reduced graphene oxide (S-rGO and P-rGO) was confirmed by various spectroscopic and electrochemical techniques. The X-ray diffractogram shows that the materials are amorphous, and a shift in 2θ value from 20^o for GO to a range of 24 - 26^o for heteroatom doped rGO was observed. Ultraviolet (UV) data obtained showed the band gap of SrGO to be 2.5V and 1.8V for PrGO,

Photoluminescence (PL) analysis reveals that the emission intensity associated with electron–hole recombination is lower for SrGO compared to PrGO. Thermal gravimetry analysis (TGA) shows that SrGO has more thermal resistance with a value of 600 °C compared to PrGO with a value of 550 ^oC. For electrochemical characterization, the results obtained indicate that the structures exhibit a surface area of 86.58cm^2 for SrGO and 260.88 cm^2 for PrGO as seen using the cyclic voltametry technique. This also corresponds to the surface area obtained from the BET analysis of SrGO and PrGO, respectively. The electron charge transfer resistance for SrGO was 69.40 **Ω** and 8.79 **Ω** for PrGO.

The results obtained portray that PrGO has a greater potential to be used in sensing applications for the detection of organophosphorus pesticides and other environmental contaminants to ensure food safety, thereby promoting human and environmental health.

CP-F-17

Metal sulphides as a potential electron transport layer in organic solar cells

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Organic solar cells (OSCs) are renowned as the most attractive alternatives to Silicon-based photovoltaics due to their low fabrication cost, mechanical flexibility, and potential for large-area applications. Since their introduction in the late 1980s, organic materials such as conjugated polymers and small molecules have undergone extensive development, enabling significant improvements in power conversion efficiency, which has surpassed 19% in lab-scale devices. These improvements have opened new frontiers for OSCs in portable electronics, building-integrated photovoltaics, and wearable energy systems. Due to their attractive optoelectronic properties, such as broad band gaps, high electron mobility, superior thermal stability, and low toxicity, metal sulphides, including ZnS, CdS, CuS, NiS, and SnS, have drawn interest as promising ETL candidates. They are appealing substitutes for traditional metal oxides due to their adjustable energy levels, compatibility with organic active layers, and capacity to inhibit charge recombination. In this talk, the incorporation of metal sulphides as ETLs in OSC designs is examined, with an emphasis on spin coating as the deposition technique. Spin coating is simpler, less expensive, wastes less material, and allows for fine thickness control—all of which are essential for the production of scalable and repeatable devices—than vacuum-based or chemical bath methods. Also suitable with flexible substrates and ambient processing circumstances, spin coating fits in nicely with roll-to-roll and sustainable manufacturing objectives. This study investigates Mn-doped ZnS metal sulphides as inter ETLs in *P3HT:PCBM*-based OSCs. The Mn-doped ZnS nanoparticles were dispersed in ethanol at doping levels of 0.4, 0.8, 2.4, and 4 mg by weight, and spin-coated onto *P3HT: PCBM*-coated devices. The

0.4 mg-doped devices achieved a power conversion efficiency (PCE) of 4.4%, comparable to the pristine devices (4.6%), demonstrating that a low doping level can maintain near-optimal performance. However, higher doping concentrations led to declining efficiencies, attributed to poor film morphology and enhanced charge recombination. The study explores other contributing factors to the declining device performance with increasing doping levels of the metal sulphides.

Keywords: ZnS:Mn metal sulphides; Charge transport, Photons-harvesting, Organic solar cell

CP-F-18

Evaluation of Energy Potential Estimation Using Modified Multi-Component Weibull Mixture Functions

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Effectively modeling wind speed distributions is crucial for evaluating wind energy potential and choosing the best locations for wind turbines. This research compares three statistical models, which include the Bimodal Mixture Weibull (BMW), Modified Mixture Weibull (MMW) and Four-Component Mixture Weibull (FCMW) while using wind speed data from Abk and Lag, Nigeria. Each model was assessed based on parameter estimates and statistical fit to determine which best captures the wind characteristics.

The BMW model managed to describe basic wind patterns but struggled with more complex distributions. For example, Abk had a Root Mean Square Error (RMSE) of 0.9878 and a Kolmogorov-Smirnov (KS) statistic of 0.3095, pointing to a weak fit. On the other hand, the MMW model showed much better accuracy, lowering the RMSE to 0.2774 and KS to 0.0354, with a strong KS p-value of 0.9114, which indicates a much closer match with actual wind data. Similarly, in Lag, MMW achieved an RMSE of 0.1119, significantly outperforming BMW's 2.4927.

The MMW model also fit the histograms more accurately, capturing the main wind speed peak (around 4.5 m/s in Abk and 8-9 m/s in Lag) and identifying secondary peaks that BMW overlooked. Yet, the FCMW model pushed the accuracy even further, modeling complex, multi-peak patterns more precisely. In Lag, FCMW covered a broad spectrum of wind speeds (β values from 8.51 to 20.00 m/s) and delivered the best performance, with the lowest RMSE of 0.1082 and KS of 0.0234, along with a nearly perfect KS p-value of 0.9991.

Monte Carlo simulation plots backed this up, showing that FCMW consistently mirrored the actual wind data, even at the extremes and across multiple peaks. Overall, the findings show that while MMW is a clear improvement over BMW, FCMW provides the most accurate and detailed representation of complex wind patterns, making it the best choice for evaluating wind energy in varied landscapes like West Africa.

CP-F-19

Exploration of plant essential oils as green, affordable, and sustainable wastewater disinfectants

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Conventional chlorine-based chemical disinfectants cause harm to humans due to producing carcinogenic by-products that pose adverse health issues [1]. Essential oils are made of a dominant bioactive component with antimicrobial activity, which may account for more than half of the chemical composition [2]. Thus, this study aims to explore essential oils as eco-friendly, sustainable, and cost-effective alternative disinfectants in wastewater treatment. Essential oils from three eucalyptus and one lippia species were extracted by steam distillation. Then characterised using Fourier Transform Infrared (FTIR) spectroscopy to identify functional groups with antimicrobial activity, Gas Chromatography Mass Spectrometry (GC-MS) to identify active compounds, and Transmission Electron Microscopy (TEM) to determine the morphology of the essential oil. FTIR confirmed the presence of O-H, C=O, and C-O-C. GC-MS identified eucalyptol and limonene as dominant bioactive compounds with antimicrobial properties in eucalyptus and lippia. TEM images revealed rod-like and spherical shapes, indicating favourable surface interactions with bacterial cells. Antimicrobial testing was conducted using the disk diffusion method to evaluate the individual essential oils' antimicrobial activity and zone of inhibition against gram-positive and gram-negative bacteria [3]. The results showed all four essential oils were active against the bacteria; however, eucalyptus was the most active, and lippia had the least antimicrobial activity. These results highlight the potential of essential oils as eco-friendly disinfectants for wastewater treatment.

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CP-F-20

Molecular hybrid Approach to Antitubercular Drug Discovery: Synthesis, Activity, Cytotoxicity, and Computational Insights

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Tuberculosis (TB) is a highly contagious airborne disease caused by the obligate pathogen *Mycobacterium tuberculosis* (Mtb), which accounts for approximately 1.4 million deaths annually. The growing emergence of multidrug-resistant (MDR-TB), extensively drug-resistant (XDR-TB), and totally drug-resistant (TDR-TB) strains, along with co-infection with HIV, has significantly complicated the diagnosis, treatment, and prevention of TB, making disease management more challenging and prolonged.

In this study, we report the rational design, synthesis, and comprehensive structural characterization of a novel series of isoniazid–dihydropyrimidinone molecular hybrids (**8a-8n**). The compounds were characterized using Fourier-transform infrared (FT-IR) spectroscopy, nuclear magnetic resonance (NMR), and high-resolution mass spectrometry (HRMS). The antitubercular efficacy of these hybrids, their corresponding intermediates (**4a-4n**), and the standard drug isoniazid (INH) was evaluated against wild-type Mtb $mc^2$6230. Among the synthesized derivatives, compounds **8g** (MIC = 6.25 µg/mL), **8h** (MIC = 1.56 µg/mL), **8k** (MIC = 0.78 µg/mL), **8l** (MIC = 6.25 µg/mL), and **8n** (MIC = 0.39 µg/mL) showed significant inhibitory activity, with **8n** identified as the most potent candidate.

However, these active compounds demonstrated reduced activity against INH-resistant Mtb strains harboring katG mutations. The most promising molecules (**8h**, **8k**, and **8n**) were further evaluated for cytotoxicity against the THP-1 human monocytic cell line, revealing a favorable safety profile. Stability studies on the lead compound confirmed its structural integrity via ^{1}H NMR, UV-visible spectroscopy, and LC-MS analyses. Furthermore, in silico molecular

docking simulations were performed to investigate the binding interactions of the potent compounds within the active site of the InhA enzyme. Drug-likeness and physicochemical stability were assessed through ADME/T profiling and global reactivity parameter evaluations through DFT.

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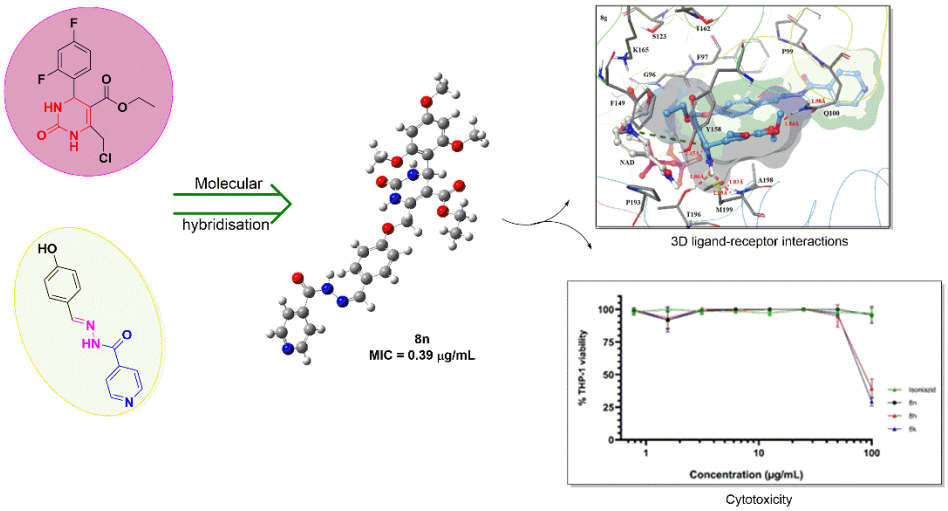

CP-F-21

A JOURNEY TO THE ROOT OF PAIN: A STUDY ON THE ANTI-INFLAMMATORY AND ANTIOXIDANT PROPERTIES OF AFRICAN GINGER

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Inflammation is a response to injury or infection, yet persistent or chronic inflammation underlies many diseases. Non-steroidal anti-inflammatory drugs (NSAIDs) inhibit cyclooxygenase enzymes (COX-1 and COX-2), primarily blocking inducible COX-2 to reduce inflammation. However, long-term use of NSAIDs can cause gastrointestinal, renal, and cardiovascular toxicities, prompting the search for safer alternatives [1]. Plant-derived natural products offer structurally diverse leads for anti-inflammatory drug discovery [2]. In South Africa, the plant *Siphonochilus aethiopicus* (African ginger) is prized for its analgesic and anti-inflammatory effects. However, overharvesting of this plant has rendered it critically endangered, highlighting the need for sustainable investigation of its bioactive constituents [3].

Lead-like extracts from the rhizomes of African ginger were assayed in a 96-well plate using a COX-2 inhibition assay. The extracts exhibited 47% relative inhibition compared to the FDA-approved inhibitor celecoxib. UPLC-QTOF-MS profiling was used to detect 19 major constituents in the crude, including four furanosesquiterpenoids, three of which were isolated and characterised by NMR and mass spectrometry (**Figure 1**). Antioxidant capacity was determined using the DPPH assay. Results from the assay yielded an EC_{50} (1.52) for the crude extract, which corresponded to a concentration of 33.1 µg/mL compared to an EC_{50} (0.62), which corresponded to a concentration of 4.2 µg/mL for ascorbic acid, confirming the presence of radical scavengers in the crude extract. Ongoing work on leaves, stems, and roots aims to map the phytochemical profile of the whole plant. This study highlights *S. aethiopicus* as a source of anti-inflammatory and antioxidant leads, with potential for future drug development.

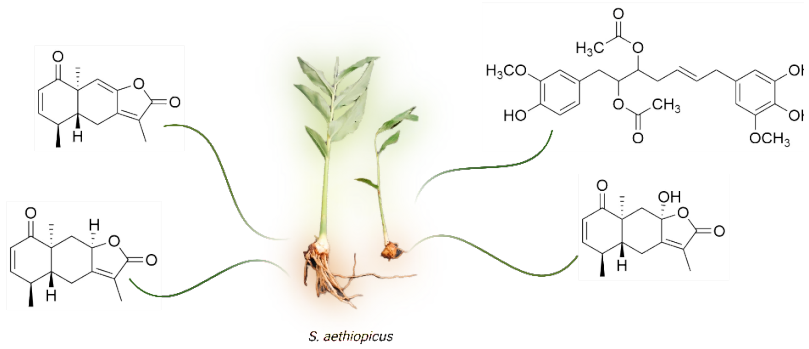

Figure 1: *S. aethiopicus* and some isolated compounds

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CP-F-22

Novel N^N^O-donor Fe(II), Ni(II) & Co(II) complexes: Synthesis, characterization, and application as pre-catalysts in ethylene oligomerization

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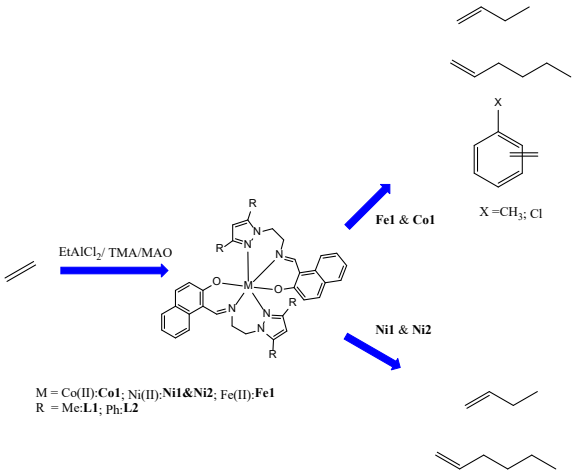
Ethylene oligomerization is one of the world's leading reactions to produce linear alpha olefins. These alpha olefins are utilized as starting materials in the energy processing, bulk & fine chemical manufacturing, food processing, and packaging industries [1]. The increase in global population has led to a rise in demand for various types of alpha-olefins in the market, serving both domestic and industrial purposes [2]. For the past few decades, researchers have been trying to improve the properties of Iron (II), nickel (II), and cobalt (II)-based catalyst structures to enhance their catalytic activity and selectivity toward specific linear alpha olefins. In this project, we prepared imine-based pyrazolyl ligands within the framework of the catalyst. The (imino)pyrazol ligands were prepared via a condensation reaction and treated with $FeCl_2$, $NiCl_2$ or $CoCl_2$ precursor to give complexes, **Ni1**-**Ni2**, **Co1** and **Fe1**. The oligomerization reactions of ethylene with these pre-catalysts, activated with either $EtAlCl_2$, TMA, and MAO as co-catalysts, afforded active pre-catalysts that produced mainly C_4 and C_6 oligomers and alkylated products, depending on the solvent used. The nickel complexes were found to be more active than the cobalt and iron complexes, with activities of up to 20 400 g (product). $mol.^{-1}catalyst.h^{-1}$. On the other hand, the nickel complex that has the phenyl substituent on the pyrazole was the most active compared to the nickel complex bearing a methyl substituent on the pyrazole unit.



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CP-F-23

ENVIRONMENTAL APPLICATIONS OF RAW AND MAGNETIZED FLY ASH AS INDUSTRIAL WASTE-DERIVED LOW-COST ADSORBENTS TO REMOVE PHARMACEUTICALS IN WASTEWATER: ISOTHERMS AND KINETICS

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Pharmaceutical compounds are emerging contaminants in aquatic environments due to their extensive use and incomplete removal by conventional wastewater treatment. Traditional adsorbents like activated carbon and zeolites, while effective, are limited by high cost and inefficiency at trace levels. This calls for cost-effective, reusable, and efficient alternatives for water remediation.

This study, therefore, investigates raw fly ash, an abundant industrial by-product, and its magnetically modified form as low-cost, sustainable alternatives for pharmaceutical removal. Characterization using FTIR, PXRD, SEM, TEM, BET, and TGA revealed that magnetization enhanced surface area, porosity, and introduced magnetic iron oxides, improving adsorption properties. Batch adsorption experiments targeting trimethoprim, dolutegravir, and ibuprofen showed significantly better performance by magnetized fly ash, attributed to its superior physicochemical attributes. LC-MS analysis, calibrated with R^2 values above 0.995, ensured accurate quantification of trace contaminants. The improved kinetics and adsorption capacity of magnetized fly ash highlight its potential for scalable, cost-effective pharmaceutical remediation, offering a sustainable solution aligned with circular economy principles.

CP-F-24

Quantum State Preparation via Coherent Feedback Control in the Continuum Limit

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We present here a time-continuous scheme to drive an initially unknown quantum state into a known target state. This research is based on the idea that a system can be forced to converge to a desired state by means of sequential application of appropriate quantum channels. We derive Gorini-Kossakowski-Lindblad-Sudarshan (GKLS) Master Equations (ME's) to describes such state convergence processes continuously in time as well as find exact analytical solutions for specific channels. The quantum channels can be implemented stochastically by measurement-based feedback or deterministically by Coherent-Feedback Control (CFC), while our primary focus is CFC. We describe the preparation process by means of two examples. In the first, information about the target state of a two-level system is encoded into the interaction with ancilla systems, where the interactions correspond to unsharp measurements with feedback. In the second example the target state of an N-level system is encoded into the initial state of the ancilla systems, where the system-ancilla interactions corresponds to a sequence of weak swaps. The respective ME's were solved directly to reveal deterministic evolution to the target state for any initial state.

CP-F-25

PRODUCTION OF BIOFUELS FROM WASTE OILS USING TRANSESTERIFICATION

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Energy is a crucial factor in measuring economic development and is essential for people's livelihoods.[1] A significant amount of energy is generated from fossil fuels, and this has led towards the exhaustion of petroleum-derived fuel and contributed immensely to global warming and environmental contamination.[2] Biofuels are alternative fuels produced from "agricultural biomass and other organic matter". [3] One of the alternative fuels being explored is biodiesel, which is primarily composed of fatty acid alkyl monoesters from vegetable or animal fats and oils, mainly produced through acidic or basic catalytic transesterification with short-chain alcohols.[4] Due to biodiesel production being more costly and limiting its commercialisation, using waste oils could potentially cut manufacturing costs. This study aims to formulate a dual-purpose detergent capable of preconcentrating and converting waste oils collected from

various sources, including restaurants, butcheries and households, into a valuable feedstock suitable for the production of high-quality biodiesel. A transesterification detergent will be formulated and tested against waste oils collected from various sources. A series of experiments and characterisations, such as determining the acid value, iodine number, cetane number, etc., will be performed to assess the quality of the waste oils and optimise the transesterification conditions of the detergent. The resulting biodiesel will be analysed using GC-MS, FTIR, and a range of physicochemical tests, including viscosity, cetane number, flash point, and calorific value. To evaluate the quality of the biodiesel produced, the results will be compared against US (ASTM D6751) and EU (EN 14214) standards.

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CP-F-26

First Principle Studies of Charged Nitrogen Vacancy Complexes and Diamond

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This dissertation presents a study on the design, construction, and testing of a high-performance computing (HPC) system tailored for calculating the electronic structures and spin dynamics of nitrogen vacancy (NV) complexes in diamond. NV centers, particularly when charged, are valued for their potential in quantum com puting, magnetometry, and sensing applications due to unique quantum properties such as long coherence times and high sensitivity to magnetic fields. This study fo cuses on the development of an optimized HPC environment capable of performing large-scale quantum mechanical calculations essential for modeling these complex quantum systems. The research investigates theoretical frameworks based on Density Functional Theory (DFT) and high-fidelity modeling approaches, examining how various charged states of NV centers affect electronic and optical behaviors in diamond. The results reveal significant symmetry breaking in electron-hole interactions and notable changes in spin textures across different charge states. These findings advance the understanding of NV center dynamics and contribute to the practical application of NV centers in quantum technologies, bridging the gap between computational modeling and real world NV center utilization in quantum devices.

CP-F-27

Exploration of aromatic plant-based materials as bio-adsorbents for the removal of pharmaceutical contaminants from wastewater

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Pharmaceutical drugs are recognized as the emerging contaminants of concern in water systems. This is an attribute to their incomplete metabolization within the human body system thus, be excreted as metabolites or active compounds through urine and feacal waste into wastewater treatment plants (WWTPs) via sewer pathways [1]. Alternative exposure of pharmaceutical drugs include wastewaters from various medical facilities, pharmaceutical industries, inappropriate disposal of unused and outdated pharmaceutical drugs into WWTPs and environmental sites. WWTPs are often challenged to efficiently remove these compounds due to their persistent, accumulative and biological active nature to biodegradation thus, be discharged as partially treated effluent water into environmental water sites (rivers, dams, lakes) [2]. Having accentuated the recalcitrant nature of pharmaceutical contaminants, sustainable and efficient water mitigation strategies necessitate urgent consideration. As a result, in this study a batch adsorption method incorporated with greener magnetized, glycine and sodium bicarbonate modified plant-based leaves (*Lippia Javanica*) as bio-adsorbents was employed to decontaminate antibiotic contaminants (Trimethoprim and Sulfamethoxazole) from wastewater. SEM and TEM analysis of the modified bio-adsorbents showed a comparatively improved surface porosity than unmodified biomaterial. In addition, FTIR analysis showed no addition of new functional groups from the modification solutions however, enhanced peak intensities of the functional groups (C=C, C-O and C-H) and an upward shifts in peak intensities. These modification effects demonstrated effectiveness on the surface morphology of bio-adsorbents thus, increasing the diffusion rate of the targeted compounds onto the sorption active sites. Furthermore, significant adsorption parameters such as sample pH, surface point zero charge, initial concentration, contact time and temperature will be evaluated to develop efficient pharmaceutical removal method.

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CP-F-28

BIFUNCTIONAL Cr-Zn/ZSM-5 CATALYSTS FOR SELECTIVE CO_2 HYDROGENATION TO LIGHT OLEFINS: EXPLORING THE METHANOL INTERMEDIATE PATHWAY

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Due to the alarming global warming increase, the urgent need to mitigate climate change has propelled research in the field of carbon dioxide (CO_2) utilization, aiming to convert CO_2 into valuable chemicals and fuels [1, 2]. Recent studies are mainly focused on the conversion of CO_2 to carbon monoxide, methanol, methane and long-chain alkanes whereas few studies report on the direct conversion of CO_2 to olefins. Lower olefins ($C_2^=$–$C_4^=$), generally referring to ethylene, propylene and butylene, are important bulk petrochemicals used to produce plastics, fibers and other chemicals [3]. This study investigates bifunctional catalysts comprising redox-active Cr-Zn-based oxides (Cr/ZnOx, $ZnCr_2O_4$, and Cr-Zn/SiO_2) supported on acidic ZSM-5 with Si/Al ratio of 13 for conversion of CO_2 to olefins via a methanol intermediacy mechanism. The prepared catalysts were characterized via techniques such as x-ray diffraction (XRD),

N_2 physisorption, temperature programmed reduction (TPR) and temperature programmed desorption (TPD) to elucidate structure-activity relationships. Catalytic performance for olefin production was evaluated under fixed-bed reactor conditions, revealing the influence of metal composition, acidity, and support interactions on selectivity and CO_2 conversion.

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CP-F-29

MORPHOLOGICAL, OPTICAL AND PHOTOCATALYTIC STUDIES OF BIOCHAR-CAPPED MAGNETITE NANOCOMPOSITES

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Biochar-capped iron oxide nanocomposites were prepared and characterized by powder X-ray diffraction, electron microscopy, and XRF. The compounds were used as photocatalysts for the degradation of single and binary mixtures of malachite green (MG) and rhodamine B (RhB) dyes. *Portulacaria afra* leaves were carbonized at 200 °C, 400 °C, and 600 °C to prepare Fe_3O_4@BC–**1**, Fe_3O_4@BC–**2**, and Fe_3O_4@BC–**3**, respectively. Powder X-ray diffraction analysis confirmed a cubic spinel Fe_3O_4 phase for all nanocomposites, while HRTEM revealed different morphologies with particle sizes ranging from 11.2 to 13.3 nm. BET analysis showed mesoporous structures, with Fe_3O_4@BC–**2** exhibiting the highest surface area (91.5 m^2/g), and Fe_3O_4@BC–**3** showing the largest pore volume and diameter. The energy band gaps ranged from 1.79 eV to 1.97 eV. Fe_3O_4@BC–**3** showed the highest photocatalytic degradation efficiencies for the individual dyes, achieving 94.91% for MG and 80.01% for RhB. In contrast, Fe_3O_4@BC–**2** exhibited superior photocatalytic efficiency in the binary dye system, with photocatalytic degradation efficiencies of 99.74% for MG and 98.89% for RhB. Scavenger studies revealed that hydroxyl radicals and superoxide anions are the dominant reactive species. The nanocomposites showed enhanced photocatalytic performance in basic media and exhibited good photostability and reusability over five cycles. These results show the potential of biochar magnetite nanocomposites as efficient, low-cost photocatalysts for organic dyes degradation.

CP-F-30

COMPARISON OF QUANTUM ALGORITHMS FOR QUADRATIC OPTIMIZATION

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Optimization problems appear widely in science and industry, yet their classical solutions often demand considerable computational resources. Quantum computing provides a promising framework for addressing such problems more efficiently by exploiting quantum superposition and entanglement [1]. In this work, we investigate several quantum

gradient descent [2] approaches to find the minimum of a quadratic cost function. Performing the implementation through Amplitude encoding, we begin by a quantum gradient descent algorithm with a phase estimation-based method. To further enhance performance, we develop and test additional strategies, including linear combination of unitaries (LCUs) [3], the Sz.-Nagy dilation method [4], and a so-called unitary selection method, where the cost function is explicitly defined as a quadratic function. These methods are evaluated in terms of circuit depth, number of iterations, and accuracy. Our results show that the unitary selection outperforms phase estimation, LCUs provide a further improvement, and the Sz.-Nagy approach achieves the highest efficiency among all tested methods. This comparative study highlights the potential of pure quantum algorithms in solving real-world quadratic optimization problems.

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CP-F-31

PYRAZOLYLAMINE MONO/DINUCLEAR COBALT(II) COMPLEXES: COORDINATION CHEMISTRY AND ETHYLENE OLIGOMERIZATION STUDIES

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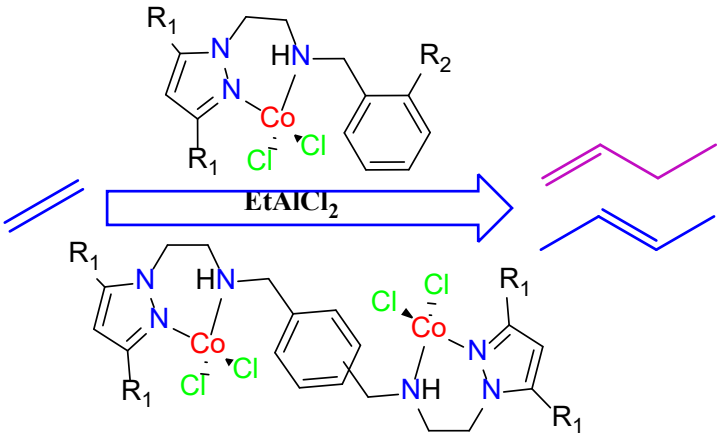
Transition metal catalyzed ethylene oligomerization is a fundamental process for the value addition of ethylene to produce a wide range of valuable feedstock for the manufacture of important domestic and industrial products.[1] The design of these metal catalysts lies mainly in achieving the delicate balance of catalytic activity, selectivity and stability.[2] Pyrazolyl-based metal complexes have emerged as ideal candidates in ethylene oligomerization catalysis due to the ease of fine-tuning both their steric and electronic properties.[3] In this work, a series of mononucleating pyrazolyl-N-benzylethanamine and dinucleating (bispyrazolylethanamine)-phenylene ligands and their resultant cobalt(II) complexes (**Co1**-**Co7**) have been successfully synthesized. These complexes were characterized using IR spectroscopy, mass spectrometry, elemental analysis, and single crystal X-ray diffraction techniques. The molecular structures of complexes **Co1, Co2**, **Co3**, **Co5**, and **Co6** confirmed the formation of mononuclear and dinuclear complexes. Activation of these complexes with $EtAlCl_2$ co-catalyst resulted in the selective ethylene dimerization (C_4). Moreover, the effects of complex structure and reaction conditions were studied and found to influence the catalytic performance of the complexes. Notably, in comparison to the mononucleated analogues (**Co1**-**Co3**), the dinuclear analogues (**Co4**-**Co7**) were found to exhibit improved catalytic activity and stability. Detailed studies on the effect of catalyst structure, reaction conditions in addition to theoretical calculations have been carried out and are herein discussed.



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CP-F-32

TUNING THE REACTIVITY of *N,N'*-pyridyl Palladium(II) Complexes: A Substitution Kinetics and DNA/BSA Binding Study.

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Prompted by the tumor resistance and severe side effects associated with platinum drugs; scientists continue to direct their efforts towards the design of non-platinum metal-based compounds with cytotoxic activity [1]. Amongst several other organometallic compounds being investigated, palladium complexes have emerged as highly functional alternatives [2,3], owing to the similarities in characteristics such as softness, size, bond length, and mode of ligand coordination to form complex, as well as thermodynamic properties [3,4]. Considering the mechanism of action of platinum(II) complexes when interacting with DNA, proteins and thiol containing biomolecules in target cells, we study the sparsely investigated substitution kinetics, as well as DNA and BSA binding of *N,N'*-pyridyl Pd(II) complexes, *viz*. dichloro-(2-pyridinemethanamine-*N,N'*)palladium(II) (**PdL1**), dichloro-(*N*-((pyridin-2-yl)methyl)aniline)palladium(II) (**PdL2**), dichloro-(cyclohexyl-N-((pyridin-2-yl)methyl)-palladium(II) (**PdL3**), dichloro-(propyl-*N*-((pyridin-2-yl)methyl)-palladium(II) (**PdL4**), and dichloro-(tertbutyl-*N*-((pyridin-2-yl)methyl)-palladium(II) (**PdL5**). The *N,N'*-bidentate amine ligands and corresponding Pd(II) complexes were synthesized and structurally characterized using ^{1}H-NMR, ^{13}C-NMR, FT-IR spectroscopy and mass spectrometry. The rate of the substitution of the chloride ligands from the complexes by the nucleophiles, i.e., L-Methionine (**L-Met**), L-Cysteine (**L-Cys**) and Glutathione (**GSH**), was studied as a function of nucleophile concentration and temperature using the stopped-flow spectrophotometric technique, under *pseudo* first-order conditions. DFT calculations and *in silico* binding interactions were performed to elucidate experimental data.

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CP-F-33

Pd(II) & Pt(II) complexes of benzimidazole ligands: synthesis, DNA binding studies substitution, kinetics and cytotoxicity

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Several Pt(II) complexes have been explored for their cytotoxic properties in the pursuit of alternate anticancer drugs due to the development of resistance to traditional platinum-based drugs. Numerous anticancer drugs have been studied and reported over the years to develop less toxic, but equally effective complexes as the well-known cisplatin [1,2]. This study investigates the electronic effects of bidentate ligands (2-(2-Aminoenyl)-1H-benzimidazole and 2-(Aminomethyl)benzimidazole) on Pd(II) and Pt(II) metal centres by exploring their DNA interactions and substitution kinetics with different biological nucleophiles.

The complexes were synthesised and characterised using ^{1}H and ^{13}C NMR, mass spectrometry, UV-visible spectrophotometer, FTIR and elemental analysis. The ligand substitution kinetics of the complexes with L-cysteine, L-methionine, and glutathione were investigated under *pseudo* first-order conditions as a function of concentration and temperature using the stopped-flow spectrophotometric technique. The reactivity of the complexes was influenced by the type of ligands attached, with the Pd(II) complexes reacting faster than the Pt(II) complexes. The mode of activation was associative.

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CP-F-35

ADVANCING GROUNDWATER SAFETY THROUGH AI-DRIVEN RADON PREDICTION IN URANIUM-AFFECTED REGIONS IN SOUTHEASTERN SOUTH AFRICA

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Problem: Radon (^{222}Rn), a naturally occurring radioactive gas, presents a critical, yet often underestimated, public health risk in groundwater sources globally, particularly in regions characterized by uranium-rich geological formations. In southeastern South Africa, where groundwater is indispensable for domestic and agricultural sustenance, current radon monitoring practices are predominantly reactive and fragmented, severely impeding proactive risk mitigation and public health protection. This pervasive challenge underscores an urgent need for innovative, scalable solutions to ensure water safety.

Innovation & Approach: This research pioneers the development of an interpretable, cutting-edge machine learning (ML) framework designed for the accurate and high-resolution prediction of groundwater radon concentrations. Our interdisciplinary approach meticulously integrates diverse geospatial, hydrological, and environmental datasets, leveraging their synergistic potential to unveil complex relationships influencing radon levels. We employ a robust suite of advanced algorithms, including ensemble methods like Random Forests and XGBoost, alongside novel physics-informed neural networks (PINNs). The integration of PINNs represents a significant methodological leap, allowing the ML models to be constrained by physical laws governing radon transport, thereby enhancing predictive accuracy, interpretability, and generalizability beyond traditional data-driven approaches.

Impact & Outcomes: The framework will generate high-resolution geospatial risk maps, providing unprecedented spatial granularity for identifying radon hotspots and informing targeted interventions. Crucially, the study will identify and quantify the key environmental and geological predictors influencing radon levels, offering actionable insights for policymakers and water resource managers. The project is deeply committed to stakeholder engagement and policy relevance, with anticipated outcomes including a publicly accessible, user-friendly predictive tool, high-impact peer-reviewed publications in Q1 journals, and evidence-based policy guidelines. These deliverables are meticulously aligned with South Africa's National Water Act and the United Nations Sustainable Development Goals (SDG 6: Clean Water and Sanitation; SDG 3: Good Health and Well-being), aiming to significantly enhance water safety, public health resilience, and environmental governance.

Significance: This interdisciplinary research not only addresses a pressing environmental health challenge in South Africa but also establishes a novel benchmark for data-driven water safety management in uranium-affected regions worldwide. By pioneering tailored AI solutions for complex environmental problems, this study exemplifies the transformative potential of integrating advanced computational methods with environmental science and public health, setting a precedent for future global initiatives in predictive environmental risk assessment.

CP-F-36

Synthesis & Antitubercular Evaluation of Quinoline– pyrazolopyrimidine hybrids and Quinoline-4-Arylamines

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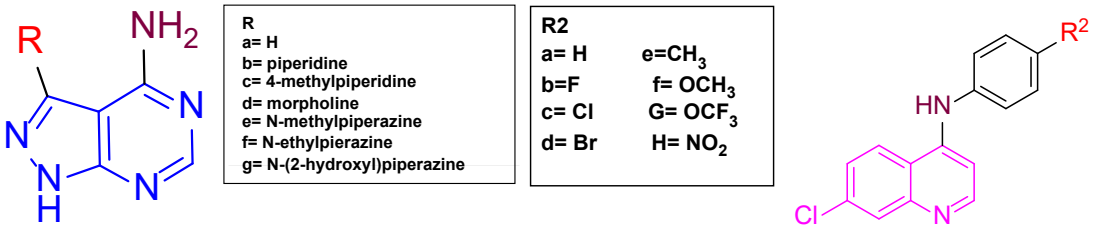
Two libraries of quinoline-based hybrids, including pyrazolopyrimidines and 7-chloro-N-phenylquinolin-4-amines, were evaluated for their anti-Tubercular activity. Several compounds demonstrated promising in vitro activity against the MTB *H37Rv* strain under aerobic conditions. Notably, pyrazolopyrimidine derivatives **8b** and **8c**, bearing piperidine and 4-methylpiperidine groups, showed excellent potency with MIC_{90} values of 7.748 μM and 7.149 μM, respectively. Moderate activity was observed in morpholine- and *N*-methyl piperazine-substituted analogues (**8d, 8e**), and further enhanced activity was noted in compound **10e** (MIC_{90} = 31.25 μM), featuring a hybrid of 4,7-dichloroquinoline and N-methyl piperazine-functionalized pyrazolopyrimidine. Substitution with para-fluoro aniline yielded compound 12g with notable activity (MIC_{90} = 9.904 μM). Overall, the incorporation of piperazine and para-fluoro aniline moieties significantly improved *anti-MTB* efficacy, identifying these hybrids as promising scaffolds for further development of anti-tubercular agents.



Keywords:
Mycobacterium tuberculosis, Anti-tubercular agents, Pyrazolopyrimidine, Quinoline hybrids, Piperazine, Structure–activity relationship.

CP-F-37

Synthesis, Characterization, and Gas Sensing Properties of Rare Earth-Substituted Cobalt and Zinc Ferrites: A Comparative Study of Gd and Nd Doping in ferrites.

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This study presents a comprehensive comparative analysis of pure and rare earth (RE)-substituted cobalt ($CoFe_2O_4$) and zinc ($ZnFe_2O_4$) spinel ferrites and their Gd^{3+}- and Nd^{3+}-substituted counterparts, synthesized via the glycol-thermal method. The substitution of RE ions at Fe^{3+} octahedral sites was employed to investigate their impact on the structural, physicochemical, magnetic, and gas sensing properties of the materials. Spectroscopic techniques such as X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FTIR), high resolution-transmission electron microscopy (HRTEM), ultraviolet visible spectroscopy (UV-Vis), electrochemical impedance spectroscopy (EIS), Raman spectroscopy (RS), and vibrating sample magnetometer (VSM) were employed for characterization of the synthesised compounds. XRD confirmed the formation of single-phase cubic spinel structures across all samples, with average crystallite sizes of 10.2 ± 0.5 nm for $CoRE_xFe_2$-xO_4 and 9.26 ± 1.0 nm for $ZnRE_xFe_2$-xO_4 (RE = gadolinium (Gd), neodymium (Nd), and x = 0, 0.1). There were slight variations following rare earth doping. FTIR spectroscopy exhibited characteristic metal–oxygen stretching bands, corresponding to tetrahedral and octahedral sites, respectively. Shifts and broadening of these peaks in RE-doped samples confirmed modifications in the local bonding environment and cation distribution. HRTEM images revealed partly spherical nanoparticles with uniform size distribution and clearly resolved lattice fringes. The Gd cobalt and Nd zinc ferrites substitutions exhibited competitively optimal results for NH_3 and LPG gases. Magnetic property measurements exhibited a multi domain soft magnetic behaviour. These results are promising for further investigation on the gas exposure and sensor material behaviour relationship. Furthermore, they are aligned well with XRD data and reflected enhanced surface roughness and boundary strain favourable traits for surface active applications. This study highlights the significant role of rare earth doping in tuning the structure–property–performance relationship in spinel ferrites.

CP-F-38

Heavy metal adsorption by *Artemisia afra*: A study on sustainable wastewater treatment.

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Access to clean and safe water is becoming a pressing concern due to increasing anthropogenic activities such as mining, urbanization, and industrialization, which contribute to the persistent rise of water pollution, including heavy metals [1]. Although various methods are employed to remove heavy metals from wastewater, they possess inherent drawbacks, including high operational cost and production of toxic sludge [2]. This work explored *Artemisia afra* plant leaves as an alternative biosorbent for heavy metals from wastewater. The effects of pH, contact time, metal concentration, and temperature on copper, zinc, and lead sorption efficiency were investigated through batch experiments. The removal % of 80-99% was achieved within a contact time of 10 minutes. Equilibrium adsorption data were best fitted with the Freundlich isotherm for Cu and Zn, and the Temkin isotherm for Pb. The pseudo-second-order model describes metal adsorption kinetics well. The adsorption capacities of raw, acid, and base-modified *Artemisia afra* leaves are compared. Although there were no significant differences between the removal efficiencies, the reusability of the modified sorbents indicates their effectiveness and stability over multiple cycles of repeated adsorption. Bio-adsorbents have emerged as cost-effective and environmentally friendly materials that have the potential to be integrated into our water purification systems.

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CP-F-39

IDENTIFICATION OF NATURAL ANTIDIABETIC AGENTS IN INDIGENOUS MEDICINAL PLANTS USED TO TREAT DIABETES

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The rising prevalence of diabetes mellitus has increased the interest in new and safer treatments to manage the disease. The increasing mortality associated with diabetes highlights the urgency for effective and affordable natural antidiabetic agents [1]. In South Africa, diabetes is one of the leading causes of mortality. Traditional medicine has been used since ancient times and plays a significant role as an alternative medicine.

Many plants, including mango trees (*Mangifera indica*), marula trees (*Sclerocarya birrea*), rooibos tea (*Aspalathus linearis*), and honeybush tea (*Cyclopia subternata*), have been reported to exhibit antidiabetic activity [2,3]. Bioactive

compounds isolated from these plants, for example, mangiferin, a compound present in mango leaves, show in vitro activity by inhibiting enzymes associated with diabetes and activity in in vivo experiments [4]. Suryawanshi et al. [4] reported that mangiferin shows comparable inhibitory activity to the standard antidiabetic drugs (sitagliptin, acarbose) against the diabetic enzyme targets DPP-4, α-glucosidase, and α-amylase. This study aimed to further investigate the inhibitory potential of these plants and to isolate the chemical constituents responsible for the antidiabetic activity. Small-scale lead-like extractions (on 300 mg of plant material) were prepared from the plants mentioned above. α-Glucosidase, α-amylase, and DPP-4 inhibitory assays were conducted on the extracts, which demonstrated significant inhibitory effects by some of the extracts. To identify the compounds in the extracts, profiling was performed using UPLC-MS. This presentation will report on the fractionation and isolation of active compounds using chromatographic techniques, with compound identification based on NMR and MS experiments.

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CP-F-40

OCCURRENCE AND REMOVAL EFFICIENCY OF SELECTED ANTIBIOTICS IN TWO WASTEWATER TREATMENT SYSTEMS, DURBAN, SOUTH AFRICA

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Antibiotics are emerging contaminants that persist in aquatic environments, posing risks to human health and ecosystems [1]. Conventional wastewater treatment plants (WWTPs) are not designed to fully remove these compounds, resulting in their continuous release into surface waters [2]. Decentralised wastewater treatment systems (DEWATS), which serve small communities, have rarely been evaluated for antibiotic removal [3]. This study aimed to develop and validate a sensitive analytical method using liquid chromatography–mass spectrometry coupled with solid-phase extraction for analysing sulfamethoxazole, nalidixic acid, tylosin and norfloxacin in wastewater. Samples were collected weekly over a five-week period from a conventional Durban wastewater treatment plant and a decentralised wastewater treatment system. The method showed good performance with linear regression values of 0.99 ($R^2 > 0.99$), limits of detection between 0.008–0.020 mg L^{-1}, and limits of quantification between 0.025–0.060 mg L^{-1}. Recoveries (accuracy) were above 60%, and precision was below 10%, indicating good sensitivity and reproducibility. In the DEWATS, sulfamethoxazole and nalidixic acid was detected at concentrations of 0.030–0.546 mg L^{-1} and 0.001–0.273 mg L^{-1}, respectively, while tylosin and norfloxacin were not detected. In the WWTP, tylosin, norfloxacin and sulfamethoxazole were detected at concentrations of 0.078–2.492 mg L^{-1}, , 0.043–0.181 mg L^{-1}, and 0.093–0.620 mg L^{-1}, respectively. These findings highlight the occurrence of antibiotics in both treatment systems and demonstrate the need for improved removal strategies to prevent environmental contamination.

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CP-F-41

Synthesis, Characterisation and Biological Studies of Oxovanadium(IV) Schiff Base Complexes of *O,N,N′*-Imidazole-aminophenol and Phenanthroline-Derived Bases.

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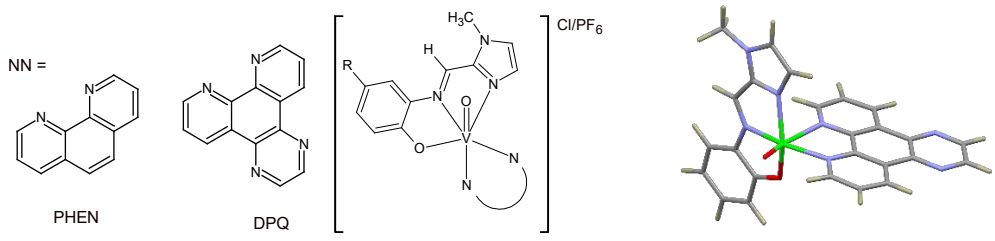
Keywords: Oxovanadium(IV), Schiff base, stability

Current pharmaceutical research aims to develop more effective and less toxic anticancer drugs capable of overcoming traditional platinum drug resistance using coordination compounds of transition metals other than platinum, such as vanadium.[1-3] The mechanism of action of vanadium-based chemotherapeutics typically involves the complexes binding to DNA via intercalation followed by oxidative DNA cleavage, which induces cell apoptosis. In this work, oxovanadium(IV) has been selected as the metal centre for the design of cationic complexes. Cationic complexes enable interaction with the negatively charged sugar-phosphate backbone of DNA. 1,10-Phenanthroline (PHEN) and dipyrido[3,2-d:2',3'-f]quinoxaline (DPQ) were chosen as the co-ligands in the heteroleptic complexes based on these ligand's ability to bind to DNA.[4] O,N,N′-tridentate Schiff base ligands complete the octahedron. Cationic oxovanadium(IV) complexes of *O,N,N′*-tridentate imidazole–aminophenol Schiff Bases and phenanthroline-derived ligands have been shown to be cytotoxic against triple-negative breast, cervical and neuroblastoma brain cancer cell lines.[5] Stability studies of the complexes in biological media are an important aspect of the biological properties of oxovanadium complexes as biological activity of a complex can be improved by increasing its bioavailability through enhancing the stability of the complex. The degree of hydrolytic stability of heteroleptic oxovanadium(IV) complexes containing a *N,N*-bidentate co-ligand can vary significantly depending on the nature of the ligands coordinated, solvent media and pH. The syntheses, characterisation and stability studies in biological media of complexes of the type [VO(ONN)(NN)]PF_6/Cl where NN = PHEN (**1,2**) and DPQ (**3,4**), as shown in Figure 1 (a) are reported. DFT-calculated electronic structures (Figure 1(b)) gain insight into the structural and electronic attributes of the compounds that might impact on their stability and interaction with DNA and other biomolecules.



(a) **(b)**

Figure 1: (a) Structures of complexes [VO(ONN)(NN)]Cl/PF_6 (R = H (**1,3**), CH_3 (**2,4**); NN = PHEN (**1,2**), DPQ (**3,4**). (b) DFT-simulated geometry-optimised structure (B3LYP/6-311G(dp) level of theory) of Complex **3**.

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CP-F-42

Temporal and spatial optical emission spectroscopy of laser ablated carbon composite targets (C, Ni, Y)

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This study presents a temporal and spatial optical emission spectroscopy (OES) analysis of plasmas generated by pulsed laser ablation of carbon composite targets. The aim is to investigate the temporal and spatial evolution of laser-induced plasma (LIP) generated from carbon composite targets comprising carbon (C), nickel (Ni), and yttrium (Y).

OES measurements were collected at various distances from the target surface to determine the spatial dependence of plasma parameters, revealing variations in ionization states, spectral intensities, and expansion velocities throughout the LIP plume. Time-resolved measurements, spanning nanosecond to microsecond delays, capture the transition from the early high-density, shock-driven phase to the later expansion phases which is dominated by collisional relaxation and recombination.

The effect of laser irradiance is investigated by varying the incident pulse energy of the laser so as to demonstrate its influence on ablation yield, plasma temperature, electron density, and spectral line broadening. Furthermore Stark broadening analysis and Boltzmann plots are employed for plasma diagnostics, with the local thermodynamic equilibrium (LTE) condition verified using McWhirter's criterion to ensure reliability and accuracy across the temporal and spatial regions investigated.

These measurements are compared with a range of foundational works on pure carbon systems by Harilal (1997), Amoruso et al. (2001), Geohegan (1994), and Kelly & Miotello (1996). In contrast to these works the present study extends this knowledge to multi-element composite targets which should reveal distinct changes in species excitation, cooling rates, and plume stratification and complexity caused by the presence of Ni and Y.

By bridging single-element and composite-target studies, this study aims to advance the understanding of composite plasma behaviour, providing insights into plasma-material interactions and plasma-laser interactions. This is important for tailoring plasma conditions in laser-based thin-film deposition, nanoparticle generation, and advanced material synthesis.

CP-F-43

Physiochemical, optical and magnetic properties of nickel-magnesium ferrite nanoparticles for various applications

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The current work focuses on the properties of $MgFe_2O_4$, $Ni_{0.5}Mg_{0.5}Fe_2O_4$, and $NiFe_2O_4$ nanoparticles synthesized via the glycothermal reaction method. The product compounds were characterized for structural, morphology, optical, and magnetic properties using X-ray diffraction (XRD), Fourier transform infrared spectroscopy (FT-IR), Transmission electron microscopy (TEM), Scanning electronic microscope (SEM), Energy dispersive X-ray spectroscopy (EDX). Their magnetic properties were evaluated using vibrating sample magnetometer (VSM) and Mössbauer spectroscopy (MS) techniques. XRD data for all materials revealed single-phase formation with no impurities detected. Using the Debye-Scherrer equation calculated from the highest peak (311) plane, the crystal sizes for $MgFe_2O_4$, $Ni_{0.5}Mg_{0.5}Fe_2O_4$, and $NiFe_2O_4$ were determined to be 11.4 ± 0.2 nm, 9.1 ± 0.2 nm, and 8.6 ± 0.2 nm, respectively. XRD data was also used to determine the values of the lattice parameters, which were 8.380 nm, 8.350 nm, and 8.330 nm for $MgFe_2O_4$, $Ni_{0.5}Mg_{0.5}Fe_2O_4$, and $NiFe_2O_4$, respectively. The reduction in these values was attributed to smaller ionic radii of Ni^{+2} (0.069 nm) substituting larger ions of Mg^{+2} (0.072 nm). A single spinel structure of the ferrites was also confirmed by FT-IR data where two bands near 400 cm^{-1} and 600 cm^{-1} were observed, which are the features of the single spinel structure. Hence, XRD and FT-IR results correlated well. TEM images reveal spherical-shaped particles for all materials with average particle size distribution for $MgFe_2O_4$, $Ni_{0.5}Mg_{0.5}Fe_2O_4$ and $NiFe_2O_4$ nanoparticles as 18.62 ± 3.42 nm, 17.46 ± 7.59 nm, and 16.11 ± 3.93 nm, respectively. The morphology of the nanoparticles observed from SEM photograms shows clustering and fewer clustered particles as the substitution of the nickel ions increases. The elements in each compound were verified using energy-dispersive EDX and confirmed to be true as the desired compounds. No contamination was observed. The optical properties were investigated using UV-visible spectroscopy. The energy values for the band gap derived from the Tauc plot were obtained for $MgFe_2O_4$, $Ni_{0.5}Mg_{0.5}Fe_2O_4$ and $NiFe_2O_4$ nanoparticles were 4.52 eV, 4.31 eV, and 3.43 eV, respectively. The magnetic nature of the prepared samples was established through VSM and MS. The VSM study confirmed the superparamagnetic nature of the materials. MS results revealed ferrimagnetic and paramagnetic Fe ions in materials. MS spectra were fitted with two sextets (ferrimagnetism) and one doublet (paramagnetism). These results suggest that these materials can be suitable for various applications such as in medical and electrical.

CP-F-44

Effect of various biomass feedstocks on the physicochemical properties of porous biochar produced through common pyrolysis conditions

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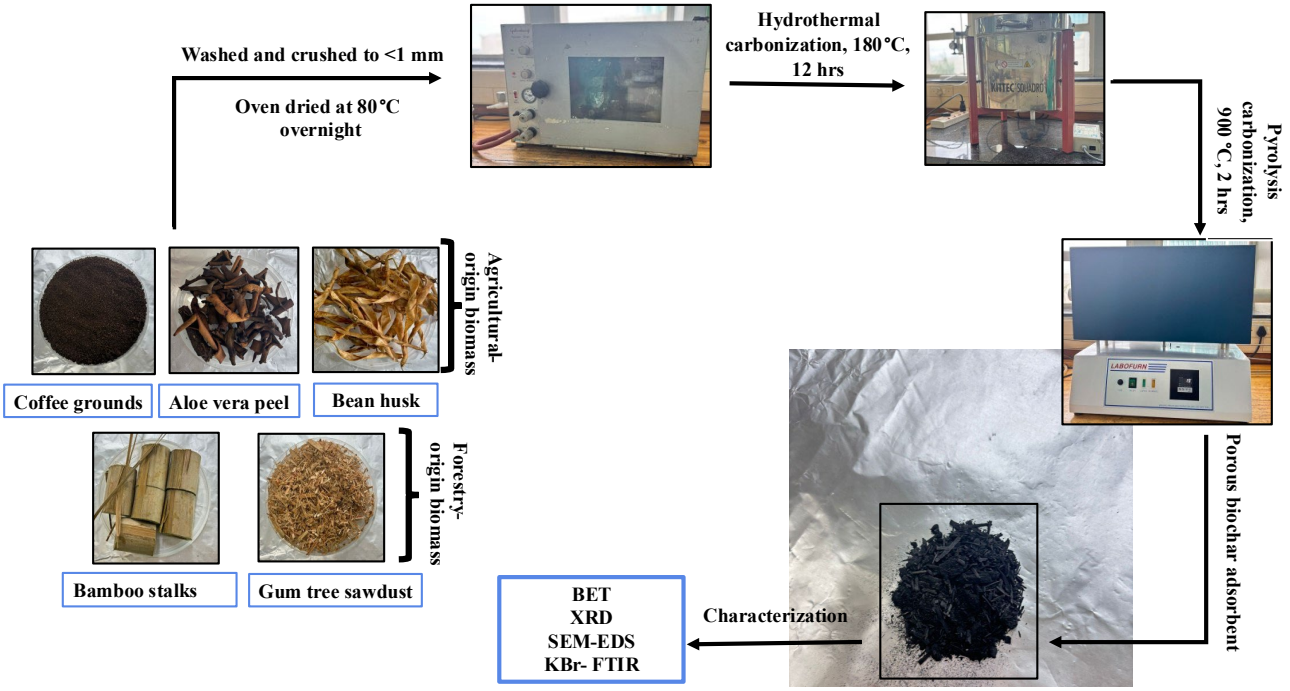
Porous biochar adsorbents are considered eco-friendly and sustainable remediation technologies for emerging contaminants. The surface chemistry and morphology of porous biochar determine its potential applications. Herein, the effects of various biomass feedstocks, forestry origin (gum tree sawdust and bamboo stalks), and agricultural origin

(coffee grounds, bean husks, and aloe vera peel) are studied to determine their impacts on the physicochemical properties of porous biochar adsorbent. Characterization techniques used were KBr-FT-IR, XRD, BET, and SEM-EDS. The results revealed that the physicochemical properties of porous biochar adsorbent were affected by the biomass feedstock origin. The forestry-origin biomass accounted more impact compared to the agricultural-origin biomass. The porous biochar adsorbent from forestry origin, exhibited hydrophobic surface chemistry and porous structure with the highest specific surface area of 383.5507 and 429.6703 m^2/g, from gum tree sawdust, and bamboo stalks, respectively. They depicted similar physicochemical properties as biomass-based adsorbents utilized for the remediation of microplastic/nano-plastic particles (MPs/NPs) in aqueous solutions. Therefore, the present study demonstrated the effect of various biomass feedstocks on the physicochemical properties of porous biochar adsorbent.

Keywords: Biomass; Porous biochar adsorbent; Physicochemical properties; Emerging contaminants



CP-F-45

DEVELOPMENT OF A SUITABLE AND SENSTIVE BIOMARKER FOR THE DETECTION AND PREVENTION OF FUEL ADULTERATION

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A significant portion of fuel stations in South Africa are illegally blending both petrol and diesel with paraffin, compromising fuel quality, increasing harmful vehicle emissions, and causing lasting damage to engines. According to recent findings by the Department of Mineral Resources and Energy (DMRE), 70 out of 1,000 service stations tested were found to dilute petrol and diesel with paraffin-a practice driven by the desire to reduce costs and evade fuel levies. Paraffin, not subject to the fuel tax, offers a way for stations to boost profits while undermining environmental and economic regulations. This growing issue is exacerbated by declining domestic refinery capacity since 2020, leading to greater reliance on imported refined fuels. By 2026, it is projected that 53% of refined fuel products (amounting to 604,000 barrels per day) will be imported into South Africa. The consequences include increased input costs, reduced

fuel security, and job losses due to refinery closures. To address this challenge, this research aims to develop and apply chemical biomarkers for detecting fuel-paraffin adulteration in both imported fuels and retail petrol station tanks. Biomarkers are hydrocarbon compounds that exhibit unique chemical "fingerprints" depending on their geological origin and refining process. They are resistant to environmental degradation and detectable at low concentrations using Gas Chromatography-Mass Spectrometry (GC/MS). This study will advance the development, characterization, and quantification of such biomarkers, alongside the application of multivariate statistical analysis to improve fuel fingerprinting and contamination assessment. The project also supports environmental protection by enabling the detection of excessive paraffin in diesel, which contributes to toxic exhaust emissions and air pollution. Furthermore, it seeks to inform policy enforcement by introducing a chemical marker into illuminating paraffin sold in South Africa, thereby preventing revenue loss and promoting fuel integrity. Ultimately, this work contributes to mitigating chemical pollution across environmental, economic, and human health systems offering a science-based solution to fuel adulteration in a developing country context.

CP-F-46

Optimisation and validation of a high – performance liquid chromatography – photo diode array method for the quantification of selected pharmaceuticals in environmental matrices

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The increasing occurrence of pharmaceuticals in biological matrices and wastewater poses significant environmental and public health challenges. These compounds, which originate from various sources, can persist in the environment, leading to adverse effects on exposed ecosystems and humans. This research aims to develop and validate a high-performance liquid chromatography method coupled to photo diode array detector (HPLC-PDA) for the quantification of selected pharmaceuticals, including acetaminophen, albendazole, diclofenac, efavirenz, lamivudine, norethisterone, and sulfamethoxazole, in wastewater samples. This method involves the optimisation of sample preparation techniques, such as solid-phase extraction (SPE), to effectively isolate and concentrate the target pharmaceuticals from complex matrices. The HPLC-PDA system will be operated over a Shimadzu SHIM-PACK GIST C18; 5 µm, 4.6 x 150 mm column to achieve good separation, and tuned for maximum sensitivity and selectivity for accurate detection of the pharmaceuticals. The developed method will be rigorously validated according to standard analytical procedures, including assessments of linearity, limit of detection (LOD), limit of quantification (LOQ), precision, and accuracy. Preliminary results suggest that the method will provide high sensitivity with LODs and LOQs suitable for trace-level detection. The recovery rates from spiked samples are also to be evaluated to ensure method reliability across different sample types. The validated HPLC-PDA method will be applied to analyse pharmaceuticals in real biological and wastewater samples collected from residents and wastewater treatment plants (WWTPs) in Durban, South Africa, respectively. This study will not only provide essential data on the occurrence and concentrations of pharmaceuticals in various environments but will also contribute to the development of strategies for monitoring and mitigating pharmaceutical contamination. The outcomes of this research will have significant implications for environmental management and public health, offering a robust analytical tool for ongoing surveillance and risk assessment of pharmaceutical residues in the environment.

CP-F-47

PHOTOCATALYTIC DEGRADATION OF ORGANIC DYES IN WATER OVER METAL OXIDE CATALYSTS

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Water pollution is the biggest problem that the world is facing nowadays due to the lack of proper disposal of wastewater by the textile industry. Since the latter half of the 20th century, the use of synthetic compounds has increased significantly. Most of these chemicals have been classified as persistent organic pollutants (POPs) because of their environmental persistence, long-range transportability, capacity to bio-magnify throughout the food chain, and ability to bioaccumulate in human and animal systems [1]. The textile industries significantly impact the worldwide economy and environmental contamination in numerous countries, including China and South African estuaries. The textile industry produces a high number of coloured effluents that contain a variety of persistent contaminants, making it a major environmental polluter [2]. The dyes released into water streams undergo biological and chemical changes and consume the oxygen dissolved in water bodies. Various methods such as ultrasonic decomposition, electro-coagulation, etc., have been implemented to degrade the organic dyes, but these processes require high energy and result in secondary pollutants. Photocatalysis has been found as an effective method for the degradation of dyes in water, as it uses metal oxides that have a suitable band gap with suitable properties for the degradation of organic dyes.

In this study, the main aim was to degrade organic dyes using different metal oxides such as ceria, zirconia and titania. The metal oxides were prepared via solution combustion and precipitation and were compared against commercial metal oxides. The catalysts were characterised by powder x-ray diffraction, Raman spectroscopy, nitrogen physisorption, UV-visible diffuse reflectance and photoluminescence spectroscopy. The catalysts were used in the photocatalytic degradation of methylene blue.

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CP-F-48

SYNTHESIS AND CHARACTERIZATION OF NOVEL SILVER(I) COMPLEXES CONTAINING 2,4,5 TRIPHENYL IMIDAZOLE DERIVATIVES

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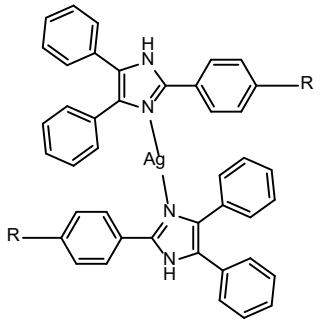
In recent years, chemical and biological usefulness of multi-substituted imidazoles has led to increased interest in the pharmaceutical industry due to their diverse biological activities [1]. Incorporating metal ions into their structure offers the potential for synergistic effects in drug development. In this study, silver (Ag) has been selected among various metals for coordination with 2,4,5-triphenylimidazole derivatives owing to its natural abundance, low toxicity at therapeutic concentrations, and minimal bioaccumulation, making it a promising candidate for drug development [2]. A series of 2,4,5-triphenylimidazole derivatives were synthesized via a catalyst-free, one-pot condensation reaction of benzil, *para*-substituted benzaldehyde (benzaldehyde, 4-chlorobenzaldehyde, 4-methylbenzaldehyde, 4-methoxybenzaldehyde, and 4-nitrobenzaldehyde), and ammonium acetate in ethanol. Subsequently, five novel Ag(I) complexes were synthesized by reacting the imidazole ligands with silver nitrate in ethanol at room temperature. All ligands and their corresponding Ag(I) complexes were thoroughly characterized using NMR (^{1}H and ^{13}C NMR), FT-IR, mass spectrometry, elemental analysis, and melting point determination. The successful formation of the ligands and Ag(I) complexes was confirmed by the analytical data, particularly mass spectrometry, where the base peaks observed at m/z values aligned with the theoretically calculated masses. These findings demonstrate the efficient synthesis of structurally well-defined imidazole derivatives and their silver complexes, which hold potential for further exploration in medicinal chemistry and drug development. All the compounds were then tested for their antitubercular and antimicrobial properties.



R = H (AgL1)
R = Cl (AgL2)
R = CH_3 (AgL3)
R = NO_2 (AgL4)
R = OCH_3 (AgL5)

Figure 1: Structures of the Ag(I) complexes.

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CP-F-49

TAILORING ZSM-5 SUPPORTED RHENIUM OXIDE CATALYSTS FOR HYDROGENOLYSIS OF GLYCEROL: SYNTHESIS AND CHARACTERISATION

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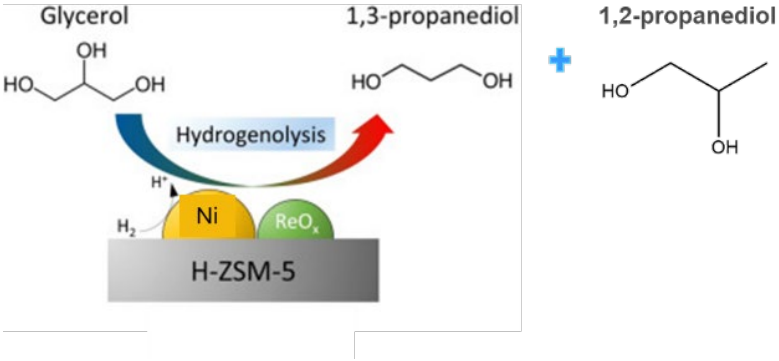
The valorisation of crude glycerol, an abundant byproduct of biodiesel production, presents a sustainable route for converting renewable biomass into value-added chemicals, particularly glycols. Propylene and ethylene glycol have

important use as antifreeze liquids and additives in liquid detergent.[1] Glycerol transformation to these glycols can be performed through various reaction pathways catalysed by zeolite-based materials, which possess acid-base sites and framework selectivity suitable for catalytic glycerol transformation [2]. This study focused on the development of mesoporous ReO_x/ZSM-5 and Ni-ReO_x/ZSM-5 heterogeneous catalysts for the selective hydrogenolysis of glycerol to propanediols, combining the hydrogen activation properties of nickel with the promotional effects of rhenium oxide species on a hierarchical zeolite support. The catalysts were prepared through an initial desilication treatment of ZSM-5 using either NaOH or a NaOH–TPAOH mixture, followed by the incorporation of metals via wet impregnation. The structural and physicochemical properties of the resulting catalysts were characterised by powder x-ray diffraction (XRD), nitrogen physisorption, and Brunauer–Emmett–Teller (BET) surface area analysis.



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CP-F-50

Screening of Indigenous South African Plants for Natural Herbicidal Agents

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The widespread application of synthetic herbicides in agriculture has led to several ecological concerns, including environmental contamination. The emergence of herbicide-resistant weed species, and negative impacts on non-target organisms. These drawbacks underscore the need for environmentally safer, biodegradable alternatives. Natural products from plants have emerged as sustainable candidates due to their ecological compatibility and sustainability.

This study explores the herbicidal potential of four South African medicinal plants *Hilliardiella capensis, Hilliardiella aristata, Helichrysum pandurifolium*, and *Helichrysum nudifolium* selected for their traditional use and documented secondary metabolite profiles. Roots, stems, leaves, and flowers of each species were dried and sequentially extracted using hexane, dichloromethane (DCM), and methanol (MeOH). The phytotoxic effects were evaluated through *Lactuca sativa* (lettuce) seed using bioassay to measure inhibition of lettuce seeds. The DCM stem extracts demonstrated the strongest germination inhibition.

Bioassay-guided fractionation using SPE DIOL columns further narrowed down the most active fractions. Positive and negative controls were used to validate assay accuracy. These results confirm the presence of phytotoxic compounds in the plants studied and suggest their potential as sources of natural herbicidal agents. Future work involves isolating and structurally illucidate the active constituents using GC-MS, LC-MS, and NMR spectroscopy.

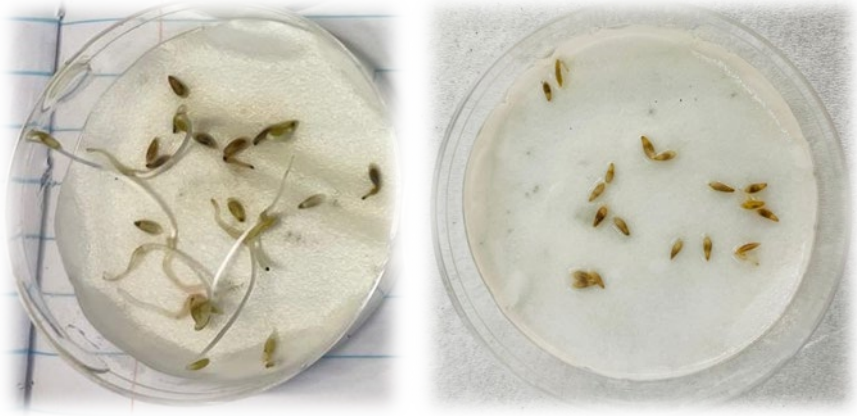

Figure 1: The phytotoxic bioassays of crude extracts.

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CP-F-51

Hydrogen-Bonding Network-Enabled Terminal Selective Heteroarylation of Allenamides in Hexafluoroisopropanol

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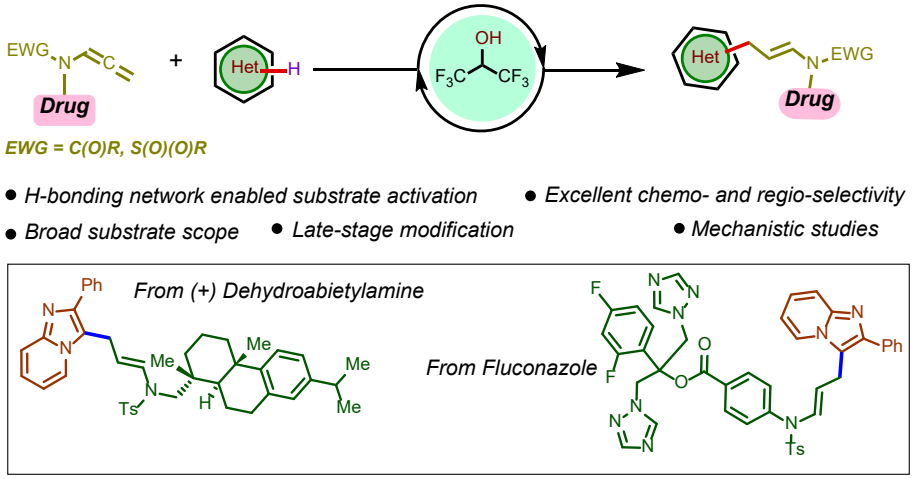
Hexafluoroisopropanol (HFIP)-mediated terminal selective heteroarylation of allenamides has been accomplished through H-bonding network-enabled substrate activation in a robust fashion. This strategy features a cascade process involving sequential nucleophilic addition followed by electrophilic heteroaromatic substitution and is well suited for late-stage functionalization of complex bioactive molecules. The elucidation of the underlying mechanism was achieved through a comprehensive combination of several control experiments, kinetic studies, isotopic labeling experiments, and the isolation of the HFIP−allenamide inter mediate adduct.



Keywords: Heteroarylation, HFIP, H-bonding, Allenamide

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CP-F-52

Antimicrobial and anti-quorum sensing activities of medicinal plants (*Rhoicissus rhomboidea, Rhoicissus capensis* and *Cyphostemma auriculatum*)

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Antimicrobial resistance is one of the greatest human health problem globally. In 2019, the researchers reported about 1.2 million of antimicrobial resistant infection deaths per year and this number is expected to reach over 10 million by the year of 2050. Antibiotics are extremely important drugs against bacterial infections however more bacteria are getting resistant to many antibiotics [1, 2]. This requires consistent development of novel drugs. The aim of this study was to evaluate the antimicrobial activity and anti-quorum sensing of methanol extracts/ fractions from the roots and leaves of traditional medicinal plants *Rhoicissus rhomboidea, Rhoicissus capensis* and *Cyphostemma auriculatum*.

The methanol extracts/ fractions were prepared and tested for antimicrobial and anti-quorum sensing activities. The quorum sensing inhibition potential of the samples has been quantified using the violacein inhibition assay, while the Mueller-Hinton Agar dilution assay was used to assess the antimicrobial susceptibility of the methanol extracts/ fractions against various Gram-negative and Gram-positive microorganisms. All the tested samples were more effective at inhibiting the short-chain acyl-homoserine lactone (AHL) producer, *Chromobacterium subtsugae* CV017 and moderate effective at inhibiting the long-chain AHL producer, *Chromobacterium violaceum* ATCC12472. Two samples RC-ML fraction 10-18 (methanol fraction from leaves of *R. capensis)* and CA-MR fraction 30-42 (methanol fraction from roots of *C. auriculatum*) displayed a notable antimicrobial activity (MIC < 1mg/mL) against methicillin-resistant *Staphylococcus aureus*. The methanol fraction from roots *C. auriculatum*, CA-MR fraction 30-42 yielded better and equivalent antimicrobial activity (MIC = 32µg/mL) against methicillin- resistant, *Staphylococcus aureus*

compare to the known antibiotics ampicillin and kanamycin. This fraction also was more effective at inhibiting the long-chain acyl-homoserine lactone (AHL) producer, *C. violaceum* ATCC12472 with violacein inhibition of 75.29% at 200 µg/mL.

The findings reveal that R. *rhomboidea, R. capensis* and *C. auriculatum* might be the suitable source of QS inhibitors to treat infectious diseases including microbial resistance pathogens.

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CP-F-53

An Investigation into the Presence of Organic Chemical Pollutants in the Reuse Water Plant at an uMngeni-uThukela Water Wastewater Treatment Plant

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Water reuse has developed into a crucial strategy for addressing water scarcity and ensuring sustainable water management. Treated wastewater, often referred to as reuse water, is more recently being considered for applications like agricultural irrigation, industrial processes, and drinkable water supplies in specific regions. The use of treated wastewater is a more applicable and eco-friendly option [1]. While conventional wastewater treatment can effectively remove a plethora of contaminants, growing concern exists regarding the presence of residual pollutants, particularly heavy metals and organic micropollutants like pharmaceuticals, pesticides, and polychlorinated biphenyls (PCBs), which may persist despite adequate treatment [2].

The presence of pharmaceuticals in water has raised several concerns about antibiotic resistance, endocrine disruption in aquatic life, and potential long-term health effects on humans [3]. Similarly, pesticides have been detected in wastewater due to agricultural runoff and industrial discharge [4]. Since Umgeni-uThukela Water does not test for organic micropollutants regularly, the quality and safety of reuse water in terms of pharmaceutical and pesticide contamination remains unclear.

This project aims to develop and validate analytical methods to detect and quantify a wide range of organic and inorganic pollutants in reuse water. Target analytes are monitored using LC-MS for pharmaceuticals, GC-MS for PCBs and pesticides, and ICP-OES for heavy metals. Early-stage work has included the preparation of model mixtures, method training, and preliminary method development and method validation. The goal is to apply these methods to real water samples collected from a reuse plant in a wastewater treatment plant and assess pollutant levels relative to physicochemical parameters. The results will contribute baseline data and practical insights that can support future monitoring strategies and improve understanding of pollutant behaviour in treated wastewater.

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CP-F-54

INVESTIGATION OF THE PHYTOTOXICITY OF *COLEUS NEOCHILUS* SCHLTR.

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The widespread use of synthetic herbicides in the agricultural sector to control weeds contributes significantly to environmental concerns [1]. The identification and quantification of bioactive compounds from plant extracts exhibiting phytotoxic properties offer promising avenues for developing of environmentally friendly herbicidal agents.

In this project, the extracts of *Coleus neochilus* Schltr., a member of the Lamiaceae family, were assayed for phytotoxicity to discover biologically active compounds that can serve as sustainable alternatives to currently used synthetic herbicides. The crude dichloromethane-methanol (DCM-MeOH) extract of the leaves of *C. neochilus* showed positive inhibition on the germination of lettuce (*Lactuca sativa*) seeds. This crude extract was further fractionated into five fractions, which were assayed for phytotoxicity, resulting in the identification of two active fractions. The EtOAc was the most active fraction, and we have identified the two major compounds as abietene diterpenoids (Figure 1) by LC-MS [2]. The next step in our project is to isolate the compounds, confirm the structures by NMR spectroscopy, and assay the compounds for the inhibition of seed germination.

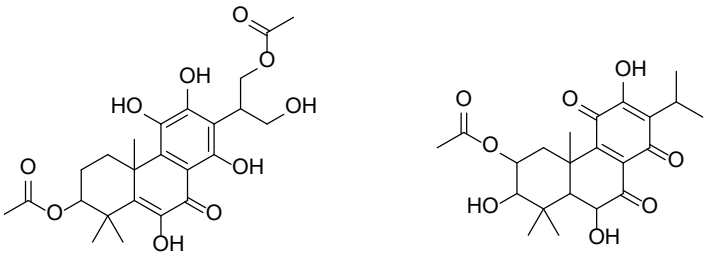

Figure 1. The abietane diterpenoids identified in *Coleus neochilus*.

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FLASH ABSTRACTS

ENGINEERING *AND* MATHEMATICS, STATISTICS AND COMPUTER SCIENCE

MSCSENG-F-1

Structural Effectiveness of Rolled Steel Bridge Girders Subject to Pitting Corrosion: A Performance-Based Approach

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Pitting corrosion poses a significant threat to the integrity and performance of steel structures, potentially leading to progressive collapse if left unaddressed. This research investigates the impact of pitting corrosion on the structural effectiveness of rolled steel bridge girders under service conditions. We adopt a performance-based approach that integrates *Finite Element Analysis* (FEA) and a *Convolutional Neural Network* (CNN) to evaluate structural degradation with respect to plastic strain.

Pitting corrosion profiles, modelled according to *American Society for Testing and Materials* (ASTM)-G46 specifications and equation for rate of corrosion, are used to simulate various levels of corrosion over time. The mechanical performance of the girder is assessed based on its stress-strain behavior, and the probability of failure is quantified using the *First Order Reliability Method* (FORM). Our results demonstrate a substantial reduction in load-bearing capacity, particularly in areas of high corrosion intensity, which significantly compromises the overall stability of the structure. We also discuss potential mitigation strategies aimed at improving the resilience of this critical structural element.

This research provides valuable insights into the long-term durability of rolled steel bridge girders subjected to pitting corrosion during their service life which in turn enables structural engineers to create an optimized design to enhance structural safety and longevity.

Keywords: Pitting Corrosion, Rolled Steel bridge girder, Finite Element Analysis (FEA), Convolutional neural Network (CNN), First Order Reliability Method (FORM), Structural Integrity, ASTM G46, Performance- Based Design

MSCSENG-F-2

The development of a Weighted HIV Risk Scoring Algorithm for high-risk women in KwaZulu-Natal

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BACKGROUND

KwaZulu-Natal, South Africa, has one of the highest HIV prevalence rates globally, particularly among young women, necessitating targeted risk assessment tools. This study aimed to develop a weighted HIV risk scoring algorithm for high-risk women to guide prevention strategies.

METHODS

2,750 participants from the VOICE study in KwaZulu-Natal were analysed to identify key HIV risk factors. Using an 80/20 training-testing split, a Stepwise Cox model was developed and validated ($\chi^2 = 12.272$, $p = 0.83$), serving as the benchmark for creating a weighted HIV risk score. Its performance was compared to machine learning models, Survival Decision Tree, and Random Survival Forest using the C-Index, IBS, and MSE.

RESULTS

The Stepwise Cox model identified younger age (18–24 years), partner's other relationships, non-marital status, and contraceptive use as key HIV risk factors, with strong hazard ratios (HR = 1.70–4.49) and a C-Index of 0.7077. The model also achieved an Integrated Brier Score of 0.0756. A Survival Decision Tree with 7 nodes captured similar predictors through interpretable splits, while the Random Survival Forest (RSF) with 1000 trees offered improved handling of complex interactions. The weighted HIV risk score, based on the Cox model's hazard ratios, assigned greater weight to younger age and the partner's other relationships, showing strong predictive performance.

CONCLUSION

We developed a simple, user-friendly HIV risk score with high sensitivity, enabling early identification of most women at risk. While specificity is lower, prioritizing sensitivity is essential for HIV prevention. The score demonstrated strong internal validity, supporting its potential for practical use in real-world settings.

MSCSENG-F-3

Enhancing Design Flood Estimation through Copula-Based Joint Modelling of Flood Peak and Volume in South Africa

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Accurate design flood estimation (DFE) is a cornerstone of hydrological planning and infrastructure safety, particularly in regions prone to hydrological extremes such as South Africa. Conventional univariate methods used in DFE often ignore the dependence between key flood variables, such as peak discharge and flood volume, leading to potentially unrealistic or underestimated design values, especially in the upper tail of the distribution. To address this limitation, the present study proposes an enhanced joint probability modelling approach using copula functions to better capture the complex interdependence between flood peak and volume. Copulas provide flexible mathematically modelling of the joint distribution of hydrological variables with different marginal behaviours. This study assesses the dependence structures between flood peak and volume using Kendall's tau and Spearman's rho, while model selection is informed by the Akaike Information Criterion (AIC). Several copula families are evaluated, including Archimedean (Clayton, Frank, Gumbel–Hougaard, Joe), Elliptical (Gaussian, Student's *t*), and Extreme Value (Galambos, Hüsler–Reiss, Tawn), based on their ability to model extreme flood distributions and the best fit copula is selected using the goodness-of-fit test and the AIC and Bayesian Information Criterion (BIC) with parameters estimated via maximum likelihood Estimation (MLE). Joint return periods are estimated, and joint design flood pairs

are extracted using the maximum joint density criterion, ensuring statistical representativeness within the defined probability contour. Results demonstrate that the copula-based joint probability approach can significantly improve the joint estimation of design flood pairs compared to traditional univariate methods.

MSCSENG-F-4

Persistent Homology: Formal Properties and Links to Other Structures in Algebraic Topology

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Persistent homology (PH) is a fundamental method in topological data analysis (TDA) for identifying how topological features like connected components, loops, and voids appear and disappear across multiple spatial or functional scales. PH is built on filtrations of simplicial complexes, where inclusion maps induce homomorphisms on homology groups, and feature lifetimes are captured in persistence diagrams or barcodes [1,2]. Because of their underlying topological nature, invariants provide stable, multiscale descriptors of shape, with resilience to data perturbations [1].

This work connects PH to key algebraic topology structures simplicial and CW complexes, relative homology, exact sequences, Betti numbers etc., that form the basis for both ordinary and extended persistence [2]. The filtration-based approach is rooted in early work on computing homology from approximations [3], where nested complexes recover topological invariants from discrete or noisy data.

We further explore how combinatorial frameworks enhance PH's efficiency and interpretability. Different filtrations (Vietoris–Rips, Čech, alpha complexes) trade off geometric fidelity and computational cost, while sparse matrix reduction and specialised algorithms enable large-scale analysis [1,4]. Beyond Betti numbers, invariants such as linking numbers can be computed over filtrations, enriching topological summaries [5].

By integrating rigorous theory, computational optimization, and extended invariants, PH demonstrates how pure mathematical principles can support practical, scalable tools for analysing complex, multi-dimensional data.

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MSCSENG-F-5

Tracking Progress Towards Sustainable Development Goal 3.2 in Kenya Using Time Series Models

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Background: Sustainable Development Goal (SDG) 3.2 is to decrease the under-five mortality rate to under 25 per 1,000 live births by 2030. This is a critical objective for enhancing child health, especially in sub-Saharan Africa, where mortality rates persist at elevated levels.

Objective: This study aims to analyse under-five mortality trends in Kenya using time series models to forecast the likelihood of achieving Sustainable Development Goal target (SDG) 3.2 by 2030.

Method: This article utilises panel data from 1995-2022 and three time series models which includes autoregressive integrated moving average (ARIMA), Autoregressive fractionally integrated moving average (ARFIMA), and a Hybrid model. The most effective model was determined to be an ARIMA (2,1,1) based on the lowest Akaike Information Criterion (AIC), root mean-squared error (RMSE) of 2.34 and Mean Absolute Percentage Error (MAPE) of 3.21%, it was the best fit model through comparison with the others. The mean absolute error (MAE) was 1.98, support for the model's correction. These metrics were used to evaluate model predicative accuracy and their usefulness in predicting future under-five mortality.

Results: The paper presents evidence of a downward trend in under-five mortality in Kenya, which the ARIMA model forecasts toward improvements in the coming years. The forecast suggests Kenya is unlikely to meet the SDG 3.2 goal, since the predicted articulation of the mortality rate is projected to plateau above the targeted level by 2030. This implies that more actions need to be put in place to achieve the goal.

Conclusion: Kenya has made strides in reducing under-five mortality, but it will fall short of its SDG 3.2 target by 2030 without further investment in interventions. Emphasis on healthcare provision, nutrition as well as addressing socio-economic differences are required to achieve the goal.

MSCSENG-F-6

Design and Benchmarking of efficient ansatzes for Variational Quantum Algorithms for application in Quantum Chemistry

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Accurate and efficient simulations of large molecular systems are significant for various applications in both healthcare and the chemical industry. However, they are computationally expensive on classical computers. Recent progress in the development of quantum computers and algorithms suggests the possibility of performing molecular simulations computationally, which is currently very expensive on classical High-Performance Computing (HPC) hardware. The Variational Quantum Eigensolver (VQE), an emerging hybrid quantum-classical algorithm, is a promising solution for approximating ground-state molecular energies. This project aims to enhance the accuracy and efficiency of VQEs by utilising Machine Learning (ML) techniques. We aim to investigate strategies for optimising the ansatz design, hyperparameter tuning, and initialising configurations. The research will initially focus on Hydrogen Hydride (H2) molecules and expand into more complex systems. We aim to provide faster and more precise energy approximations. This research will advance knowledge on the efficacy of machine learning techniques in optimising quantum circuits.

MSCSENG-F-7

Designing Advanced Ti-6Al-4V Alloys with Iron, Nickel, and Manganese additions for Biomedical Applications

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This research focuses on enhancing the performance of Ti-6Al-4V, a widely used titanium alloy in biomedical applications, through strategic alloying with Iron (Fe), Nickel (Ni), and Manganese (Mn). The escalating demand for durable and biocompatible orthopaedic and dental implants necessitates continuous material innovation to improve implant longevity and patient outcomes. This study aims to investigate the definitive influence of these specific alloying elements on the microstructure, mechanical properties, and corrosion resistance of Ti-6Al-4V, addressing the critical need for next-generation implant materials.

The methodology will involve preparing Ti-6Al-4V alloys with controlled additions of Fe, Ni, and Mn. Material synthesis will employ the technique of arc melting in an inert atmosphere. Subsequent characterization includes detailed analyses of the microstructure using advanced microscopy (e.g., SEM), assessment of mechanical properties through hardness testing and tensile testing, and evaluation of phase structure and crystallographic characteristics.

The addition of iron is expected to contribute to improved fracture toughness and potentially reduce production costs, aligning with established principles of Fe alloying in titanium systems. Manganese, a known beta-phase stabilizer, is projected to enhance both mechanical properties and biocompatibility. Nickel, while requiring careful consideration for biocompatibility, offers specific advantages related to phase stability and the potential for tailoring mechanical responses. This investigation is designed to elucidate how these elements, individually and in combination, can be leveraged to optimize the strength-to-weight ratio, elastic modulus, and corrosion resistance of Ti-6Al-4V, thereby bringing its properties closer to those of human bone and minimizing stress shielding effects.

This work is poised to contribute significant insights into the compositional design of advanced titanium alloys for biomedical implants. By systematically exploring the effects of Fe, Ni, and Mn, this research seeks to develop materials with superior mechanical performance, enhanced biocompatibility, and improved long-term reliability, ultimately addressing critical challenges in the field of orthopaedics and dental prosthetics.

MSCSENG-F-8

Stability and Optimal Control Analysis of an HCV Model with Immune Response

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This paper presents a mathematical model to comprehensively analyze the dynamics of Hepatitis C Virus (HCV) infection. The system of nonlinear ordinary differential equations (ODEs) integrates hepatocyte cells, the virus, immune cells, and cytokines. We establish the well-posedness of the model within a biologically feasible region, determine the basic reproduction number $\Re 0$ using the next-generation matrix method, and conduct sensitivity analysis of $\Re 0$. Conditions for the stability of both the disease-free and endemic equilibria are derived. This study contributes to a deeper understanding of HCV infection dynamics and the critical role of immune responses in disease progression.

Furthermore, an optimal control problem is formulated and solved using Pontryagin's minimum principle to identify the best treatment strategies. Two treatment controls are investigated to minimize infection and treatment costs. Numerical solutions are obtained using the forward-backward sweep method.

MSCSENG-F-9

Determinants of Mental Health and Psychological Well-Being in Gauteng

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Mental health is a growing concern within urban populations, particularly in regions facing inequality, unemployment, and infrastructural challenges. In South Africa's Gauteng province, psychological well-being is shaped by a complex interplay of socio-demographic and environmental stressors. This study investigates the key determinants of mental health using data from the Gauteng City-Region Observatory's Quality of Life Survey 7 (2021/22), which includes over 13,000 respondents across the province.

The research explores the relationships between self-reported mental health indicators (including PHQ-2 scores) [1] and variables such as age, gender, employment status, education level, perceptions of safety, food security, and social support. The methodology incorporates generalized linear mixed models (GLMMs) and spatial statistical techniques to assess both individual-level and geographic disparities in psychological distress.

Preliminary findings suggest that perceived safety, household food insecurity, and lack of emotional support are significantly associated with poorer mental health outcomes. Spatial analysis reveals distinct geographic clustering of distress, highlighting municipalities with elevated mental health vulnerability.

The study contributes to a more nuanced understanding of mental health determinants within the urban South African context and offers evidence to support targeted interventions in both policy and public health spheres.

Keywords: mental health, psychological distress, generalized linear mixed models, spatial disparities, Gauteng, PHQ-2, social determinants

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MSCSENG-F-10

SELF-ADAPTIVE PROXIMAL ALGORITHMS FOR UNIFORMLY SMOOTH EQUILIBRIUM PROBLEMS IN BANACH SPACES

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This paper presents a simple proximal point method for approximating solutions to equilibrium problems within the framework of 2-uniformly smooth Banach spaces. We apply the golden ratio technique as an extrapolation method and utilize a self-adaptive process, simplifying our proposed algorithm's implementation by eliminating the need for prior estimates of Lipschitz-like constants. The proposed algorithm is proven to be strongly convergent under mild assumptions, and we further establish its linear convergence. Several numerical examples are included to demonstrate our method's effectiveness and computational superiority compared to other existing algorithms. These results validate the scheme's practical performance and enhance the theoretical understanding of algorithmic behaviour in Banach spaces.

Key words and phrases: Banach space; Equilibrium; Golden Ratio; Proximal; Pseudomonotone; Strong convergence; Linear convergence.

MSCSENG-F-11

INNER CIRCLE TRADING METHODOLOGIES AND MACHINE LEARNING: A SYSTEMATIC REVIEW AND TYPOLOGICAL CLASSIFICATION OF HYBRID STRATEGIES

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Retail trading has experienced significant growth in recent years, driven by technological advancements and increased access to financial markets (Securities and Exchange Commission, 2021; World Federation of Exchanges, 2022). However, this growth has been accompanied by notable challenges. Odean (2022) highlights that real-world investors often deviate from rational models, trading frequently, selecting underperforming stocks, and making decisions influenced by media and personal biases. These behaviours contribute to substantial losses in retail CFD trading accounts, with 74–89% of such accounts incurring losses (ESMA, 2007; Odean, 2022).

In response, a variety of trading methodologies have emerged to mitigate retail trading losses, including Position Trading (Elder, 2002; Covel, 2009), Swing Trading (Farley, 2000; Aziz & Pezim, 2018), Day Trading (Aziz, 2016), Price Action Trading (Brooks, 2009; Beggs, 2010), Algorithmic Trading (Chan, 2013; Narang, 2013), News Trading (Lien, 2008), and Trend Trading (Covel, 2009; Burns, 2015). One particularly promising approach is the Inner Circle Trader (ICT) methodology, developed by Michael J. Huddleston. ICT aims to emulate institutional trading behaviour through a systematic framework for market analysis, high-probability trade identification, and risk management (Huddleston, 2001). Practitioners report success rates of 60–70% under optimal conditions, though outcomes vary based on market dynamics and trader discipline.

The integration of ICT methodologies with machine learning (ML) has the potential to catalyse a new paradigm in financial trading. This systematic review synthesizes existing literature on ICT and ML, following PRISMA guidelines to critically examine the typological classification, effectiveness, and implementation of hybrid strategies. This research explores the intersection of ML and 'Inner Circle' trading methodologies—especially the Inner Circle Trader (ICT) framework—which blends technical and fundamental strategies to emulate institutional behaviour. Drawing on recent empirical studies, including applications of deep reinforcement learning (DRL), sentiment-driven models, and Transformer-based architectures, this study conducts a systematic review and typological classification of ML-driven trading strategies. It addresses four key questions: (1) What are the dominant supervised and reinforcement learning techniques in trading? (2) How do these techniques compare in predictive performance and risk management? (3) What is the potential for hybridisation and paradigm shifts within ICT and similar frameworks? (4) How do emerging architectures like Transformers and clustering-causality hybrids extend the typology of trading strategies?

While machine learning (ML) has demonstrated promise in enhancing trading strategies in previous studies, its application within the ICT framework remains largely unexplored. Hence, this research aims to bridge this gap and

offer valuable insights into the potential synergy between the ICT framework and ML algorithms ultimately contributing to the mitigation of retail account losses?'

Keywords: *Retail Account Losses, Machine Learning, Inner Circle Trader Framework, Trading Strategy Optimization, Risk Mitigation*

MSCSENG-F-12

Thermal analysis of functionally graded material in longitudinal fin profile with spatially varying conductivity and porosity using a spectral collocation method

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This study outlines the thermal analysis of functionally graded longitudinal fins under a temperature-dependent spatially varying thermal conductivity and porosity. The aim is to investigate how spatial variation in the properties of the materials influences the temperature distribution and heat transfer performance. This research fills a gap in existing studies, which often examine only one varying property at a time. The model is developed in a transient state with specified boundary conditions and constraints. Four types of thermal conductivity variations are considered: linear, quadratic, exponential and sinusoidal. Porosity is modelled using an exponential decay function. The bivariate spectral quasilinearisation method (BSQLM) is employed for approximate solutions. To verify the accuracy of the approximated numerical solutions of the linear partial differential equation, the residual error was obtained. The results of the transient state show that the FGM fin in the exponential and sinusoidal cases has the fastest thermal response compared to the linear and quadratic cases. The porosity parameter increases more in the exponential case. The reduced effective thermal conductivity caused by the porous structure diminishes heat transfer from the hot base to the fin tip and the surrounding environment. The effect of radiative and biotic parameters on heat transfer through the fin is analysed. The findings indicate that the increase in the radiative and biot parameters enhances the thermal performance of the FGM fin. Overall, the results demonstrate that strategically grading the properties of the materials can significantly increase heat transfer rates. These insights offer a solid foundation for designing and optimising high-performance thermal management systems, especially in areas like electronics and aerospace.

MSCSENG-F-14

New Solutions for Charged Gravitating Spheres in EGB Gravity

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We explore Lovelock theories of gravity, particularly focusing on the Einstein-Gauss-Bonnet (EGB) gravity as an extension to general relativity. We consider a spacetime that is static and spherically symmetric. We generate field equations for charged gravitating perfect fluid leading to the charged condition of pressure isotropy that is an Abel differential equation of the second kind. Through this framework we generate new solutions containing existing ones. We show how previously obtained solutions led to nonphysical results. Our work will not only provide new insights

into the behaviour of highly dense stars but also establish a basis for future observational tests of these extended gravitational theories.

MSCSENG-F-15

Modelling under-five child mortality in Tanzania including estimation of unobserved Heterogeneity

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This thesis focuses on the risk determinants of infant and child mortality in Tanzania. It specifically examines how infant and child mortality is related to environmental, demographic and socio-economic factors. A survival analysis approach is used to analyze the determinants of child mortality. Duration or time-to-event models are easily applicable to the problem of child mortality as this class of models is able to account for problems like right-censoring, left-censoring and interval censoring, structural modeling and time varying covariates which other classes of models, such as logistic regression, cannot handle adequately. In this application the age at the child's death is used as the time to event. Household, environmental, demographic and socio-economic factors are found to have significant impact on child mortality. Policies aimed at achieving the goal of reduced child mortality should be directed on improving the households environmental and / or socio-economic status of a child for this goal to be realized. Keywords: child mortality, infant mortality, neonatal mortality, duration model, survival analysis, failure function, hazard rate.

MSCSENG-F-16

DEEP LEARNING TECHNIQUES TO ENHANCE EARLY TUBERCULOSIS DIAGNOSIS USING X-RAY IMAGES FOR ANALYSIS

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Tuberculosis (TB) is one of the leading fatal diseases globally [1], even though it is curable [1]. TB also has high incidence globally with Africa forming a shocking incidence of 24% as of year 2024[2]. Radiography has been used to diagnose TB which is known to identify TB abnormalities even before a patient displays any clinical symptoms, especially following the high number of missed cases by traditional testing methods that rely on biological samples (sputum) such as TBNAAT tests which can miss over 20% TB cases [3], due to low bacterial load among other reasons. TBNAAT tests also require two further tests which in South Africa means an additional annual cost of R13,649,824[4]. This delays diagnosis and consequently, treatment initiation. Another factor that perpetuates this delay is the scarcity of certified radiologists[5], especially in under-resourced regions, who can interpret radiographs (x-ray images) accurately and fast to enhance early TB diagnosis which has been proven to speed up treatment initiation, reduce TB related mortality, and assist in TB spread management, consequently improving survival chances[6]. This work is aimed at developing an Artificial Intelligent model by implementing Deep Learning frameworks namely ResNet101, XceptionNet, VGG19, DenseNet169, MobileNet and Multi-Scale Vision Transformers (MViT) to detect TB through classification, as well as UNet for segmentation of areas of interest, all of which are known to perform exceptionally well in learning hierarchies and spatial features on visual data such as images [7]. This work utilizes

responsible AI (RAI) and Explainable AI (XAI) to strengthen its findings, the ethicality of results[8] and to promote a positive attitude towards AI by health workers through introducing Data Science for visualization x-ray images showing heatmaps on areas that the model uses to make a decision or prediction or classification and to explain how much each of those areas contributed to the final classification prediction which enforce transparency, safety and accountability and understandability to human beings. Tools used for RAI and XAI are Grad-Cam and Shapley Additive Explanations (SHAP). To eliminate bias, and achieve model robustness, the model(s) will be trained on a dataset of x-ray images publicly available and ethically collected, representing various ages, different genders and races. The results of Grad-Cam and SHAP outputs will be looked at by a professional radiologist or medical practitioner to confirm if the model is indeed focusing on the TB abnormalities in each x-ray image predicted as positive. Cohen's Kappa will be used for the evaluation of results to ensure that the model is not simply guessing but rather making informed decisions beyond chance [9], along with ISO and IEEE evaluation metrics for AI models such as ROC, F1 score, recall, accuracy and precision [10].

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MSCSENG-F-17

Charged isotropic solutions with linear barotropic equation of state in Einstein-Gauss-Bonnet gravity

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In the present work we investigate new class of charged isotropic solutions with a linear barotropic equation of state (EoS) in the framework of Einstein–Gauss–Bonnet (EGB) gravity for 5 and 6 dimensional spherically symmetric static distributions. Imposing such a restriction of the EoS, one more further assumption on the metric potentials must be chosen in order to close the system. For example, the constant gravitational potential which is responsible for an isothermal distribution in Einstein gravity and as well as different forms of temporal potential are analyzed. Through graphical analysis we demonstrate that the obtained exact models satisfy the basic elementary astrophysical requirement for physical plausibility.

MSCSENG-F-18

A spectropolarimetric study of extended radio galaxies in the MERGHERS pilot sample

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Radio galaxies dominate the sky at radio wavelengths. They show enormous regions of radio emissions outside the optically visible extent of the host galaxy. Different classes of radio galaxies can be used as tracers of the cosmic environment. Spectral and polarimetric studies of the extended radio galaxies give insight into their electron population and associated magnetic fields. This project will explore the polarization calibration methods of the MERGHERS pilot sample, which had om-target observations that did not include a polarization calibrator. The methods produced in this project will be applicable to the larger MERGHERS sample. The scientific component of the project will include the analysis of polarization products and spectral index maps of the extended radio galaxies in the vicinity of the cluster environment.

MSCSENG-F-19

EVALUATION OF BIOCHAR & ACTIVATED CARBON PRODUCED FROM DIFFERENT FEEDSTOCK FOR USE AS AN ADSORBENT

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Water contamination caused by compounds of emerging concern(CECs), primarily pharmaceuticals, hinders water reuse in South Africa [1]. Conventional wastewater treatment technologies are unable to completely remove these contaminates, leading to detrimental environmental impacts and posing a risk to human health and aquatic ecosystems[2]. This has led to a recent increase in the discovery and development of inexpensive materials for the removal of pharmaceuticals in wastewater treatment. This study attempts to assess several forms of biochar and activated carbon made from various feedstocks for use as an adsorbent for the removal of pharmaceuticals in wastewater treatment facilities.

The biochar was generated from three renewable feedstock (black wattle, eucalyptus and horse manure) through the process of pyrolysis at 350 °C and 700 °C. Subsequent chemical activation was performed using potassium hydroxide(KOH) and phosphoric acid(H_3PO_4). Adsorption tests using tartrazine dye as a proxy were carried out to determine the effect of initial concentration on the adsorption process. To understand the physiochemical composition of the biochar and activated carbons, the materials were characterized by Brunauer-Emmet-Teller surface area analysis (BET), scanning electron microscopy (SEM), and thermogravimetric analysis (TGA).

High surface area of 383,477 m^2/g, 400 m^2/g, 396,0873 m^2/g was observed for BW-700-KOH, E-700-KOH and HM-700-KOH respectively. A high adsorption capacity of 93 m^2/g was achieved by BW-700- H_3PO_4. Adsorption experiments indicated that biochar and activated carbon may be used as sustainable material for removing tartrazine dye from water.

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MSCSENG-F-20

DEVELOPMENT OF A DIGITAL TWIN FOR MONITORING POSTHARVEST QUALITY CHANGES IN FRESH TOMATOES

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In South Africa, postharvest losses of tomatoes account for over 30% of annual production, roughly 161 177 tons per year, resulting in an economic impact of R1.61 billion. These losses also translate to 2.9 billion wasted calories, enough to feed approximately 1.38 million people daily, and more than 38 billion litres of water lost annually due to the crop's high water demand (214 L/kg). As a climacteric fruit, tomatoes deteriorate rapidly, further shortening their shelf life.

While various methods exist to reduce produce losses along the supply chain, the numbers continue to rise. Conventional quality assessment methods, such as penetrometer testing firmness, are destructive, time-intensive, and laborious. There is an urgent need for rapid, non-destructive, and data-driven solutions that can better track quality and reduce waste along the fresh produce supply chain.

This study introduces a novel Digital Twin (DT) framework designed for real-time, non-destructive grading of tomato quality in the South African postharvest supply chain. The DT system leverages computer vision, deep learning (ResNet50), IoT, cloud computing, big data, and 3D modelling to synchronise physical and virtual tomatoes. Three classification models, defect detection (defective/healthy), colour classification (red/green), and final quality grading (healthy/reject), are developed using a transfer learning approach. A real-time feedback loop across all models allows adaptive fine-tuning during deployment, enabling incremental learning, an uncommon feature in agricultural DT systems.

In addition, pixel-based defect localisation is implemented to extract shape, texture, and position features at the pixel level, which are then mapped onto a 3D model of the tomato. This 3D visualisation enhances traceability and interpretability by dynamically illustrating external quality changes. The proposed DT system represents a first-of-its-kind application in horticultural postharvest monitoring in South Africa, showcasing the potential of intelligent, real-time systems to reduce losses and increase supply chain efficiency significantly. Future research may extend this framework to other crops, integrate additional imaging technologies, or explore hybrid AI models to balance accuracy with computational efficiency.

MSCSENG-F-21

Malaria Prevalence and Associated Factors with reference to the 2021 Nigerian Malaria Indicator Survey

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Malaria remains a major cause of illness and death among children under-five in Nigeria, despite efforts to control transmission. Accurate and reliable prediction of malaria outbreaks is crucial for health authorities to take timely measures. This study aims to identify the most robust machine learning classification algorithms for predicting malaria status in children under-five (0-59 months) and the most relevant predictors.

The 2021 Nigeria Malaria Indicator Survey (NMIS) included 10,655 children under-five, who were tested for malaria using the Rapid Diagnostic Test (RDT). Various machine learning models were explored, including Decision Trees, K-Nearest Neighbor, Naïve Bayes, Random Forest, Support Vector Machines, and Survey Logistic Regression, and evaluating their performance metrics such as accuracy, AUC, balanced accuracy, F1-Score, negative predictive value, precision, sensitivity, and specificity.

The results show that Random Forest (RF) is the most robust and balanced classification model due to its superior accuracy (79%), precision (77%), recall (62%), F1-score (69%) and AUC (80%). Support Vector Machine (SVM) also shows strong performance, particularly in accuracy (74%) and AUC (80%). Survey Logistic Regression (SLR) and Decision Tree (DT) offer moderate results but fall short compared to RF and SVM, indicating the need for further optimization. Naive Bayes (NB) and K-Nearest Neighbors (KNN) have limitations, making them less reliable for this task. The findings indicate that there are many risk factors associated with malaria outbreaks in children under-five which are the level of anaemia, birth order, age in months, mother's language and educational level, wealth index, mosquito bed net for sleeping, type of mosquito bed net, number of bed nets in a household, residence, region, and source of drinking water.

In conclusion, the study reveals that RF and SVM are the best classification models for predicting malaria status in children under five years old. RF is reliable and balanced, while SVM is preferred for recall. SLR and DT show potential but need optimization. NB and KNN have significant performance gaps, making them less suitable. These findings will help policymakers and malaria intervention programs address key factors, enabling more targeted public health interventions to reduce the malaria burden on young children and improve the well-being of vulnerable populations in Nigeria.

Keywords: malaria, machine learning, classification algorithms, performance metrics

MSCSENG-F-22

On Unicoherent Topological Spaces.

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In this presentation, I will delve into unicoherent spaces: these are topological X for which every pair of closed connected subsets A and B such that $X = A \cup B$, the intersection $A \cap B$ is connected. This concept was introduced in 1929 by Kuratowski in the context of continua, and was later studied by famous authors such as Vietoris, Whyburn, Dickman Jr, Duba, and Clapp. I shall discuss the general behaviour of these spaces and some of their compactifications. I will then outline some results regarding the concept of a space being unicoherent at its subcontinuum.

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MSCSENG-F-23

DETECTING TRENDS IN MULTI-DAY RAINFALL EXTREMES IN KWAZULU-NATAL

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Detecting trends in hydrological extremes is vital for adequate design of hydraulic structures. The current methods and models used to estimate design rainfall and flood in South Africa assume that data andhydrological processes are stationary. However, the increased reported flood events in South Africa have raised the question of whether changes in the magnitude and frequency of observed extreme rainfall events are already evident in South Africa. Therefore, there is a need to determine if there are changes in rainfall event trends and to develop a method to account for non-stationary models in extreme design rainfall and flood estimates. Several studies have shown that non-stationary design flood estimation is mainly influenced by incorporating rainfall as a covariate. Therefore, this study will investigate trends in 1-day, 3-day, 5-day, and 7-day rainfall to determine which duration is most suitable to be used as a covariate in non-stationary design flood estimation in South Africa. In this study, the peak-over threshold approach was used to extract 1-day, 3-day, 5-day, and 7-day rainfall exceeding the 90th, 95th, 99th, and 100th percentile from 40 observational stations with a 50-year record length in KwaZulu-Natal, South Africa. Temporal trends in the data were investigated using the non-parametric Man-Kendall tests. The results indicate weak evidence that the multi-day rainfalls have increased in magnitude and frequency over time. The trends detected in the magnitude and frequency of the extracted multi-day rainfall varied across the sites, with most stations along the east coast of KwaZulu-Natal showing a negative annaul trend. Analyis of seasonal rainfall showed that winter rainfall has increased in both magnitude and frequency compared to summer. This results of this study can be used for water resource management and further emphasizes the need to consider non-stationarity in design rainfall and flood estimation.

MSCSENG-F-24

Investigating the Use of UAVs for Cadastral Surveying in South Africa

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Efficient land management and administration requires the documentation of information relating to the ownership of land. This information includes the individual who holds the right to the land, the form of right the individual holds, and the dimensions of the land the individual has the right to. The need to document this information is met by the cadastral system. The South African cadastral system uses a fixed boundary system to determine the dimensions of the land for documentation. This system involves the ascertaining of existing land rights, the emplacement of beacons on the ground to delineate land parcel boundaries, a cadastral survey to measure the coordinates of the emplaced beacons, and the recording of the land right and land parcel dimensions. A title deed can be issued only after the completion of the described stages, providing the holder with security of tenure guaranteed by the state.

Land management and administration is a lengthy and complicated process with many challenges. It often requires comprehensive reforms, capacity building, investment in technology, and efforts to improve transparency and

accountability in land administration processes. Its lengthy nature has created a backlog in the issuance of title deeds in South Africa. One of the challenges in fast-tracking this process are the speed and cost of undertaking the boundary determination process using total stations and GPS equipment. In the early 2000s, aerial photogrammetry using aircrafts was critiqued for being too costly and not meeting the accuracy requirements for cadastral surveying. The emergence of Unmanned Aerial Vehicles (UAVs) which are cheaper than aircrafts and provide better accuracy since they can fly at lower altitudes presents an opportunity to fast track the rate of boundary determination to meet the needs of the South African cadastral system.

This study will review the cadastral surveying standards regarding boundary determination set out by the South African Geomatics Council (SAGC) and other relevant legislation. It will explore the technological and methodological considerations for UAV mapping for boundary delineation in a cadastral system that uses fixed boundaries. This will be demonstrated by capturing images using a camera mounted on a UAV. The captured images will then be used to create an orthophoto which in turn will serve as a backdrop for delineating land parcel boundaries based on location of boundary beacons placed on the ground prior to imagery capture. The study will also review the South African Civil Aviation Authority (SACAA) regulations for compliance with UAV mapping and compare the regulatory framework with international standards to identify gaps and make recommendations.

MSCSENG-F-25

Statistical Modelling of Diabetes Prevalence and Its Associated Risk Factors Among Kenyan Men

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Diabetes prevalence has increased globally over the past decades, affecting both developed and developing countries. Diabetes affects millions of people worldwide and contributes to increased rates of sickness and mortality, making it a significant public health concern. Complete well-being depends on maintaining excellent health, and effective prevention and management of diabetes depend on understanding the factors associated with the disease. According to earlier research, the prevalence of diabetes varies by population, and men frequently have distinct risk factors from women. Therefore, identifying factors associated with diabetes in men is an essential problem that needs consideration.

This study uses some statistical methods that are suitable to estimate the effect of the risk factors associated with diabetes among men (aged 15 years and older). The study utilised the 2022 Kenyan Demographics and Health Survey data. The Generalised Linear Models, such as the binary logistic regression model that assumes a simple random sampling as a sampling method, followed by the survey logistic regression model that incorporates the complex design by means of robust standard errors of estimates, were applied to the data. The findings revealed that models that account for complex design are more suitable than those that do not account for complexity. To account for variability between the clusters, a generalised linear mixed model was then used. GLMMs account for correlation within clusters by means of random effects, which also account for cluster-to-cluster heterogeneity. Furthermore, a generalised additive mixed-effect model was used to fit nonlinear and non-normal data; the categorical variables were modelled parametrically and continuously by non-parametric models.

The study findings revealed that the risk factors age, health status, hypertension, province, and wealth index were influential factors significantly associated with diabetes. The study also revealed that the interaction effects of age and health status, health status and wealth index, and health status and hypertension are strongly associated with diabetes in survey logistics, which accounts for model complexity. The findings highlight the complex interaction of socio-demographic, clinical, and economic factors in influencing diabetes risk among Kenyan men. Targeted interventions should prioritise older men, those in poor health, and those in lower wealth groups. The significant interaction effects emphasise the need for multifactorial prevention strategies. Public health policies should integrate routine screening, socioeconomic support, and workplace health programmes to reduce the diabetes burden effectively.

The identified significant factors can inform the development of targeted strategies to reduce diabetes prevalence in Kenya. These findings emphasise the need for context-specific interventions focused on high-risk groups. Strengthening routine health screening and addressing social determinants are critical for effective diabetes prevention and control.

MSCSENG-F-26

JOINT MODELLING OF MICROBIOLOGICAL COUNTS ASSOCIATED WITH WATER QUALITY DATA

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Ensuring the safety of drinking water is critical for public health, as contaminated water can lead to widespread disease outbreaks and long-term health risks. Monitoring water quality involves measuring microbiological indicators, which often result in count data, such as the number of bacteria colonies present in water samples. In health and environmental research, such count data are commonly skewed, with frequent occurrences of zero counts and long positive tails, leading to overdispersion. These features violate the assumptions of standard statistical models, particularly those relying on normality, and necessitate more flexible distributional approaches.

This study aims to identify and compare advanced statistical methods capable of modelling these complex microbiological counts accurately. We used five years (2011–2015) of daily water quality data collected from three Umgeni Water treatment sites in Durban, focusing on key bacterial indicators: E. coli, Total Coliforms, and Heterotrophic Plate Counts at 37°C. Due to the nature of the data being over-dispersed and zero-inflated, we evaluated and compared the performance of Negative Binomial and Zero-Inflated Negative Binomial models within a Bayesian framework. All models were implemented in R using the Integrated Nested Laplace Approximation for computational speed.

Preliminary results show that the Zero-Inflated Negative Binomial model provides the best fit across all bacterial indicators, effectively capturing the excess zeros and variability in the data. Furthermore, chlorine levels were consistently associated with lower bacterial counts, confirming their critical role in water treatment. These findings contribute to better understanding of treated water quality and provide a robust statistical framework for monitoring and promoting water safety and sustainability.

Keywords: INLA, Bayesian Analysis, Overdispersion, Multivariate Models

MSCSENG-F-27

On localic aspect of SIN-groups

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In this talk, we shall introduce the notion of localic SIN-groups. Examples of such localic groups include the compact and the commutative ones. One of the important properties about these localic groups is that they are complete [1].

Among other things, we shall present functional characterizations of localic SIN-groups. A glance at the natural way of uniformizing co-products will permit us to present some open problems related to SIN-groups.

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MSCSENG-F-28

Conditional Performance of Decision Transformers

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Reinforcement learning is a machine learning approach where an agent learns a policy by interacting with the environment that provides feedback in the form of rewards. A policy is a mapping from states in the environment to an action. The goal of reinforcement learning is to train an agent to learn a policy or behaviours that maximises its rewards during environment interaction. In return conditioned policies [2], an agent must interact with the environment to generate a sequence of observations and actions that lead to a specified return, meaning the agent must learn a wider distribution of behaviours. An example of this is in AI game agents or NPCs (Non playable characters) which must perform at different skill levels based on user specifications or difficulty level. Our work focus is on the efficacy of a recent reinforcement learning technique in developing reward conditioned policies. Decision transformers [3] are neural network models that solve reinforcement learning by casting it as a sequence-to-sequence decision making problem.

Decision transformers have shown strong ability at mapping to high or maximum returns, but their ability in generating reward conditioned policies has been less studied. Furthermore, preliminary experiments suggest that the condition value used as input has little effect on the performance of the model at test time. Our aim is to determine how aspects such as the dataset, model architecture and hyperparameters affects performance of decision transformers for solving these problems. Additionally, we benchmark different variations of decision transformers to provide a clear overview of conditional performance across different environments. We do this by first training the decision transformer on a fixed dataset for a particular environment. Once training is completed, we evaluate how well the model maps to returns by initialising each run with a desired return and record the average accumulated return over the course of each evaluation episode. Our aim is to identify key design choices that lead to high correlation between the desired return and the achieved return.

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MSCSENG-F-29

A SCOPING REVIEW OF LITERATURE ON IMAGE CLASSIFICATION OF BREAST CANCER

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Image classification is a task in computer vision which involves automated classification of images into predefined classes based on their visual content. The use of image classification techniques has found applications in domains like object recognition, medical imaging, and remote sensing. However, challenges such as data quality, computational complexity, and model interpretability persist. Classification of images is vital in reducing the morbidity and mortality rates.

This paper scopes literature in the image classification domain. We seek to analyse existing literature through identifying gaps and trends.

Computational breast cancer image classification articles published between January 2020 to 17 May 2024 regardless of breast cancer image type, gender and stage were considered. The relevance of the publications was determined by their titles, abstracts, conclusions, and full content based on the implemented inclusion and exclusion criteria. We conducted the search and screening process to determining articles with research relevant to our scoping review of image classification of breast cancer cells. Key information from extracted data was organized and visually represented in a structured way for analysis.

Preferred Reporting items for systematic Reviews and Meta-Analysis (PRISMA) guidelines were followed to ensure transparent and complete reporting.

The study discovered gaps associated with the limited availability of large and diverse publicly benchmarked datasets, insufficient implementation of deep learning models, as well as limited research on multi classification of images. Consequently, image classification models still require improvement in accuracy. Also, related research still needs to be fairly spread through all the continents and the need to create large and diverse public benchmarked datasets is apparent. Implementation of deep learning models that focus on multi classification of images is lacking. Additionally, improvement of image classification models' performance and expansion of related research efforts to non-Asian countries are key future direction of focus.

Conclusively, there is need for the creation of large and diverse public datasets, reviewing of deep learning methods in the multi classification of images, implementation of deep learning models that go beyond traditional feature extraction and binary classification, implementation of foundation models for image classification, model performance enhancement and research efforts expansion to non-Asian countries.

MSCSENG-F-30

Performance Evaluation of Pavement's Seal Course Using Nanomaterial and Sasobit REDUX

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Chip seal and Cape seal are among the various surface treatments used in South Africa and across the globe as a cost-effective pavement maintenance strategy. A chip seal is constructed by spreading an asphalt binder onto the pavement surface, which is followed by the application of aggregate, then compacted to achieve the desired embedment. Cape seals are vital surface treatments providing smooth and convenient surfaces for road users. Cape seals are constructed by filling the voids in the chip seal with slurry or microsurfacing. Extended pavement's service life and water-proof surface are key benefits of these seals. However, an unmodified binder often underperformed, particularly at cold temperatures, resulting in cracking and aggregate-binder adhesion failure in seals.

The aim of this investigation is to advance the construction and performance of chip and Cape seals in cold regions using Sasobit Redux and nano-modified bitumen emulsion (NME). Sasobit Redux is a synthetic wax, produced using the Fischer-Tropsch process, and it is widely used in warm mix asphalt. In this study, Sasobit Redux shall be used as an additive for the tack coat in the chip seal to improve aggregate binder adhesion at low cold temperatures. The Cape seal will be made with NME to resist cracking. The anticipated outcomes promise enhanced performance of seals at low temperatures and ensure hydrophobic seals, thereby contributing to sustainable solutions to prevalent challenges in the pavement sector. Additionally, the insight from this study will contribute to the best practices and methodology in chip and Cape seal construction in cold weather.

Keywords: Surface treatment, Cape seal, Sasobit Redux, hydrophobic, chip seal, cold regions nano-modified bitumen emulsion

MSCSENG-F-31

INERTIAL SELF-ADAPTIVE ALGORITHM FOR SOLVING NON-LIPSCHITZ MONOTONE VARIATIONAL INCLUSION PROBLEMS.

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In this paper, we introduce a modified Tseng extragradient for solving monotone variational inclusion problem in real Hilbert spaces. Our method does not require the associated single-valued operator to be Lipschitz continuous. Rather, it requires uniform continuity which is a weaker assumption. We prove the strong convergence of our new method under some condition on the control parameter. We carry out numerical experiment to show the computational advantage of the new method over some existing methods in the literature. Our results extends and generalizes some well-known results in literature.

The monotone variational inclusion problem (MVIP) seeks a point $x^* \in \mathcal{H}$ such that

$0 \in (\Phi + \psi)x^*$, where Φ is a single-valued operator and ψ is set-valued and maximal monotone. This framework unifies several models from optimization, mechanics, and machine learning, including convex optimization and variational inequalities.

The classical forward-backward algorithm (FBA) by Lions and Mercier [1] (1979) solves MVIPs but requires Φ to be inversely strongly monotone, which is restrictive. Tseng's forward-backward-forward (FBF) method relaxed this assumption but still required Lipschitz continuity and only guaranteed weak convergence.

Later, Zhang and Wang [2] introduced a projection and contraction algorithm that also attained weak convergence under similar assumptions. However, strong convergence is often preferable, especially in infinite-dimensional applications like image reconstruction and machine learning.

Efforts to achieve strong convergence led to various modified algorithms. Notably, Gibali and Thong [3] proposed a strong convergent variant of Tseng's method. To accelerate convergence, several like Lorenz and Pock [4] proposed inertial algorithms, but they still achieved only weak convergence. This motivates the development of strongly convergent, inertial, and self-adaptive algorithms for MVIPs involving non-Lipschitz monotone operators, which is the focus of this work.

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MSCSENG-F-32

Disrupting Bound Water in Faecal Sludge to Improve Water Removal Processes

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Faecal sludge (FS) solids are a valuable resource rich in nutrients and organics which could provide circular economic opportunities for local communities as a fertilizer or fuel. The high-water content of FS matrices (usually above 75% water by mass) remains a challenge in FS management systems. Although unbound water can be removed relatively easily, water within the sludge that is bound physically, chemically, mechanically or intracellularly to the solid phase - termed as bound water (BW), is a limiting factor in FS management systems due to the additional energy required for its release. Releasing BW influences the overall dewaterability of the sludge [1]. Transportation and treatment costs decrease significantly due to a decrease in volume of the sludge. Additionally, pathogen inactivation occurs as the water content decreases due to a decrease in water activity [2], improving the overall health and safety of all personnel in every step of the waste management process (collection, transportation, treatment and disposal). There is a need to improve BW removal processes in a sustainable, yet cost-effective, manner. During the course of this study, the key disruption mechanisms found were (EPS) degradation [3], and cell lysis [4]. Selected treatments included Microwave (MW) radiation, Lime treatment, Enzyme treatment, cyclic freeze-thawing and mechanical shearing were

benchmarked at lab-scale against key performance indicators (KPI) in dewatering, drying and rheology. The experiments at the WASH R&D Centre (University of KwaZulu-Natal) were conducted with faecal sludge collected from onsite sanitation facilities, which included Ventilated Improved Pit (VIP) latrines, Urine Diverting Dry Toilets (UDDT) and Septic Tanks (ST) located in the eThekwini Municipality (Durban, South Africa), as well as fresh faeces supplied by donors at the University of KwaZulu-Natal. The experimental results obtained were used to screen the selected treatments, optimize the design variables and compare hybridized treatments. Cellulase enzyme treatment with a dosage of 1mg enzyme/g DS of sludge was determined to be the best overall treatment method with the most significant improvements against the KPIs. A technoeconomic analysis will be conducted to determine the viability of this treatments in the context of the South African sanitation landscape.

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MSCSENG-F-33

Development of a Temperature Monitoring Subsystem for Quantifying Environmental Effects on the 21cm Power Spectrum Measured by HIRAX

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The Hydrogen Intensity and Real-time Analysis eXperiment (HIRAX) is designed to map large-scale structures in the universe by observing the redshifted 21cm emission line of neutral hydrogen. Gain stability in radio front-end electronics, especially Low Noise Amplifiers (LNAs), is strongly influenced by temperature variations, which can introduce significant systematics that compromise the measurement of Baryon Acoustic Oscillations (BAOs) and cosmological parameters. This work focuses on developing and validating a precision temperature monitoring system to quantify the impact of thermal variations on system visibilities and serves as a foundational component of a broader environmental monitoring framework.

A comprehensive evaluation of three analog temperature sensors (TMP235, TMP36, and LM35) was conducted under controlled conditions, with the TMP235 demonstrating superior thermal tracking performance with an error margin < 0.5%. A stacked PCB system was designed using a BeagleBone Black controller, I2C multiplexer (TCA9548A), and precision analog-to-digital converter boards, optimized for the constraints of the dish feed environment. The system incorporates real-time data integration through custom firmware, InfluxDB logging pipeline, and Grafana visualization dashboards, with data transmission via optical fiber for long-distance, low-latency monitoring.

This subsystem establishes the groundwork for comprehensive correlation studies linking temperature variations with LNA gain drift, visibility fluctuations, and system phase shifts, ultimately aiming to improve calibration fidelity and

visibility analysis for accurate 21cm power spectrum measurements. Future work includes ground-truth calibration with high-precision thermocouples, scaling deployment across the full HIRAX array, and integration with complementary environmental monitoring subsystems at the Klerefontein and Swartfontein observatory sites.

MSCSENG-F-35

DEVELOPMENT OF A URINE EVAPORATOR FOR INNOVATIVE NON-SEWAGE SANITATION SYSTEMS

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Urine found in domestic wastewater contributes 80% N, 56% P, and 63%K of the total N, P, and K content in wastewater. Evaporation of urine via evaporation is a vital process to remove the water content and repurpose the concentrated urine solution as a fertilizer. The evaporation process is energy intensive due to the high latent heat of water vaporization. A conventional evaporator for urine dehydration will impose high running costs, maintenance complexities, and extensive electricity/fuel consumption. Therefore, the characteristics of urine must be understood to design an efficient, renewable, and cost-effective urine evaporator. Almost no research has been conducted on the physical properties of urine, particularly the properties associated with evaporation – which influences the evaporator design.

The aim of this research is to develop a cost-effective urine evaporator for non-sewage sanitation systems. The physical properties associated with urine evaporation are measured through experiments to provide the parameters needed for evaporation calculations, aiding the urine evaporator design.

The objectives of this work are to firstly, measure the physical properties of urine during its evaporation via laboratory experiments to provide the parameters aiding the urine evaporator design, and secondly, build and test the urine evaporator design.

MSCSENG-F-36

Some ring-theoretic characterizations of *J*-spaces and the like

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This project investigates advanced structures in general topology through the framework of *J*-spaces and their connected analogues. Originally introduced by Michael [2], a *J*-space is a topological space in which every two closed cover with compact intersection guarantees that at least one of the covering sets is compact. This concept, inspired by generalizations of the Jordan Curve Theorem, allows for further exploration by substituting compactness with other topological properties. We introduce the notion of *JP*-spaces as those topological spaces where, whenever the space is covered by two closed sets and the intersection has a certain property *P*, then at least one of those two sets must also have that property. The main point is to use ideals or subrings of the ring C(X) to characterise *JP*-spaces where *P* varies through different topological properties.

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MSCSENG-F-37

Context-Aware Resource Allocation in 5G RAN Slicing using Hierarchical Multi Objective Reinforcement Learning

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5G Network Slicing enables the creation of virtual networks, known as slices, over a shared mobile infrastructure, each tailored to a specific use case or application, with distinct quality of service (QoS) requirements. However, existing slice resource allocation methods face two major challenges: They typically rely on static thresholds and predefined policies which can't adapt to dynamic traffic patterns, user mobility, and varying service demands. While they prioritize QoS assurance, they struggle to balance conflicting objectives, such as throughput and latency, especially in scenarios where enhanced mobile broadband and ultra-reliable low-latency communication services co-exist. To address these limitations, we propose a novel radio access network (RAN) slice resource scheduling and allocation model based on context-awareness and hierarchical multi-objective deep reinforcement learning. First, we formulate a slice utility multi-objective optimization problem. Due to the NP-hard nature of dynamic resource allocation, we adopt a hierarchical decomposition strategy and solve the resulting sub problems using hierarchical reinforcement learning (HRL). To manage the trade-offs between competing objectives, we design a hierarchical reward weighting (HRW) mechanism, which decomposes the global reward signal across multiple layers and enables the adaptive reward aggregation based on the learned priorities. We design a hierarchical multi-objective deep reinforcement learning (H-MODRL) architecture that dynamically adjusts the reward weights during training and execution, thereby facilitating reliable service level agreement (SLA) adherence under varying network conditions. Lastly, we propose a context-aware slice resource weighting (CSRW) scheme that leverages domain-specific contextual features such as physical resource block (PRB) utilization, user mobility, slice type and spatial user distribution, to guide slice-level prioritization and enhance responsiveness to real-time environmental changes. Extensive simulations demonstrate that our approach achieves superior trade-offs between throughput, latency, and SLA compliance, compared to both static scheduler and the flat Multi-Objective Reinforcement Learning (Flat MORL) baselines.

MSCSENG-F-38

Mitigating the effects of Intrinsic Alignment in Cosmic Shear using HI Redshifts from HIRAX

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Weak gravitational lensing, or cosmic shear, is one of the most powerful probes of the largescale structure of the Universe and the growth of cosmic density perturbations. By measuring the coherent distortions in the shapes of distant galaxies caused by gravitational light deflection, cosmic shear surveys can place stringent constraints on cosmological parameters such as the matter density (Omega_m), the amplitude of matter fluctuations (sigma_8), and the dark energy equation of state parameter (w) [1][2]. However, the statistical power of upcoming deep optical surveys, such as the Vera C. Rubin Observatory's Legacy Survey of Space and Time (LSST), is threatened by systematic errors with intrinsic alignments (IA) of galaxies being one of the most significant astrophysical contaminants.IA arises because galaxy shapes are not only sheared by gravitational lensing but also preferentially aligned with the local tidal gravitational field during formation and evolution [3]. These alignments produce correlations that can mimic or bias the shear–shear correlation signal, particularly on large scales, leading to biased cosmological parameter estimation if not adequately modeled or mitigated. The impact of IA is especially severe for Stage IV lensing surveys, where statistical errors are expected to be subdominant to systematics [4].

In this work, we develop and forecast the performance of a mitigation strategy that leverages 21 cm intensity mapping (IM) observations from the Hydrogen Intensity and Real-time Analysis eXperiment (HIRAX) to reduce IA contamination in cosmic shear analyses. HIRAX is a planned radio interferometric array located in South Africa, designed to map the large-scale distribution of neutral hydrogen (HI) via the redshifted 21 cm emission line over the range $0.8 < z < 2.5$. Unlike optical surveys, HI intensity mapping measures the collective 21 cm signal from unresolved galaxies, providing precise spectroscopic radial distance information without requiring galaxy detection. This work demonstrates that the synergy between optical weak lensing and 21 cm intensity mapping is a powerful avenue for mitigating astrophysical systematics in precision cosmology. As both LSST and HIRAX are expected to operate in overlapping redshift and sky regions, the methodology presented here is directly applicable to upcoming survey data.

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MSCSENG-F-39

Classification of equations using λ -symmetries.

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Lie symmetries are very useful because they can be used to solve differential equations. However, many equations do not admit Lie symmetries. As a result, we need to consider extensions; the one we consider here is the idea of λ-symmetries. These symmetries generalise Lie symmetries by introducing a function λ to allow reduction of equations that do not admit Lie symmetries. We will study the λ-symmetries of second-order ordinary differential equations of the form $y''=f(x, y)$ through a classification perspective. We will provide functional forms of f that will admit λ-symmetries, and we will show how these symmetries can be used to solve those equations.

MSCSENG-F-40

A LITERATURE REVIEW OF MATHEMATICAL MODELLING FOR DIABETES MELLITUS

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This study provides an overview of diabetes and the evolution of mathematical modeling in understanding and managing the disease, diabetes mellitus. It begins with foundational definitions and physiological mechanisms of diabetes, including the roles of insulin, glucose, glucose plasma concentrations, and the distinctions among major types of diabetes; Type 1, Type 2, and Gestational. Furthermore, the study focuses on the historical development of mathematical models in diabetes research, starting from the discovery of insulin to the emergence of more diverse modeling approaches such as SDEs, ANN, DDE's and IDE's. Key contributions are highlighted, particularly in relation to glucose-insulin dynamics, glucose homeostasis, and clinical versus non-clinical model classification. The research critically reviews model complexity, applications in diagnostics and therapy, and identifies gaps in data transparency and methodological reporting in past research.

MSCSENG-F-41

EVALUATION OF A SOLAR CHIMNEY-BASED NATURAL VENTILATION EVAPORATIVE COOLING SYSTEM FOR ENERGY-EFFICIENT PIG HOUSING

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This study aims to evaluate a solar chimney-based natural ventilation evaporative cooling (NVEC) system in pig housing environments as a low-cost and sustainable solar energy solution for cooling pig housing environments across growth stages. The system was tested in four different pig growth stages, including weaning, nursery, growing, and finishing. The results showed that solar energy-driven chimney ventilation can maintain a desirable thermal environment for pigs at weaning, nursery, and growing stages, but cannot for pigs at the finishing stage, as they require a much cooler environment. There is a significantly strong positive correlation ($r = 0.96$, $p < 0.05$) between solar chimney temperature and ventilation rate, highlighting the significance of solar thermal energy in the solar chimney to initiate and facilitate airflow, and passively remove heat from the pig house environment. Compared to traditional ventilation, solar chimney ventilation had 37% of energy saving efficiency, which could translate to improved economic viability for pig farmers. The solar chimney ventilation system is not only limited to pig barns but it also applies to different livestock facilities. This study not only promotes the integration of solar thermal energy into regulating thermal environment in livestock facilities, but also promotes efficient energy use, environmentally friendly initiatives and sustainability in livestock farming.

MSCSENG-F-43

LEVERAGING DEEP LEARNING FOR HUMAN ACTIVITY RECOGNITION

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Video surveillance has become a norm in both public and private spaces, while closed-circuit television (CCTV) plays a pivotal role in deterring crime and providing evidence [1], the manual monitoring of video feeds is often inefficient, error-prone, and mentally taxing—especially when tracking multiple screens or extended footage [2]. These limitations have driven the development of Human Activity Recognition (HAR), a field within computer vision that focuses on the automatic detection and classification of human actions from video data. Although HAR has evolved significantly, current systems still struggle to perform reliably in complex, real-world environments. Key challenges include accurately modeling long-term temporal dependencies, managing subtle variations in similar actions (e.g., walking vs. running), and mitigating the effects of video noise caused by occlusions, lighting variations, and background clutter [3]. Many state-of-the-art models also require large datasets and significant computational resources, making real-time deployment difficult.

This research proposes a novel, integrated HAR system designed to address these persistent issues. The approach combines advanced video preprocessing techniques with a deep learning architecture to improve the accuracy of activity recognition even in the presence of video imperfections. The system is expected to achieve highly competitive results on benchmark datasets such as UCF-101, especially for action classes with subtle motions or challenging environmental factors. The significance of this work lies in its potential to bridge the gap between research and practical application. By tackling multiple longstanding limitations within a single, modular system, this research contributes to the development of HAR models that are not only accurate and robust but also computationally efficient and scalable. Real-world applications span from intelligent surveillance systems for public safety to automated patient monitoring in healthcare settings, where real-time, reliable activity recognition can have life-saving implications. Ultimately, the proposed framework aims to set a new benchmark in video-based HAR and offer a solid foundation for future advancements in the field.

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FLASH ABSTRACTS

SCHOOL OF LIFE SCIENCES

LS-F-1

INHIBITION WITHOUT KILLING: EVALUATING THE ANTI-VIRULENCE POTENTIAL OF ENDOPHYTIC *Bacillus* SPECIES FROM *Kigelia africana*

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The escalating threat of antibiotic resistance, projected to cause 10 million deaths annually by 2050, demands alternative therapeutic strategies. Unlike bactericidal agents that promote resistance through selective pressure, targeting non-lethal bacterial processes such as quorum sensing (QS) and biofilm formation offers a promising approach. *Bacillus* species are known producers of diverse bioactive compounds with therapeutic potential (antimicrobial, antifungal, antiviral, immunosuppressive, and antitumor). This study, therefore, investigated the QS and anti-biofilm activities of secondary metabolites from endophytic *Bacillus* species isolated from *Kigelia africana* leaves. Six endophytic *Bacillus* species isolates were cultured in medium mannitol using submerged fermentation for 7 d, followed by extraction using ethyl acetate. Extracts (100-1600 µg/ml) were assessed for QS inhibition using *Chromobacterium* species as biosensors to evaluate their potential to inhibit Gram-negative acyl homoserine lactone signalling. Methicillin-resistant *Staphylococcus aureus* ATCC 43300 (MRSA), *S. aureus* ATCC 6358, *Pseudomonas aeruginosa* ATCC 27853 and *Acinetobacter baumannii* ATCC 19606 were used to determine the extracts' ability to inhibit initial adhesion and disrupt mature biofilm. Extracts were subjected to gas chromatography-mass spectrometry (GC-MS) and Fourier Transform Infrared (FTIR) spectroscopy to determine metabolite profiles. Extracts did not exhibit antibacterial activity at the concentrations tested. While none of the extracts significantly inhibited QS, several demonstrated promising anti-biofilm effects. Against MRSA, 50% (3/6) of extracts inhibited initial adhesion and 33.3% (2/6) disrupted mature biofilm. For *A. baumannii*, only 16.7% (1/6) inhibited initial adhesion, while 33.3% (2/6) disrupted mature biofilm. The *Bacillus subtilis* KA-M14 extract inhibited the initial adhesion of three strains tested and disrupted the mature biofilm of two strains tested. GC-MS analysis revealed bioactive compounds including benzeneacetic acid, diisooctyl phthalate, eicosane, malic acid and trans-cinnamic acid, which have been associated with anti-biofilm activity. FTIR analysis reveal the presence of carboxyl, ester, alkane, alkene and hydroxyl functional groups in the extracts. Given the role of biofilms in high-level antibiotic tolerance, these findings highlight the potential of *Bacillus*-derived metabolites from *K. africana* as promising leads for anti-biofilm agents in pharmaceutical development.

Keywords: *Bacillus*, endophytes, biofilm disruption, quorum sensing inhibition, antibiotic resistance.

LS-F-2

ENVIRONMENTAL RANGES OF SELECTED ESTUARINE INVERTEBRATES IN SOUTH AFRICA

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The biodiversity, productivity, and provision of numerous ecosystem services highlight the importance of estuarine environments which face increasing anthropogenic stressors globally. Climate change effects such as global warming, ocean acidification, increasing flood and drought occurrence, along with persistent pollution resulting in water quality degradation, causes the environmental parameters in estuaries to vary beyond the natural range. This results in anthropogenically induced increased variability of environmental conditions which estuarine and estuarine associated species may not be able to cope with. To investigate the environmental ranges that estuarine species occur in and the relationship between environmental parameters and species abundances, we analysed the habitat association of selected estuarine mesozooplankton and macrobenthos species. Species abundances and environmental data was extracted from numerous literature sources and scientific reports conducted on 15 South African subtropical estuaries ranging from 1984 until 2020. Little to no relationships between individual species abundances and individual environmental variables were apparent. A few exceptions were the correlations between abundances of Tarebia granifera and salinity (r= -0.69), Diaphonosoma excisum and salinity (r=-0.69) and of Mesocyclops spp. and salinity (r= 0.65). One-way ANOVA analyses showed that Dendronereis arborifera prefer normoxic and hyperoxic conditions between 4 and 10 mg/L, Desdemona ornata abundance was highest at dissolved inorganic nitrate values below 1 µmols, and Pseudodiaptomus hessei was most abundant in environments with particulate organic matter readings below 12 mg/L. Due to weak correlations and few species showing clear preferences for specific environmental conditions, many of the species may be adaptable to the changing environmental conditions, within the ranges investigated. However, with future estuarine conditions predicted to change further due to anthropogenic effects, further investigation and experimental studies are advised for currently robust species.

LS-F-3

A comparative study of the morphology, phytochemistry, and biological activity of *Ocimum americanum* (l.) and *Ocimum tenuiflorum* (l.)

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In this research, leaf morphology, phytochemical constituent and biological activities of OA and OT were examined and contrasted. The *Ocimum* species, which are part of the Lamiaceae family, serve as valuable spices in culinary uses, fragrances in cosmetics and have applications in treating various bacterial infections. The stereomicroscope, scanning electron and transmission electron microscope were used to identify the trichomes found in the leaves of *Ocimum americanum* and *Ocimum tenuiflorum*. Phytochemicals were extracted using three solvents (hexane, chloroform, and methanol) and tested using various reagents to identify their phytochemical components. Thin layer chromatography, UV-visible spectroscopy, and gas

chromatography-mass spectrometry were utilized to analyze the phytochemical constituents. The antibacterial properties of the extracts were tested against four bacteria strains (*Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus, Methicillin Resistant Staphylococcus aureus*) using agar well diffusion method. Non-glandular trichomes were distinctly visible on the adaxial and abaxial surfaces of *Ocimum tenuiflorum* in comparison to *Ocimum americanum*. Glandular trichomes, peltate and capitate were found on both species. The phytochemicals present in both species include flavonoids, phenolic compounds, saponin, and fixed oil, although with differing intensity. None of the extracts from *Ocimum tenuiflorum* exhibit antibacterial effects, while the chloroform and methanol extracts from *Ocimum americanum* exhibited antibacterial activity. However, *Pseudomonas aeruginosa* was resistant to all the extracts from both *Ocimum* species. The glandular trichomes of *Ocimum americanum* produce phytochemicals that exhibit antibacterial properties. Since these species were collected form Reservoir Hill, Kwazulu-Natal, South Africa, it is recommended that *Ocimum americanum* be cultivated, and its leaves used for the treatment of bacterial infections in addition to the other benefits derived from the plants.

LS-F-4

Gut Microbiome of *Eldana saccharina*: Unlocking Microbial Interactions for Improved Pest Management Strategies in Sugarcane

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Understanding the gut microbiome of agricultural pests offers promising avenues for innovative and sustainable pest control strategies. This study examines the gut microbial communities of *Eldana saccharina*, a major lepidopteran pest in southern African sugarcane systems, and their potential application in improving pest control practices and reducing reliance on chemical insecticides. Field-collected sugarcane stalks with visible *E. saccharina* damage were decontaminated for microbial isolation. *Eldana saccharina* larvae found in stalks were also decontaminated and dissected for microbial isolation from the gut. Fungi and bacteria were extracted from larval guts and surrounding plant tissue and identified using DNA sequence analysis of the Internal Transcribed Spacer region (ITS) and the Fast MicroSeq® 500 16S rDNA sequencing kit, respectively. In total, 55 fungal and 50 bacterial morphospecies were recovered. Fungal isolates were dominated by *Fusarium* spp., while bacterial isolates belonging to the genus *Enterococcus* spp. were present. Olfactory choice bioassays revealed that several microbial isolates significantly attracted neonate larvae. Notably, *Enterococcus gallinarum*, *Enterococcus casseliflavus* and *Gordonia sp.*, among bacteria, and *Fusarium sacchari* and *Fusarium verticillioides* among fungi, were attractive. These isolates were further evaluated via dietary inclusion assays, which showed enhanced larval growth and development compared to controls. This research highlights the ecological importance of the gut microbiome in pest physiology and behaviour. The results support the potential use of selected microbial strains to improve the efficiency of mass-rearing protocols in sterile insect technique programmes and other biologically based pest management strategies. By aligning with global change priorities and sustainability goals, it supports the transition toward low-impact, high-efficacy pest control in the face of mounting environmental and climate challenges.

Keywords: *Eldana saccharina*, sugarcane, *Fusarium*, microbiota

LS-F-5

People's perceptions and attitudes towards owls in urban-rural mosaic landscapes of KwaZulu-Natal, South Africa

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In a changing world, effective wildlife conservation requires translating ecology into management. This emphasises the need to understand the relationships between humans and wildlife, as the survival of ill-perceived species such as bats, reptiles, and owls is influenced by environmental factors and cultural and social values associated with them. Ethno-scientific approaches, such as structured questionnaires, have proven invaluable in bridging this gap. This study used a mixed methods approach (face-to-face interviews and online questionnaires) to investigate people's perceptions, attitudes, and emotions towards owls in KwaZulu-Natal, South Africa. A total of 904 questionnaires were conducted via face-to-face interviews (simple random sampling, n = 802) and online interviews (stratified random sampling, n = 102); only 681 responses from the participants met the inclusion criteria. We analysed our data using Cumulative Link Mixed Models (CLMMs). We found that in KwaZulu-Natal, most perceptions were negative and primarily associated with witchcraft, bad omen, death, and sickness. Positive perceptions of owl species were influenced by an interplay of multifaceted factors, such as having a higher tolerance for owl species, a general understanding of the ecological importance of owl species to agriculture and the environment, and positive feelings. We also found that socio-demographic variables alone were not significant predictors of people's perceptions of owl species. Therefore, future conservation initiatives should be more directed at educating people about the ecological importance of owl species, addressing cultural myths, thus increasing tolerance, and changing people's perceptions of owl species.

LS-F-6

Exploring *Dichotomaria diesingiana*'s Protective Effects towards Oxidative Stress and Enzyme Regulation in Pancreatic Dysfunction

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Obesity is associated with excessive amount of body fat, which is one of the major causes for the development of type 2 diabetes (T2D). T2D is the most prevalent form of diabetes, and it not only alters the metabolism of carbohydrates but also proteins and lipids. Obesity and T2D exacerbate each other through a vicious cycle of oxidative stress, inflammation, and insulin resistance. There are a number of FDA approved drugs for both diseases that need to be used in conjunction with a healthy diet as well as physical activity. None of these pharmacological therapies are without side effects. Additionally, these medicines are not affordable for people in developing countries. Hence, there has been a growing interest in the development of alternative medicines from natural sources for the treatment of obesity and T2D. It has been suggested that seaweeds contain bioactive compounds with positive health benefits. Hence, this study aimed to investigate the potentials of *Dichotomaria diesingiana* extracts (hot, cold, and ethanol) to attenuate oxidative stress and inflammation as

well as ameliorating insulin resistance as a possible therapeutic agent towards treating obesity and T2D, by using *in vitro* and *ex vivo* experimental models. The seaweed extracts were screened for *in vitro* antioxidant activity using Nitric oxide (NO), and non-site-specific hydroxyl radical (HO•) scavenging activity. The extracts were also evaluated for α-glucosidase and pancreatic lipase inhibitory activities, as well as on glucose uptake using yeast cells. The study also assessed the i*n vitro* anti-inflammatory activity using Bovine Serum Albumin Protein Denaturation Assay (BSA), Proteinase Inhibitory Activity, and Lipoxygenase (LOX) inhibition. The extracts were further assessed for antioxidant potentials through the investigation of oxidative stress biomarkers *ex vivo* including, lipid peroxidation (MDA) levels, nitric oxide (NO) levels, reduced glutathione **(**GSH) levels, catalase (CAT) and superoxide dismutase (SOD) enzymatic activities on pancreatic tissue after inducing oxidative stress. The ethanol extract and the cold-water extracts exhibited the best *in vitro* antioxidant activity through OH• and NO scavenging ability. The hot-water and ethanolic extracts exhibited the best anti-hyperglycaemic activity through, α-glucosidase and lipase inhibition, and glucose uptake by yeast cells. They also showed anti-inflammatory activities though *in vitro* inhibition of BSA denaturation and proteinase inhibitory activity. Following the induction of oxidative stress in the pancreas, the hot-water extract showed the best ability to improve CAT enzyme activity and increase GSH levels. The ethanol extract exhibited the best ability to improve SOD enzymatic activity as well as decrease MDA and NO levels. Furthermore, the ethanol extract showed the best ability to regulate purinergic enzymes activity via improving ATPase and ENTPDase activity. The hot water exhibited better abilities to regulate gluconeogenic enzyme activity through reducing glucose-6-phosphatase and fructose-1,6-Bisphosphatase activity and glycolytic enzyme activity via reducing the activity of glycogen phosphorylase. The results of this study suggest that *Dichotomaria diesingiana* has potentials for the management of diabetes and obesity. However, further studies on animal model and human subjects are needed to ascertain the results of this study.

LS-F-7

A COMPARATIVE ASSESSMENT OF BIOSYNTHESIZED METALLIC NANOPARTICLES FOR THERAPEUTIC APPLICATIONS

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As an emerging field, nanotechnology has gained global interest due to its various applications such as in combating antimicrobial resistance and water treatment etc. Nanoparticles (NPs) have unique optical, physical and chemical properties due to their size and potential to be functionalized hence making them innovative therapeutic agents [1]. When NPs are small enough, these properties can be owed to quantum confinement, reinforcing the strong link between nanoparticles and quantum dots [2]. Biological NP synthesis (a type of bottom-up synthesis) accounts for a more environmentally friendly strategy in comparison to other approaches involving high energy consumption and the use of toxic chemicals for physical and chemical synthesis respectively [3]. In this study, silver (Ag) and gold (Au) NPs were synthesized from plant extract. African Wild Ginger, *Siphonochilus aethiopicus*, is a traditional medicinal plant that exhibits antimicrobial and antioxidant activities [4]. The tuberous root extract of ginger was used to reduce metallic salts and to produce Ag and Au NPs with a mean size of 12 nm and 9 nm respectively. Additionally, all NPs synthesized displayed mainly spherical shapes with some triangular, hexagonal and rod shapes also observed. DPPH scavenging assay and well diffusion assay were used to determine the antioxidant and antimicrobial activity of the NPs respectively. Preliminary results suggest that AgNPs from ginger portray higher DPPH scavenging and antibacterial activity compared to AuNPs from ginger. GC-MS analysis confirms that the phytochemicals present in ginger extract are present in the NP samples, suggesting the phytochemicals act as capping agents on the metallic NPs, aiding in the biological activity. Therefore, in the age of antibiotic resistance and complications in wound healing, it is crucial that alternative antimicrobials are explored for potential activity.

The development and testing of biosynthesized NPs can prove to be a suitable option to aid in lifting the burden placed upon the healthcare system by multidrug-resistant microbes [5].

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LS-F-8

Comparison study of the genetic diversity of an invasive crustacean, *Megabalanus* sp. using 16s markers.

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Marine invertebrates offer valuable models for gaining a deeper understanding of the genetic aspects of invasive species and their rapid propagation. Of all marine invertebrates, barnacles have demonstrated the highest level of invasive success, primarily due to their capacity to be carried through both hull fouling and ballast water mechanisms.

The initial objective of the research was to ascertain whether the *Megabalanus* species identified from COI alignments correspond to the same species when employing 16s primers (16SAR and 16SBR). The subsequent goal of the study was to determine if these identified *Megabalanus* species exhibit invasiveness and dissemination due to human-induced activities or climate change, as well as to examine the presence of any pseudogenes within the sampled populations.

Sequences were analysed for genetic variation in DNAsp and MEGA by constructing a Maximum Likelihood and Neighbour Joining tree. Findings of the study demonstrated that the populations expanded in a fashion characteristic of invasive species. There was variation within the identified species when the 16s rRNA marker was used compared to the COI gene marker previously used. The expansion patterns these species displayed suggest that they have spread via anthropogenic means.

Future research should determine whether the morphological characteristics of these species result in their misidentification.

LS-F-9

Delivery of pCMV-*Luc* DNA to cancer cells *in vitro* using polyethyleneimine functionalized gold nanospheres (AuNS).

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Cancer is a significant public health challenge worldwide, with a high annual fatality rate. Non-viral delivery methods have been extensively studied for gene therapy. Gold nanospheres (AuNS) have gained momentum since they show low toxicity, better stability, faster cellular uptake and internalization rates than the other shapes, thus making them suitable vectors for gene therapy. In this study, AuNS were synthesized using a green synthesis method that utilizes sodium alginate as a reducing agent. The AuNS were functionalized and stabilized using polyethyleneimine (PEI), and the targeting moiety, Lactobionic acids, was added for hepatocyte-specific delivery.

The physicochemical characteristics of AuNPs were evaluated using UV spectroscopy, Fourier-transform infrared spectroscopy (FTIR), transmission electron microscopy (TEM) and nanoparticle tracking analysis (NTA). TEM revealed AuNS to be spherical and relatively monodisperse. Binding studies, viz. band shift and ethidium bromide intercalation assays, showed that all AuNPs were able to fully complex and efficiently condense pCMV-*luc* plasmid DNA, with PEI and targeted AuNPs being capable of protecting DNA from nuclease degradation, as determined in nuclease protection assays. In vitro studies were conducted in the human embryonic kidney (HEK293), lung adenocarcinoma (A459), and the Asialoglycoprotein receptor-positive hepatocellular carcinoma (HepG2) cell lines. MTT assay was used to assess the cytotoxicity, which revealed AuNS to be relatively nontoxic to all the cell lines mentioned above. The luciferase gene reporter assay was conducted to assay the transfection efficiency of AuNS. The increase in luciferase gene expression was evident for LA-targeted AuNS compared to non-targeted AuNP. The AuNS shows the potential to be safe and suitable to be utilized as targeted delivery vehicles for liver-targeted gene delivery.

LS-F-10

Integrative Genomic, Transcriptomic, and Molecular Docking Analysis of Bedaquiline Resistance Mechanisms in *Mycobacterium tuberculosis*

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Tuberculosis (TB) is still one of the world's leading infectious disease-related causes of illness and death. In 2022, TB accounted for nearly twice as many fatalities globally as HIV/AIDS and was the second most common infectious agent-related cause of death worldwide, after coronavirus disease. Treatment success rates for tuberculosis are reported to be 85%; however, this figure falls to 57% when the patient has multidrug-resistant *Mycobacterium tuberculosis* (Mtb), for which there are fewer treatment alternatives. Effective treatment of multidrug-resistant TB is seriously threatened by the global increase in bedaquiline resistance in Mtb.

This study combines genome-wide association studies (GWAS), RNA sequencing, and molecular docking to elucidate established and novel resistance factors. From 1,000 high-quality whole-genome sequences, SNPs and InDels were identified and filtered (Phred ≥100, depth ≥10). The GWAS, employing phylogenetically informed models (PhyC via Hogwash), could not advance in the preliminary stage due to the lack of susceptible isolates following quality screening. Phylogenetic analysis, however, uncovered unique clonal clusters among resistant strains. Notably, significant genes connected to critical metabolic and stress response pathways, such as ***prpC*** (Rv1131), ***rmlD*** (Rv3266c), ***ideR*** (Rv0338c), and ***groEL2*** (Rv0440), were found to have high-impact alterations. The frequency of mutations in protein-coding areas was verified by SNP heatmaps, indicating shared resistance mechanisms.

The following stage will identify differentially expressed genes by analyzing RNA-Seq from 20 BDQ-resistant and susceptible isolates using HISAT2, featureCounts, and DESeq2. Fisher's exact test will determine whether overlapping DEGs with GWAS loci are enriched. Using AutoDock Vina, prioritized targets will be molecularly docked with BDQ; this will be confirmed by redocking known ATP synthase inhibitors (RMSD < 2 Å). This integrative paradigm will inform future diagnostics and treatment targeting of BDQ resistance in Mtb, increasing confidence in novel resistance loci.

References

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LS-F-11

Spatio-temporal dynamics of sessile reef biodiversity on Aliwal Shoal, KwaZulu-Natal

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Aliwal Shoal is a subtidal, subtropical rocky reef that is located approximately 5km off the coast of Umkomaas on the KwaZulu-Natal south coast. Aliwal Shoal is characterized by a rich diversity of marine organisms and is formally protected within the Aliwal Shoal Marine Protected Area (MPA). It is an extremely popular recreational diving destination and indirectly supports local fisheries. Aliwal Shoal has been the topic of relatively little research and there remains a lack of comprehensive, long-term data on the benthic community dynamics. Understanding the changes occurring in the sessile benthic community over time is important for management and assessing potential climate change impacts. The study investigates the spatial and temporal variations in the benthic sessile community on Aliwal Shoal by comparing it to historical data. Contemporary data were collected on SCUBA using photo-quadrats along predetermined transects originally surveyed 20 years ago.

The project is the first temporal comparison of the benthic biodiversity on Aliwal Shoal. It will help to identify areas and threats that require conservation intervention and provide insight into the effectiveness of conservation measures that have been implemented since the expansion and rezoning of the MPA. The findings will contribute to a broader understanding of the ecological processes influencing the biodiversity on Aliwal Shoal and similar shallow reefs within the Natal Ecoregion.

Preliminary data will be included in time for the symposium.

Keywords: benthic monitoring, conservation, MPA management, shallow subtidal reef, spatial ecology, temporal trends

LS-F-12

Integrated *In Silico* and *In Vitro* Evaluation of Isoleucine, Lysine and Serine: Targeting Digestive Enzymes and Antioxidant Pathways

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Diabetes mellitus is currently ranked as the eighth leading cause of death globally, and its effective management remains a significant global health challenge. In response to this growing burden, research efforts are increasingly focused on identifying potential inhibitors that target key carbohydrate and lipid metabolising enzymes. These enzymes represent critical biochemical switches involved in the regulation of glucose and lipid homeostasis, making them strategic targets for the management of type II diabetes. The present study synergistically used both *in silico* and *in vitro* approaches to elucidate the inhibitory capacity of isoleucine, lysine and serine on specific metabolising enzymes such as α-amylase and α-glucosidase. Their antioxidative ability was also evaluated using the DPPH radical scavenging assay and ferric reducing power (FRAP). Molecular docking simulations were further conducted to examine the mode of enzyme inhibitory activity of the amino acids.

Docking analysis revealed that acarbose exhibited the highest binding affinity toward α-amylase (–7.2 kcal/mol) and α-glucosidase (–7.6 kcal/mol), with highly stable binding poses (RMSD = 0.0 Å). Among the test compounds docked with α-amylase, isoleucine showed the strongest interaction (–4.8 kcal/mol), followed closely by lysine and serine (–4.6 kcal/mol and -4.0 kcal/mol, respectively) while with α-glucosidase, isoleucine and lysine showed the strongest interaction (–5.2 kcal/mol), while serine (–4.3 kcal/mol). The three amino acids demonstrated structurally consistent docking poses, with several conformations exhibiting RMSD values below 3 Å, which implies a considerable affinity in the enzyme's binding pocket.

In vitro, assays substantiated the computational predictions, with the amino acids showing considerable inhibitory ability in α-amylase and α-glucosidase. Inhibition percentages ranged between 35% and 60% for α-amylase and α-glucosidase, while DPPH radical scavenging activities and FRAP also reflected moderate bioactivity. These multi-target profiles indicate a therapeutic potential of the selected amino acids in diabetes management. Therefore, the study identified isoleucine, lysine and serine as potential compounds that are worth further validation through pharmacokinetic and *in vivo* studies.

LS-F-13

Urban persistence and species interactions: diverging trends in the abundance of Peregrine Falcons *Falco peregrinus* and Lanner Falcons *F. biarmicus* across southern Africa using the Southern African Bird Atlas Project

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Citizen science has emerged as a powerful tool for engaging the public in ecological data collection, crucial for monitoring species' distributions and abundance over large geographic scales and extended time periods. This study used data from the Southern African Bird Atlas Project (SABAP) to investigate the distribution and relative abundance of the Peregrine Falcon *Falco peregrinus* and Lanner Falcon *F. biarmicus* (family *Falconidae*) across South Africa, Lesotho and Eswatini. These species are known for their adaptability to diverse environments, share similar habitat preferences and prey species, and often coexist across sub-Saharan Africa. We analysed data from SABAP1 (1987–1992) and the ongoing SABAP2 (2007–2024) to detect changes in distribution patterns and abundance over time. Reporting rates indicate a notable increase in the Peregrine Falcon population, particularly in urban areas, suggesting successful adaptation to anthropogenic landscapes where tall buildings provide suitable nesting sites. In contrast, the Lanner Falcon displayed a more varied pattern, with declines in some regions, especially where Peregrine Falcons were more prevalent during SABAP2, potentially indicating competitive displacement mediated by urbanisation. The findings underscore the complex interplay between urbanisation, species competition and habitat preferences in shaping these raptors' distributions and population trends. While the behavioural plasticity of the Peregrine Falcon to urban environments highlights the species' resilience, the mixed responses of the Lanner Falcon suggest a need for targeted conservation strategies to mitigate the impacts of habitat fragmentation and urban encroachment. Our use of the SABAP data illustrates its value in long-term ecological monitoring and its potential for informing conservation efforts.

Keywords: citizen science, competitive displacement, conservation, distribution mapping, nest site selection, raptors, reporting rate, urban ecology

LS-F-14

Evaluating fish biodiversity in estuaries in eThekwini Municipality, KwaZulu-Natal, a snapshot using environmental DNA metabarcoding

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Estuaries function as transitional zones between freshwater and marine environments, where habitat productivity facilitates various ecosystem services with high ecological and economic value. The increasing threat to natural systems globally leaves these habitats and the associated biodiversity vulnerable. Biomonitoring programmes are essential to detect, analyse, and track changes in community composition and structure. In this study, environmental DNA (eDNA) metabarcoding was employed, targeting the mitochondrial cytochrome c oxidase subunit I (COI) gene to investigate fish biodiversity across five estuaries in eThekwini Municipality. Water samples were collected from five estuaries, vacuum filtered and stored until extraction. A two-step PCR assay was conducted to amplify the target gene followed by Next Generation sequencing. The DADA2 pipeline was adopted for bioinformatics and observed ASV-level data was used to calculate alpha and beta diversity metrics, allowing for the comparison of biodiversity among the estuaries. The study yielded 2 130 771 raw reads resulting in 257 unique ASVs and 93.39% met the identification criteria, the remaining 6.61% did not meet the criteria and were unidentified. Fish made up approximately 88.92% of the identified ASVs and the remaining 4.47% were insects. Among the fish ASVs, taxonomic assignment resulted in 57 families, 84 genera, and 87 species, 30 and 14 ASVs were identified to genera and family level, respectively. iSiphingo estuary had the highest species identification with 82 unique taxa whereas aManzimtoti estuary had the lowest (26 unique taxa). Species diversity across estuaries was generally high, with Shannon's index ranging from 3.10 – 4.42 and Simpson's index ranging from 0.884 – 0.986, indicating relatively even and species rich communities. While this study only displays a single temporal snapshot, it

forms the premise of urban estuarine biodiversity data and demonstrates the potential of eDNA as a suitable monitoring tool in conservation management strategies.

Keywords: eDNA, estuary, biomonitoring, COI, bioinformatics, DADA2

LS-F-15

EFFECT OF FERMENTED WHITE CORN STARCH ON THE IN VITRO FERMENTATION OF FECAL MICROBIOTA FROM TYPE 2 DIABETIC RATS

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The present study elucidates the modulatory potential of fermented white corn starch (FWCS) on the *in vitro* fermentation dynamics of fecal microbiota derived from type 2 diabetic (T2D) rats. Biochemical analyses revealed that FWCS elicited a significant attenuation of key carbohydrase activities—α-glucosidase and α-amylase—as well as pancreatic lipase, relative to both the normal control (NC) and diabetic control (DBC) groups ($p < 0.05$). These enzymatic modulations suggest a potential to mitigate excessive carbohydrate and lipid hydrolysis, thereby influencing postprandial metabolic responses and increasing the production of short chain fatty acids. FWCS supplementation further induced a pronounced elevation in microbial ATP levels concomitant with a suppression of ATPase activity, indicative of enhanced microbial energy conservation and metabolic efficiency. Lipidomic profiling uncovered substantive reconfiguration of fecal lipid constituents, with partial least squares (PLS) score plots, hierarchical clustering heatmaps, and biplots demonstrating clear discrimination between FWCS-treated and control cohorts. Parallel metallomic assessments revealed marked shifts in fecal metal ion composition, underscoring FWCS-mediated alterations in mineral–microbiota interactions and associated metabolic pathways. Collectively, these findings provide compelling evidence that FWCS can beneficially remodel the enzymatic, metabolic, and compositional landscape of the T2D gut microbiota, thereby offering a promising functional dietary strategy for the amelioration of metabolic derangements inherent to type 2 diabetes.

LS-F-16

PHYTOCHEMICAL CHARACTERIZATION AND BIOACTIVITY ASSESSMENT OF LEAF AND STEM EXTRACTS OF *Tecomaria capensis* (Thunb.) Spach

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Tecomaria capensis, a flowering plant native to South Africa and a member of the Bignoniaceae family, has been traditionally used in medicine for various therapeutic purposes. This study aimed to investigate the phytochemical composition and biological activities of leaf and stem extracts of the plant. Preliminary phytochemical screening confirmed the presence of several bioactive compounds in both plant parts. Gas Chromatography–Mass Spectrometry (GC-MS) analysis identified 49 distinct compounds, while Fourier Transform Infrared (FTIR) spectroscopy revealed a diverse range of functional groups—including alcohols,

carboxylic acids, phenols, amides, and alkyl halides—based on characteristic peak values in the powdered samples.

Elemental analysis using EDX indicated a high carbon content (63.02%) along with elements such as oxygen, chlorine, sodium, calcium, potassium, magnesium, and copper. Antioxidant activity was notably strong in methanolic stem extracts, with low IC_{50} values in both DPPH and FRAP assays. In contrast, leaf extracts exhibited weaker antioxidant activity (IC_{50} > 1000 µg/mL). Stem extracts showed potent antioxidant potential, with IC_{50} values of 2.61 µg/mL (methanol), 3.41 µg/mL (chloroform), and 4.00 µg/mL (hexane). Cytotoxicity testing on HEK293 cells showed moderate IC_{50} values: 42.61 ± 0.08 µg/mL (leaf) and 46.37 ± 0.08 µg/mL (stem) for hexane extracts.

Additionally, methanolic extracts demonstrated significant antibacterial activity against *E. coli*, *S. aureus*, and *P. aeruginosa*. These findings position *T. capensis* as a promising source of natural antioxidant, antibacterial, and anticancer agents, warranting further pharmacological exploration.

Keywords: Phytochemical, antioxidants, cytotoxicity, antibacterial

LS-F-17

Mini-barcodes improve species detection rates in DNA metabarcoding of marine zooplankton

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DNA metabarcoding allows for the simultaneous identification of multiple zooplankton species in mixed samples, making it well-suited for biodiversity surveys of marine pelagic ecosystems. However, the presence of some zooplankton groups in samples may be underestimated because of primer bias or incomplete barcode reference libraries. To increase the detection rates of copepods, euphausiids, chaetognaths and hydrozoans in metabarcoding outputs, novel taxon-specific mini-barcode primers were designed for the cytochrome c oxidase subunit I (COI) gene region. Mini-barcodes increase the likelihood of species detection when DNA obtained from environmental samples, such as from plankton net tows, are degraded. To identify the most variable and taxonomically informative regions for each target group, publicly available COI sequences downloaded from BOLD and GenBank were analysed. Selected gene regions (250-350 base pairs) were then validated for species-level resolution using a DNA barcode gap analysis. The designed mini-barcode primers consistently outperformed both standard COI and universal miniCOI primers, generating higher-quality sequences across all target groups. Metabarcoding of four bulk zooplankton samples collected with plankton nets towed by the RV Agulhas II on the Agulhas Bank in 2022 and processed with a combination of designed taxon-specific and pre-existing universal primers identified 220 species. The proportionate representation of the target taxa was increased by three- to fivefold, compared to a previous study that relied on universal primers alone. Read counts were dominated by copepods and euphausiids, suggesting that they had the highest relative biomass in samples. Overall, we demonstrate that combining universal and taxon-specific primers in metabarcoding workflows achieves a more comprehensive assessment of marine pelagic biodiversity, by enhancing species richness estimates across different groups.

Keywords: Metabarcoding, mini-barcode, species level, taxon-specific, marine zooplankton

LS-F-18

A systematic review on the importance of insect pollinators for avocado (Persea americana) productivity in Africa

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Pollination is a vital ecosystem service that supports, among other crops, the production of avocado (*Persea americana*). Avocado is a developing high-value crop in Africa, considerably contributing to income generation and rural livelihoods. Its productivity is, however, highly dependent on efficient insect pollination, a service continuously at risk under the global environmental change. This systematic review synthesises 15 peer-reviewed studies on the role of insect pollinators in avocado production in Africa. In particular, we aim to (i) determine the contribution of insect pollinators to avocado pollination and production; (ii) determine the most frequent (diverse and abundant) and efficient avocado insect pollinator groups and how they differ throughout Africa; and (iii) assess how insect pollination may be enhanced for higher yields. Results show that even though insect pollination improves fruit set and quality, limited local data remains, and there is a prominent knowledge gap on the ecology, diversity, abundance, and effectiveness of insect pollinators within African avocado orchards. Climate extremes, pesticide misuse, and land-use change compound risks to pollinating insect populations, jeopardising food security and economic avenues, underscoring the need for adaptive management strategies. Sustainable agricultural practices, such as habitat conservation and reduced pesticide use, are recommended to improve pollinating insects' resilience, diversity and abundance. This review stresses the pressing need for consolidative pollinator-friendly agricultural approaches and climate-resilient agroecosystem preparation. It also highlights the potential of balanced pollination services to force transformative socio-economic empowerment, especially for agro-entrepreneurs and smallholder farmers.

LS-F-19

Cytotoxicity and Cellular uptake of Co-polymer-Functionalized Gold Nanoparticle: siRNA nanocomplexes in Breast Cancer Cell models

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RNA interference (RNAi), mediated by synthetic small interfering RNA (siRNA), is a powerful molecular tool with significant potential for the treatment of genetic diseases. However, its clinical application is limited by poor cellular uptake, instability, and rapid degradation, necessitating the development of efficient, stable, and non-toxic delivery systems. Recent advances in nanotechnology have highlighted dendrimers and metal nanoparticles as promising carriers for siRNA delivery.

In this study, four nanoparticle formulations were developed using poly(amidoamine) (PAMAM) dendrimers, gold nanoparticles (AuNPs) synthesized via the Turkevich method, and the targeting ligand folate. These were evaluated for their ability to deliver siRNA targeting the c-MYC oncogene in two breast cancer cell lines (MCF-7 and MDA-MB231) and a non-cancer cell line (HEK293). PAMAM was included to enable efficient

siRNA binding, while folate was incorporated to exploit its high affinity for folate receptors, which are overexpressed in certain breast cancer cells.

Nanoparticle and nanocomplex characterization were performed using transmission electron microscopy (TEM), nanoparticle tracking analysis (NTA), and Fourier-transform infrared (FTIR) spectroscopy. siRNA binding, compaction and protection were assessed using band shift, ethidium bromide intercalation, and RNaseA protection assays, respectively. Cytotoxicity was evaluated using the MTT assays and acridine orange/ethidium bromide staining. Cellular uptake was quantified via FITC-labelled siRNA in all cell lines.

The nanoparticle formulations efficiently bound, condensed, and protected siRNA from degradation, while exhibiting low cytotoxicity and inducing a degree of apoptosis in treated cancer cells. Nanoparticle-mediated delivery achieved efficient intracellular siRNA uptake. These findings indicate that PAMAM–gold nanocomplexes, particularly when functionalized with folate, are promising candidates for targeted siRNA delivery and c-MYC silencing in breast cancer therapy, studies of which are currently ongoing.

LS-F-20

SALVIA AFRICANA LEAF INFUSION IMPROVES HEPATIC DYSFUNCTION AND OXIDATIVE STRESS: A MULTIMODE STUDY

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The medicinal plant *Salvia africana* (*S. africana*) is an integral part of traditional medicines in South Africa.It is an edible shrub often used in traditional herbal teas to treat various disorders, like tuberculosis, asthma, angina, and diabetes. This study aims to evaluate the antidiabetic and anti-obesogenic effects of *S. africana* leaf infusion using several experimental models. The infusion was assessed for its phytochemical content, antioxidant activity, and carbohydrate and lipid digestive enzyme inhibition *in vitro*. An *ex vivo* model was used to assess the effects of the infusion on redox imbalance and the altered activities of cholinergic, purinergic, and glucose-metabolizing enzymes in oxidative stress-induced liver tissues. The infusion was also analyzed using LCMS, and the identified compounds were examined using an *in silico* approach. The infusion had a high flavonoid and phenolic content with potent radical scavenging activity. It also exhibited strong α-amylase and α-glucosidase (IC_{50} =21.88 µg/mL and 112.20 µg/ml), cholesterol esterase and lipase inhibitory activities. The infusion (IC_{50} = 53.70 µg/mL) also significantly increased glucose uptake, which is even better than the metformin standard (IC_{50}=125.03 µg/mL). The addition of infusion to the oxidative stress induced rat liver tissue significantly ameliorated oxidative stress via increasing the levels of reduced glutathione (GSH), superoxide dismutase (SOD), catalase, and ENTPDase activities and reducing nitric oxide and malondialdehyde (MDA) levels, and improving the activities of glucose and lipid metabolism related enzymes such as fructose-1,6-bisphosphatase, glucose-6-phosphatase, glycogen phosphorylase, 5′-nucleotidase, ATPase, and acetylcholinesterase. Bioactive phytochemicals such as vanillic acid, luteolin, rosmarinic acid and scutellarin were found to bind strongly to the carbohydrate and lipid metabolic enzymes. These findings suggest that *S. africana* may be an effective natural medicine for the management of diabetes and obesity. Further studies in experimental animals and humans are warranted to confirm the results of this study.

LS-F-21

DEVELOPMENT OF A SNP-STR MULTIPLEX ASSAY TO STUDY GENETIC POLYMORPHISM IN SOUTH AFRICAN BLACK AND INDIAN POPULATIONS.

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SNP-STR is a compound genetic marker consisting of a single nucleotide polymorphism (SNP) in close proximity to a short tandem repeat polymorphism (STR). Mixture samples in forensic cases are difficult to analyse as they contain profiles of more than two individuals. SNP-STR will help distinguish individual contributors in complex DNA mixtures where standard STR analysis may be inconclusive. This study aims to develop a novel multiplex SNP-STR assay based on capillary electrophoresis (CE), for the South African Indian and Black populations. Optimization of a multiplex assay is done using four compound SNP-STR markers. The STRs with high heterozygosity for the African population were chosen from the Global Filer STR panel, along with their associated SNPs. The study will identify SNP-STRS that display population specific polymorphism patterns by calculating forensically significant parameters such as allele frequencies to analyze match probability, power of exclusion, observed and expected heterozygosity and homozygosity. The establishment of a novel multiplex assay will identify the discriminatory power that SNP-STR markers hold in distinguishing DNA profiles in forensic mixture samples.

Keywords: SNP-STRS, polymorphisms, mixtures, multiplex.

LS-F-22

SHORT-TERM EFFECTS ON NON-PHOTOCHEMICAL QUENCHING OF A COMBINED LIGHT AND CHILLING STRESS IN LICHENS

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While light is essential for photosynthesis in lichens, when the light that is absorbed exceeds that which can be used in carbon fixation the excess energy can instead activate oxygen. This will result in the formation of a range of reactive oxygen species (ROS), which can damage photosystem II (PSII), eventually reducing growth rates. One of the ways that photosynthetic organisms reduce the harmful effects of light stress is to convert any excess energy to heat in a process termed non-photochemical quenching (NPQ). It has often been observed that treatment of lichens with moderate light stress increases NPQ. In the field, lichens are subject to multiple abiotic stresses at the same time, e.g. desiccation and temperature stress. The effects of multiple stresses can be synergistic. For example, it seems likely that damage caused by excess light will be exacerbated by chilling stress. This is because while rates of photophosphorylation are almost temperature-independent, low temperatures will decrease carbon fixation, which is dependent on enzyme activity. The aim of the work presented here was to test the hypothesis that lichens treated with a combination of moderate light and chilling stress will display greater induction of NPQ than lichens treated with moderate light stress alone. Five lichen species were used, *Ramalina celastri*, *Usnea undulata*, *Crocodia aurata*, *Lobaria pulmonaria*, and *Roccella montagnei*. The effect of combinations of stress on PSII activity was tested using chlorophyll fluorescence.

F_V/F_M (maximum efficiency of PSII) and rETR (relative electron transport rate) were measured to test for photoinhibition, and NPQ to test for photoprotection. Treatments used were 100 µmol m^{-2} s^{-1} at both cold (5 °C), and room temperature (22 °C). Measurements were made after 0, 3, 6 h and then following recovery for 18 h at 15 °C under dim light. Results suggested that all lichen species increase NPQ in response to moderate light stress. For some species, the induction of NPQ was greater under chilling stress, but other species appeared to upregulate other mechanisms when a combination of light and chilling stress occurs.

LS-F-23

Microbiological assessment of the uMsunduzi River in KwaZulu-Natal, South Africa: Prevalence of faecal indicators and antibiotic-resistant *E. coli*

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Access to clean water is a fundamental requirement for public health. Yet rivers in urbanised and peri-urban areas in South Africa often receive untreated sewage, sewer overflow, or agricultural runoff. This study aimed to assess the microbiological quality of the uMsunduzi River in KwaZulu-Natal over four seasons (April 2024 to April 2025), focusing on bacterial indicator organisms, potential pathogens, and antibiotic resistance.

A total of 19 water samples were collected, and selected microbiological parameters such as the aerobic plate count (APC), the most probable number (MPN) for total and faecal coliforms, and *Escherichia coli*, and viable counts for intestinal enterococci and presumptive *Klebsiella* spp. were established. In addition, the presence of *Salmonella* spp. was analysed, and selected physicochemical parameters (temperature, pH, chemical oxygen demand (COD)) were determined.

The pH of the river water ranged from 6.49 to 7.26, the COD from 10 to 30 mg/L, and the water temperature varied from 14.1°C (winter season) to 27.7°C (summer season).

APC values for river water samples ranged from 3.87 to 5.21 log CFU/mL, total coliforms from 4.04 to 5.54 log MPN/100 mL, and faecal coliforms from 3.23 to 5.11 log MPN/100 mL, while *E. coli* reached up to 4.83 log MPN/100 mL. Presumptive *Klebsiella* spp. were detected at levels ranging from 2.56 to 3.18 log CFU/mL, and intestinal enterococci from 2.78 to 3.78 log CFU/100 mL. *Salmonella* was detected once during the winter season.

Antibiotic susceptibility testing (AST) revealed that out of 60 representative *E. coli* isolates, 35% were antibiotic resistant, and 4 isolates were classified as multidrug-resistant (MDR).

In conclusion, the presence of high microbial loads, faecal indicators, opportunistic pathogens, and MDR *E. coli* confirms that the uMsunduzi River is unsuitable for domestic and recreational purposes, stressing the need for continuous water quality monitoring, improved wastewater management, and antibiotic resistance surveillance.

LS-F-24

ENRICHMENT AND GEO–ACCUMULATION OF TRACE AND HEAVY METALS IN SURFACE SEDIMENTS ALONG URBANISED AUSTRAL WETLANDS

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Urban wetlands are often polluted by heavy and trace metals being discharged from industries, urbanisation and agriculture, which tend to alter the sediment quality. Sediments are important as they act as a sink for nutrients in aquatic environments. Wetlands play an important role in maintaining ecological balance, preventing floods and droughts, providing shelter for various animals and plants, and supporting human well-being through essential services such as carbon sequestration and water purification. The present study aimed to assess the spatiotemporal distribution and sediment pollution indices of trace and heavy metals in surface sediments and identify potential sources of contamination in urbanised Austral wetlands. Sediment samples were collected within the Riverside's Wetlands, City of Nelspruit, South Africa, across three seasons (i.e., hot–dry, hot–wet and cool–dry seasons). A multivariate principal component analysis (PCA) was used to determine the metal relationship. The metal pollution indices, such as contamination factor, enrichment factor, geo–accumulation factor and pollution load index were used to determine the pollution of metals in the sediments across different sites among seasons. The study found that only the lower Na concentration was observed during the cool-dry season, which was lower compared to the concentrations of other metals. The pollution indices indicated that wetland sediments were highly contaminated, mainly with Mn, Co, Cu, Pb, Zn, Al and Fe, especially during the cool–dry season. The current study highlights an urgent need to come up with immediate measures to control severe heavy metal pollution from the industrial emission into the wetlands. These immediate measures should be carried out to minimize the rate of contamination and extent of future metal contamination.

LS-F-25

Insights into metal biotransformation by bacterial isolates from industrial wastewaters: An investigation on molecular pathways in metal precipitations.

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Heavy metal contamination of ground and surface water bodies is a persistent environmental concern caused by the rapid industrial and urban development **[**1]. Heavy metals pose significant risk to human health and the surrounding environment [2]. The accumulation of these heavy metals can cause damage to human organs, enhance carcinogenicity and induce cognitive impairment [3] [4]. This study aims to elucidate the cellular processes involved in the bacterial transformation of heavy metals. Wastewater samples from three sites: Site 1, Site 2 and Site 3 with pH values of 8, 3, and 6, respectively, were collected and analyzed. Chemical analysis of the samples revealed sulfate concentrations of 2568, 6115 and 2720 mg/L and various metal concentrations at levels surpassing SANS limits. The samples were further inoculated onto nutrient agar with increasing metal concentrations (V, Zn and Pb) and pH values (5, 7 and 9) to apply selective pressure. A total of thirty-four aerobic and anaerobic bacterial isolates were obtained and subjected to different microbial characterization methods. The minimum inhibitory concentration (MIC) for each isolate was determined. Less than ten percent of the total isolates obtained were able to tolerate 500 mg/l of V^{3+}. Additionally, twenty-four percent tolerated up to 500 mg/L of lead, while ninety-four percent of the isolates tolerated Zn concentrations up to 1400 mg/L. The bioremediation strategy used by the selected isolated was revealed by scanning electron microscope and the transmission electron microscope which three metal biotransformation approaches were observed: biosorption, bioaccumulation and redox transformation. These results suggest that indigenous bacteria can be used as an effective solution for heavy metal bioremediation in industrial wastewater.

Keywords: Bacteria, bioprecipitation, bioremediation, biotransformation, heavy metals

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LS-F-26

Complex habitats support higher species richness, occurrence, and unique assemblage composition in Babanango Game Reserve, Northern KwaZulu-Natal.

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Habitat complexity plays a critical role in maintaining biodiversity and ecosystem functioning. Ants (Formicidae) are key ecological indicators due to their sensitivity to habitat structure and environmental change. This study assessed the diversity, species assemblage composition, and distribution patterns of ground-dwelling ant species across three habitat types–savannah, grassland, and thicket and provides distribution data within the Babanango Game Reserve in the Northern KwaZulu–Natal. Ants were sampled using pitfall traps, yielding a total of 17 539 individuals representing 97 species from 32 genera and five subfamilies. Myrmicinae and Formicinae were the most dominant subfamilies across all habitats. Species richness was highest in the thicket (75 species), followed by grassland (66 species), while savanna had the lowest richness (59 species) which nonetheless recorded the highest ant occurrence. Grassland had a unique assemblage composition however, with greater similarity between thicket and savanna. These findings suggest that structurally complex habitats such as thicket support higher diversity and niche differentiation, while more simplified grasslands host distinct assemblages with lower richness. Habitat structure and complexity appear to be key drivers of ant diversity in the reserve. The results highlight the importance of conserving habitat heterogeneity to maintain invertebrate biodiversity in protected areas. Although the findings of this study suggest that habitat type affects the ant species composition it is recommended that future research should explore biotic and abiotic factors influencing the observed patterns to better inform conservation and management strategies.

Keywords: ants, biodiversity, habitat complexity, savanna, grassland, thicket, habitat heterogeneity, species composition

LS-F-27

IMMUNOINFORMATIC SCREENING FOR POTENTIAL VACCINE CANDIDATES IN SMALL RUMINANTS USING *TOXOPLASMA GONDII* VIRULENCE FACTORS TO COMBAT TOXOPLASMOSIS

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Toxoplasmosis is a significant zoonotic disease that continues to impend public health and livestock industries. With the growing concerns about the impact of *Toxoplasma gondii* on the livestock industry, available control strategies for this disease currently pose critical throwbacks contributing to parasite resistance and inefficient elimination of the parasite tissue cysts due to complexity of parasite life cycle and genome. This study aimed to construct a multi-epitope vaccine by targeting *T. gondii* virulence factors: microneme rhoptry (ROPs) and dense granule (GRAs) to identify potential epitope candidates that are safer and can decrease the devastating burden of infectious diseases like toxoplasmosis in small ruminants. Following *in-silico* approach, we successfully predicted T cell peptides binding to MHC class I and II molecules, where identified epitopes for goats were: ROP (33 T-cell and 8 B cells), MIC (13 T-cell and 1 B-cell) and GRA (6 T-cell and 24 B cells) and sheep epitopes were ROP (86 T-cell and 16 B cells), and GRA (26 T-cell and 4 B cells. These epitopes were characterized as conserved, antigenic, immunogenic, and non-allergen.

The construction of our proposed vaccine constructs for both sheep and goat species was achieved through incorporation of linkers and 2 adjuvants (cholera B toxin and monophosphoryl lipid-A) for enhanced immunogenicity and stability. The tertiary structures of the constructs were further linked to TLR-4 through molecular docking which revealed 2 ideal construct confirmations with binding affinity scores of −356.00 and −556.90 kcal/mol. The interaction and behavior of molecules of residues within constructs was assessed using molecular dynamic simulation. The proteins of the designed vaccine constructs for both species were assessed for physicochemical properties, where both sheep and goat vaccine constructs were observed to be thermostable and hydrophilic with instability index of 37.81 and 35.72; and a GRAVY score of −0.406 and −0.575, respectively. Immune simulation confirmed capability of our proposed vaccines in triggering production of cytokines that are critical for immune response, such as interleukin-4, IFN-γ, TFN-b and IFN-β. The observed properties of our designed constructs showed potential in conferring cellular and humoral immune response against *T. gondii*, providing a platform for future laboratory validation and designing a potential vaccine.

Keywords: Toxoplasmosis; Sheep; Goat; Bioinformatics; infectious disease; Animal welfare, Animal Health

LS-F-28

Traditional Methods Used by Small-Scale Farmers to Control Arthropod Pests Affecting Crop Production in Africa: A Systematic Review

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Small-scale farming systems across Africa are mainly impacted by arthropod pests, leading to significant losses in crop yields. Resource-limited farmers often depend on traditional pest control methods using locally available organic and household products. This review examines these traditional pest management strategies used by small farmers throughout Africa, focusing on their effectiveness against key pests. A systematic search was conducted across the selected databases, including Google Scholar, ScienceDirect, Wiley, and PubMed, which identified 36 relevant studies from 2000 to 2024 in 12 African countries. Commonly affected crops included maize and beans, frequently attacked by aphids, weevils, fall armyworms, and cutworms. Small-scale farmers utilize traditional pest controls involving plant- and animal-based pesticides, inorganic chemicals, and synthesized inputs. From these studies, 80 pesticidal plants from 29 plant families were identified to combat 23 arthropod pests affecting 19 crops. Ten biopesticides derived from animal products were reported in studies from Tanzania, South Africa, Ethiopia, and Kenya. Botswana was the only country where farmers reported using sand on their crops for pest control. Essential oils and soaps emerged as the most common pest management tools among small farmers in Ghana, Tanzania, Benin, and Ethiopia. The failure to integrate the traditional pest management practices with modern agricultural technologies hinders the broader evaluation of effective pesticidal inputs used in rural communities. There is a pressing need to evaluate the effectiveness of traditional pest control in small-scale farming systems to promote sustainable farming and improve food security.

Keywords: Small-scale farmers, Africa, arthropod pests, efficacy, traditional methods, crop production

LS-F-29

ANTIOXIDANT, ANTIBACTERIAL, AND CYTOTOXIC PROPERTIES IN CRUDE EXTRACTS OF *BOUGAINVILLEA GLABRA* LEAVES, STEMS, AND FLOWERS

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The global search for plant-based bioactive compounds has intensified due to the rising challenges of antibiotic resistance and cancer prevalence. *Bougainvillea glabra*, a plant traditionally utilized in folk medicine, remains significantly underexplored in scientific literature. This study aimed to evaluate the pharmacological potential of crude extracts from its leaves, stems, and flowers to identify new antioxidant, antibacterial, and cytotoxic agents. Extracts were prepared using hexane, chloroform, and methanol, and phytochemical analyses were conducted to quantify total flavonoid and phenolic contents using a UV-Vis spectrophotometer. Antioxidant activity was assessed through DPPH and FRAP assays, while antibacterial efficacy was tested against *Staphylococcus aureus* and *Escherichia coli*. Cytotoxicity was evaluated using human cell lines from embryonic kidney, cervical cancer, and breast adenocarcinoma. Among the methanolic extracts, the leaf extract exhibited the highest flavonoid content (42.39 ± 1.14 mg QE/g DW) and phenolic content (6.05 ± 0.09 mg GAE/g DW), followed by the stem (30.22 ± 1.02 mg QE/g DW; 4.87 ± 0.12 mg GAE/g DW) and flower extracts (25.74 ± 0.87 mg QE/g DW; 3.91 ± 0.08 mg GAE/g DW). The DPPH assay showed significant free radical scavenging in the leaf (16.95 µg/mL), stem (14.27 µg/mL), and flower (17.84 µg/mL) extracts. All extracts exhibited lower reducing power in the FRAP assay compared to ascorbic acid. The cytotoxicity assays revealed IC_{50} values exceeding 63 µg/mL across all samples. Antibacterial tests indicated that the stem extract moderately inhibited *S. aureus* (18.17 mm), while the leaf extract was more effective against *E. coli* (18.05 mm), outperforming gentamycin. Chloroform extracts showed minimal activity and were excluded from further discussion. In conclusion, the methanolic extracts of *Bougainvillea glabra* demonstrate promising antioxidant, antibacterial, and moderate cytotoxic potential, supporting further investigation into its phytochemical constituents for therapeutic development.

LS-F-30

OPTIMIZING ARTIFICIAL OVIPOSITION SUBSTRATES FOR MASS REARING OF *ELDANA SACCHARINA* IN STERILE INSECT TECHNIQUE PROGRAMS

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Sugarcane (*Saccharum officinarum*) is an important industrial crop in South Africa but suffers significant losses due to *Eldana saccharina* Walker (Lepidoptera: Pyralidae), a major stem borer. The sterile insect technique (SIT) provides a sustainable alternative to chemical control for *E. saccharina* management but requires efficient mass-rearing systems. For efficient mass rearing, oviposition substrate selection is crucial for maximising egg laying and hatching success. However, the use of natural hosts is costly and environmentally detrimental, thus the need for artificial substrates. Under no-choice tests, this study investigated the oviposition preferences and hatching success of irradiated and unirradiated *E. saccharina* females on artificial substrates over five days. Seven artificial substrates (wax paper, kitchen towel, corrugated paper, blotting paper, bubble wrap, greaseproof paper, and paper towel) were evaluated for oviposition and hatching rate under laboratory conditions. The number of eggs and the hatching percentage were recorded per female. The results showed that most eggs were laid on paper towel (irradiated: 385 eggs; unirradiated: 108 eggs) and perforated wipes (irradiated: 388 eggs; unirradiated: 76 eggs). However, the highest egg hatching percentage for both groups was recorded on wax paper, with 58.42% for irradiated moths and 3.56% for unirradiated moths. These findings underscore the critical role of oviposition substrate type in influencing reproductive outcomes within SIT programmes. Identifying and utilizing artificial substrates such as paper towel, perforated wipes, and wax paper could improve the efficiency, cost-effectiveness, and scalability of SIT, particularly under increasing pest pressures. Additionally, integrating these substrates into SIT protocols could strengthen environmentally friendly pest management strategies by reducing reliance on natural substrates. Further research is necessary to validate these findings at pilot production scale and to evaluate their applicability across other lepidopteran pest species under diverse climatic conditions.

LS-F-32

MEROPLANKTON ASSEMBLAGES ASSOCIATED WITH MESOPHOTIC REEFS IN THE DIFFERENT MANAGEMENT ZONES IN THE UTHUKELA BANKS MPA

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South Africa has achieved significant progress toward achieving its ocean conservation objectives, moving from 0.4 % to 5.4% marine protected area (MPA) coverage in 2019. When properly managed and enforced, MPAs result in positive ecological impacts through improved biodiversity and socio-economic benefits such as improved fisheries and tourism. Since the MPAs in South Africa are fairly new, there is a need to establish a monitoring program to assess their effectiveness over time. This study aimed to compare the abundance and diversity of meroplankton from mesophotic reefs (depth range 30-120 m) located within the controlled, restricted and outside zones of the uThukela Banks MPA. Zooplankton samples were collected using a 500

μm WP2 net, and meroplankton was extracted for identification and counting. Before counting and the identification of meroplankton taxa, exploratory settled biovolume data were recorded as a proxy for quantifying zooplankton abundance. The biovolume results indicated a significant interaction effect of year and reef within the MPA management zones, but there was no significant main effect of year or reef within the MPA management zones. Higher biovolume was observed in the restricted zone at Carpenters reef (0.98 ± 0.34 ml m^{-3}) in 2021 and Grumpy reef (1.60 ± 0.45 ml m^{-3}) in 2023, both of which are located in the central part of the MPA, while the lowest biovolumes in 2021 (0.42 ± 0.22 ml m^{-3}) and in 2023 (0.46 ± 0.14 ml m^{-3}) were observed outside the MPA. The results suggest that the MPA is a significant retention zone of meroplankton due to the reduced impacts of the Agulhas Current in the central KZN Bight. The findings from this research will provide critical baseline data for monitoring the pelagic and benthic invertebrate communities within the MPA.

LS-F-33

THE MORPHOLOGICAL ALTERATIONS AND SURVIVAL RATES OF *Danio rerio* EMBRYOS EXPOSED TO ENVIRONMENTALLY REALISTIC COPPER SULPHATE CONCENTRATIONS COUPLED WITH HYPOXIA.

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Pollution of receiving waters has emerged as a global problem. It affects both the developed and developing nations at varying degrees. Freshwater ecosystems play a fundamental role in providing goods and services to humans and is home to the extraordinarily rich aquatic biota. However, freshwater ecosystems remain the most altered ecosystems in the world due to different land use activities. This study aims to evaluate the effects of four different environmentally realistic copper sulphate ($CuSO_4$) concentrations under normoxic and hypoxic conditions, respectively, on the early developmental stages of the zebrafish. Zebrafish embryos were harvested from an existing breeding population at the Zebrafish Research Facility at UKZN, Pietermaritzburg campus. Fertilized embryos were identified by the development of a blastula and non-viable and abnormally developed embryos were excluded and discarded accordingly. Ten embryos (in triplicates) were used for each test concentration replicated under normoxia and hypoxia at four different developmental windows which are: 4-28 hours post fertilization (hpf), 28-56 hpf, 56-76 hpf and 76-100 hpf. Exposed at each interval lasted 24 hours. After exposure, endpoints such as mortality rates, heart rates and hatching success were assessed. Thereafter, embryos were euthanised with clove oil (90% eugenol) and samples were preserved in 4% paraformaldehyde at 4°C for further analysis. To analyse deformities, embryos were stained with haematoxylin and eosin (H&E), whole mounted, and photographed under the light microscope (X10 magnification). $CuSO_4$ exposure resulted in a significantly higher mortality rate under normoxia at 4-28 hpf, under hypoxia for the other three developmental windows. The heart rates were not significantly different between the treatments for both 52-76 hpf and 76-100 hpf developmental windows, but both treatments of the 52-76 hpf developmental window had poor hatching success. Morphological alterations such as body deformities, notochord alterations, tail bends were prevalent in both treatments than in their respective controls. The results of this study provide insight into the physiological and functional state of early developmental stages of aquatic animals in response to multiple stressors because hypoxia and other environmental contaminants often co-occur in the natural systems.

LS-F-34

ANTIBACTERIAL AND ANTIOXIDANT PROPERTIES OF IPOMEA PES-CAPRAE LEAF, STEM AND FLOWER CRUDE EXTRACTS

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Ipomoea pes-caprae (morning glory) is a coastal dune species known as a valuable medicinal plant with a broad spectrum of antibacterial and anti-inflammatory activities. Traditionally, this plant is used to treat inflammation, diuretic disorders, hypertension, and pain. Studies have also revealed phytochemical compounds present in the plant. Phytochemical tests revealed the hexane crude extract contained alkaloids, carbohydrates, phenols, saponins, terpenoids and sterols, while chloroform crude also revealed the presence of amino acids and methanol crude extracts revealed the presence of flavonoids. In the present investigation, hexane, chloroform, and methanol extracts of leaves of *I. pes-caprae* were studied for their antibacterial properties against gram-positive bacteria such as *Staphylococcus aureus* and gram-negative bacteria such as *Escherichia coli* and *Pseudomonas aeruginosa* using the agar-well diffusion method. This revealed a strong presence of activity against *S. aureus* and *E. coli*. Methanolic leaf extracts inhibited *S. aureus* (12.6 mm) more effectively than streptomycin (11.4 mm), while outperformed gentamycin against *E. coli* (14.2 mm vs. 17.5 mm). However, the methanol stem extract did not yield any zones of inhibition against both bacterial strains. Antioxidant activity, measured via DPPH and FRAP assays, showed that methanolic extracts of leaves had notable DPPH inhibition at 55.1 ug/L though their reducing power was lower than that of ascorbic acid.. The highest flavonoid content (49.97 ± 0.20 mg GAE/g DW) was seen in leaf methanol crude extract with hexane stem extracts following closely (19.72 ± 0.02 GAE/g DW). Methanol crude extracts of the leaf also resulted in the highest total phenolic content (97.33 ± 1.76 mg GAE/g DW) when compared the other extracts. The results of the study reveal the presence of bioactive compounds and their potential their antibacterial properties. With use of these applications, *I pes-caprae* has the potential to be source for alternative for modern medications.

LS-F-35

MOLECULAR IDENTIFICATION OF HELMINTH PARASITES OF FREE-RANGING CHICKENS FROM SELECTED RURAL COMMUNITIES OF KWAZULU-NATAL PROVINCE OF SOUTH AFRICA

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Free-range chickens are predisposed to diverse parasitic infections during scavenging. Accurate identification of these parasites using morphological characters has been a challenge. Therefore, this study aimed to identify nematodes from the Heterakidae and Ascarididae family infecting free-ranging chickens from KwaZulu-Natal province of South Africa using a combination of morphological and molecular techniques. Forty-two free-ranging adult indigenous chickens were purchased from randomly selected households in Shongweni (n=12),

Umzinto (n=10), Gingindlovu (n=10) and Ozwathini (n=10) rural villages and examined for nematodes of the Heterakidae and Ascarididae family.

Collected specimens were identified morphologically and confirmed using mitochondrial and nuclear ribosomal markers. Results showed that *Ascaridia galli* was common, occurring at all sampling locations with an overall prevalence of 58.3%, while *Heterakis gallinarum* and *H. beramporia* occurred in three locations. *Ascaridia galli* had high prevalence in Shongweni (58.3%), followed by Gingindlovu (40%), Ozwathini (20%) and Umzinto (10%). *Heterakis gallinarum* infection was prevalent in three locations, with an overall prevalence of 90% in Gingindlovu, 80% in Ozwathini and 58.3 % in Shongweni. *Heterakis gallinarum* and *H. beramporia* were not recorded in Umzinto. *Heterakis beramporia* was recorded in low prevalence in Gingindlovu (20%), Ozwathini (10%) and Shongweni (8.3%) villages. Mixed infections of *A. galli* and *H. gallinarum* were recorded in Gingindlovu, Ozwathini and Shongweni, and *H. gallinarum* and *H. beramporia* in Gingindlovu.

Molecular analysis confirmed identification of *A. galli*, and further showed close relationship with the GenBank-derived South African isolates. Haplotype network further con- firmed their ancestral history, where all South African *A. galli* isolates formed five novel haplotypes corresponding with the structure of the phylogenetic tree. Similar structure was observed with *Heterakis* isolates, where analysis of the cox1 gene showed that *H. gallinarum* formed a well-supported monophyletic clade with other *Heterakis* species. The ITS marker identified three specimens from Gingindlovu, Ozwathini and Shongweni as *H. beramporia*, which formed strongly supported sister clade to *H. indica* and this is the first report confirming the occurrence of *H. beramporia* in South Africa.

Key words: free-range chickens, gastrointestinal helminth, Ascarididae, Heterakidae, South Africa

LS-F-36

DETECTION OF PARACETAMOL FROM THE GUT CONTENT OF INSECTS COLLECTED FROM INTOXICATED PIG CARCASSES

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This study explores the detection of paracetamol and its metabolites in necrophagous insects as a tool in forensic entomotoxicology, which examines the use of insects to determine toxicological evidence in decomposing remains. In suspected drug-related deaths, where conventional biological samples such as blood or tissue may be compromised, insects feeding on decomposing bodies can serve as alternative matrices for toxicological analysis. The aims of this study were: (1) to detect and quantify paracetamol in different insect life stages, including larvae, pupae, pupal cases, and newly emerged adults; and (2) to identify insect species that can serve as bioindicators of paracetamol poisoning in decomposing bodies during homicidal and suicidal investigations. Paracetamol-spiked pig carcasses were used to simulate human decomposition under uncontrolled natural field conditions. Insects were collected from carcasses exposed to three paracetamol concentrations (low, medium, and high) over time. Species were identified using both morphological characteristics and molecular species identification. Drug extraction was carried out on different developmental stages, and samples were analysed using Liquid Chromatography–Mass Spectrometry (LC-MS) to detect and quantify paracetamol and its major metabolites, including paracetamol glucuronide and paracetamol sulfate. The LC-MS analysis confirmed the successful detection of paracetamol and its metabolites in insect samples of *C. Albiceps, C. Megacephala, C. Cuprina, C. Marginalis, L. Putoria & T. Micans*, across different developmental stages of 1^{ST},2^{ND} and 3^{RD} instar, post-feeding, pupae, and pupal cases. *Chrysomya albiceps* had the highest detection rate overall, with 9 out of 13 samples testing positive.

Chrysomya megacephala also showed consistent detection, with positive results across all treatment groups. The highest detection rate was generally detected in post-feeding larvae and pupae stages. These species serve as a toxicological indicator of paracetamol in this region. In contrast, *Thanatophilus micans* exhibited low detection rates, but it is an expected observation as beetles usually colonise towards the last stage of decomposition, where drug levels are low. In conclusion, the findings demonstrate that paracetamol and its metabolites can be reliably recovered from necrophagous insects using LC-MS analysis and consequently, used to determine the cause of death in suspected overdose or poisoning cases. These results support the value of incorporating insect evidence into toxicological investigations when conventional biological matrices are unavailable or degraded.

LS-F-37

PUBLIC'S INTEREST ON INVASIVE SPECIES: INTEREST VIS-A-VIS READABILITY

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Human activities have caused the proliferation of invasive species, leading to a growing body of research recommending public involvement in studying and managing these species. Public knowledge and awareness are crucial in changing public behavior regarding invasive species, but the level of public interest and comprehension of public information regarding invasive species is largely unknown. To address this issue, the study used Google Insights for Search (GIFS) to examine the public's interest in invasive species from 2004 to 2020, analyzing the search popularity for eight terms related to invasive species. The study also conducted readability analyses on public sources of information about invasive species using established readability tests. The findings show that the relative search volume for terms related to invasive species simple linear regression ($R2=0.020$) has steadily increased over time, indicating growing public interest in invasive species. Most sources of information about invasive species are suitable for readers with junior university degrees and above, the readability of most websites was higher than the recommended level for the public to comprehend, highlighting the need for a balance between public engagement activities on invasive species through popular media and the readability of the information presented. The study concludes that infoveillance using GIFS can serve as a proxy marker for public biodiversity needs and priorities, emphasizing the importance of making public information about invasive species more accessible to a broader audience and aid in planning for public engagement activities related to invasive species.

LS-F-38

Assessing the Baseline Susceptibility of Lepidopteran Pests Against Bt Toxins in Crops: A Systematic Review

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Lepidopteran species are one of the most important pests in agriculture, leading to significant yield losses by boring into the internal plant tissues. This behaviour often necessitates repeated application of conventional insecticides, leading to resistance development and reduced effectiveness. In response, genetically modified crops expressing *Bacillus thuringiensis* (Bt) have been used in several plants as an alternative control technique. However, the continued effectiveness of Bt crops is threatened by the potential evolution of resistance, particularly if resistance monitoring is not implemented. Despite the widespread adoption of Bt crops, data on the baseline susceptibility of lepidopteran pests remain fragmented and inconsistent. This systematic review addresses current knowledge on the baseline susceptibility of key pest species to various factors, evaluating differences in test methods, target species and geographic distribution. Literature searches were conducted using Web of Science, JSTOR, CABI Direct and Scopus for studies published between 2000 and 2024. A total of 49 articles were included, documenting the susceptibility of lepidopteran pests to various Bt toxins. Most studies were conducted in the USA (n =19), Brazil (n =9) and India (n =7). The test method used in the studies varied substantially, with diet incorporation (43%) and surface contamination (37%) being the most used. Less frequent methods included a diet combination and surface contamination (7%), spraying application (3%), topical application (3%), leaf dipping and the combination of leaf dipping and diet incorporation (3%). The most frequently tested toxins were the combination of Cry1 and Cry2 (43%) and Cry1 alone (24%). There is limited research on Bt susceptibility in developing countries due to resource constraints. This gap is most evident in Africa, where data on pest response to Bt crops remains poorly understood. Standardised testing methods and broader geographic coverage are essential to strengthen global resistance management efforts.

LS-F-39

BIOREMEDIATION OF INDUSTRIAL WASTEWATERS AND POTENTIAL OF METAL BIO-PRECIPITATION, RECOVERY AND VALORIZATION BY INDIGENOUS BACTERIAL CONSORTIA

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Industrial wastewater pollution is a global concern due to rapid increase in the development of industries [2]. Heavy metals contaminating water from various industrial processes are toxic at high concentrations and pose serious threats affecting soil, air, water [1,2]. Limited research has been conducted on the use of indigenous bacteria that thrive in different harsh industrial wastewater conditions for their applications in the removal of heavy metal for their recovery and valorization. The current study examines the use of indigenous bacteria for bioremediation and recovery of valuable heavy metal and their valorization. Wastewater samples were collected from three industrial sites and water chemistry was analyzed using ICP. The total DNA was extracted and universal primers 341F/908R was used for the amplification of 16S rRNA gene. A metagenomic approach was adopted to determine bacterial communities in wastewater. Bacterial cultures were enriched from the water samples using nutrient and minimal media for minimum inhibitory concentrations (MIC) and maximum tolerance concentrations (MTC) test with three metals of interest: Zinc (Zn), Lead (Pb) and Copper (Cu) dozed in the media. Bacterial growth and metal precipitation was monitored at different maximum metal concentrations: 2500 mg/L for Zn, 500 mg/L for Pb, and 200 mg/L for Cu which proved high tolerance by the enriched bacteria as compared to previous reports in literature. Effects of pH on metal precipitation were also evaluated by subjecting the consortia to three pH conditions: 3, 7, and 9. The results of heavy metals in wastewater were found that concentrations of Zinc-0,01 mg/L, Ca-222 mg/L, Fe-43 mg/L, Vn-2720 mg/L and Al- 19 mg/L. The results from SEM and TEM demonstrated that indigenous bacterial consortia use different mechanisms, primarily Bioprecipitation for Pb, Bioaccumulation for Zn, and Biosorption for Cu removal from

their dissolved state. These results further prove the potential and effectiveness of using indigenous bacteria for the removal of toxic heavy metals from water contaminated by industrial waste.

Keywords: *Bioremediation, Water contamination, metal recovery, waste valorization, indigenous bacteria.*

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LS-F-40

PHYTOCHEMICAL AND ANTIBACTERIAL SCREENING OF THE LEAVES AND STEMS OF *TREMA ORIENTALIS* (L) Blume.

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Trema orientalis L. Blume, belonging to the Cannabaceae family, is a widely distributed medicinal plant traditionally used to manage respiratory conditions, fevers, wounds, and gastrointestinal disorders across African and Asian cultures. This study aimed to evaluate the phytochemical composition, histochemical properties, and antibacterial potential of the leaves and stems of *T. orientalis*. Plant material was extracted using solvents of increasing polarity (hexane, chloroform, and methanol) via Soxhlet extraction. Preliminary phytochemical screening revealed the presence of key secondary metabolites such as alkaloids, phenolics, flavonoids, terpenoids, sterols, fixed oils, and carbohydrates, with methanolic extracts showing the richest phytochemical profile. Histochemical tests on fresh leaf and stem sections further confirmed the presence of phenolic compounds, proteins, starch, lipids, lignin, and alkaloids based on localized colour reactions, which aligned with the phytochemical results. Antibacterial activity was assessed using the disc diffusion method against methicillin-resistant *Staphylococcus aureus* (MRSA) and *Escherichia coli*. Methanol and hexane leaf extracts exhibited the strongest inhibition against MRSA, with the methanol extract producing zones up to 13 ± 0.47 mm at 200 mg/mL, while activity against *E. coli* was minimal. Chloroform extracts showed limited or no antibacterial activity. Anatomical characterization using stereomicroscopy revealed distinctive morphological features, including the presence of glandular trichomes and vascular bundle arrangements that support species identification. These findings validate the traditional use of *T. orientalis* and emphasize its potential as a source of bioactive compounds for antibacterial applications. The combined phytochemical, histochemical, and microscopic analyses contribute valuable data toward the pharmacological and botanical standardization of this medicinal plant.

LS-F-41

Optimization of tissue culture protocols for cassava multiplication and conservation

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Cassava (*Manihot esculenta* Crantz) plays a critical role in food security, income generation, and industrial applications across tropical and subtropical regions, including South Africa. Despite its importance, conventional propagation through stem cuttings is hindered by slow multiplication rates, susceptibility to disease, and genetic deterioration, resulting in limited access to healthy planting material. Tissue culture presents a viable solution for rapid, disease-free propagation and genetic conservation, yet existing protocols are not optimized for low-performing cultivars.

This research seeks to develop an efficient and reproducible tissue culture protocol for cassava by optimizing the concentrations of two key plant growth regulators: BAP (6-Benzylaminopurine) and NAA (Naphthaleneacetic acid). The study will assess their effects on shoot multiplication, root induction, and overall plantlet viability using nodal explants from selected cultivars (96/0505, 98/0505, P10/3, P1/19, UKF4, and control P4/10). Modified Murashige and Skoog (MS) media will be prepared with specific concentrations of sucrose, agar or gelrite, and growth regulators, then sterilized and used under controlled environmental conditions (25°C, 16-hour photoperiod). Cultures will be subcultured and the experiment will be replicated three times to ensure statistical reliability.

The anticipated outcome is a robust tissue culture protocol that enhances cassava multiplication efficiency, improves plantlet quality and survival, and facilitates long-term conservation of elite germplasm. This advancement will support sustainable cassava production in South Africa by ensuring a consistent supply of high-quality, disease-free planting material suited to local agricultural needs.

Keywords: Cassava, *Manihot esculenta*, tissue culture, BAP, NAA, shoot multiplication, root induction, plantlet viability, MS medium, genetic conservation, South Africa, sustainable agriculture

LS-F-42

THE EFFECT OF ALIEN INVASIVE PLANT SPECIES ON BIODIVERSITY BETWEEN THE RIPARIAN ZONES AND ADJACENT UPLAND HABITATS ALONG UMNGENI RIVER

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Sustaining high plant diversity in both riparian zones and adjacent upland areas is crucial to ensure that these natural ecosystems continue to perform key functions such as water regulation, water quality improvement, erosion prevention, and pollution mitigation. South Africa has experienced negative impacts from alien invasive species, which have become a major threat to the country's biodiversity. Riparian ecosystems are amongst the habitats that are threatened by the presence of invasive alien species. This study aimed to determine the effect of invasive alien plant species on biodiversity between the riparian zones and adjacent upland habitats along uMngeni River. Data was collected from three sites along the uMngeni River (Wakefield Research Farm, Doreen Clark Nature Reserve, and Fountain Hill Estate). We sampled at 0 m (the starting sampling point downstream), 300 m, 600 m, and 900m along the river. We also sampled away from the river to the upland habitats, starting at 0 m (on the edge of the river) and 300 m away from the river. At each sampling point, two 30 m long transects that will be 10 m apart were laid out parallel to the river. In each transect, at the beginning and end of the transect, a 1 m^2 quadrat was dropped. The percentage cover of each plant species rooted in the quadrat was visually estimated to the nearest 1% and recorded. Soil samples were collected from the surface down to a 10 cm depth using a soil auger on the same transects where the plant data were collected. Riparian zones showed higher soil nutrient levels and a greater number of alien invasive

species, but lower native species richness compared to upland habitats across all sites. This may be because riparian zones experience more frequent disturbances. These findings provide baseline data on the composition and diversity of native and alien invasive plant species in riparian zones and adjacent upland habitats along the uMngeni River. Understanding these patterns is essential for developing effective management strategies aimed at mitigating flood risks and controlling the spread of invasive species.

LS-F-43

Water quality and macro-invertebrate responses to land use and climate changes in KwaZulu-Natal rivers

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Freshwater ecosystems have been vital in supporting human livelihoods since ancient times. Presently, anthropogenic factors exert a global impact on freshwater ecosystems, primarily because of pollution, water abstraction, and the construction of physical barriers in rivers. Achieving clean water and sanitation (SDG 6) remains a significant challenge in African countries, including South Africa, where infrastructure failures, inadequate legislative implementation, and sporadic pollution events have degraded freshwater environments to unacceptable levels. We are reassessing the biological responses at 52 sites across KwaZulu-Natal, South Africa, that were used in the River Eco-status Monitoring Programme (REMP) to re-evaluate the ecological status and function of KwaZulu-Natal rivers during a period of above-average rainfall and recorded flooding in 2024-2025. These sites were surveyed during the 2014-2016 drought (Agboola et al. 2019, 2020a, b; Evans et al. 2022). We studied the macro-invertebrates through the SASS5 technique as one component. We also collected diatoms, and 2L water bottles to complement in situ water quality monitoring. We are 75% through with our fieldwork, having covered the low flow season of 2024, the high flow season of 2024 and most recently, the high flow season of 2025. These surveys assist in a comprehensive collection of relevant data to understand the impacts of climate and land use changes, especially when compared to long-term existing databases. In our study, with the monitoring of biological responses, we aim to contribute valuable data for holistic river management, offering valuable insights into freshwater ecosystems' overall health and functioning with a changing climate and land uses.

LS-F-44

Isolation and Initial Characterization of *Gardnerella vaginalis* Extracellular Vesicles in the Context of Bacterial Vaginosis

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Background: Bacterial vaginosis (BV) is the most prevalent vaginal infection among women of reproductive age and is associated with increased HIV acquisition, particularly in African populations. *Gardnerella* species are dominant in the BV-associated microbiota, and they have been shown to produce extracellular vesicles

(EVs), which may play a role in pathogenesis, recurrence, and antimicrobial resistance. Despite their potential relevance, the characteristics and functions of *Gadnerella* EVs remain largely unexplored.

Methods: This study focuses on the isolation and preliminary characterization of EVs produced by *G. vaginalis under in vitro conditions.* Extracellular vesicles were isolated using polyethylene glycol (PEG) precipitation followed by purification steps to reduce protein and media contaminants. Isolated EVs were then quantified using nanoparticle tracking analysis (NTA) to assess concentration and size distribution. The isolation protocol is currently being optimized to improve EV yield and consistency for downstream applications such as molecular cargo profiling.

Results: Preliminary data confirmed successful isolation of *G. vaginalis*-derived EVs, with average concentrations of approximately ~1 × 10^{11} particles/mL and a mean diameter of ~160 nm, consistent with known bacterial EV size profiles. Protocol refinement is ongoing to improve yield and consistency for future cargo and functional analyses.

Conclusion: These findings establish a foundation for future investigations into the molecular cargo and potential immunomodulatory functions of *G. vaginalis* EVs. This work represents an early step toward understanding the role of these vesicles in BV pathogenesis and related health outcomes.

Keywords: *Gardnerella vaginalis*, extracellular vesicles, bacterial vaginosis, EV isolation, HIV risk

LS-F-45

Evaluating nitrate pollution and potentiality of native bacterial consortia in WWTPs across KwaZulu-Natal for *in-situ* complete denitrification

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Mounting global pollution, particularly from ammonia (NH_4^+) and nitrate (NO_3^-) accumulation, threatens water and land ecosystems [1]. Elevated levels leads to harmful algal blooms, eutrophication and increase colorectal cancer risks in humans through the formation of carcinogenic N-nitroso compounds when consumed with water [2]. Anthropogenic activities such as agriculture and wastewater management, contribute to nitrous oxide (N_2O) emissions: an ozone-depleting bio product and potent greenhouse gas [3]. Partial treatment of NO_3^-, generates secondary nitrogenous pollution in effluents [4]. Conventional wastewater treatment plants (WWTPs) which are often challenged with resource limitations and outdated infrastructure, impedes their ability to remove nitrogen compounds efficiently [5]. Biological denitrification, utilizing microbial consortia, offers a sustainable and cost-effective alternative, in converting harmful NO_3^- into harmless nitrogen gas (N_2) without the reliance on chemical treatments [6]. The current research focuses on evaluating the effectiveness of indigenous bacterial consortia enriched from four WWTPs in achieving complete denitrification under in-situ conditions. Physico-chemical and molecular analysis revealed that NO_3^- concentrations in WWTP effluents surpassed the SANS drinking water limit of 11mg/L by over five times on average. Batch experiments tested denitrification dynamics using glucose and brewer spent grain as carbon sources, at concentrations of 1000mg/L, 500mg/L, 250mg/L and 0mg/L. Glucose achieved a 100% removal of both NO_3^- and NO_2^- within 24 hours at a concentration of 500mg/L. Whilst at glucose concentrations of 1000mg/L and 250mg/L, 68.91% and 98.20% of NO_3^- was removed respectively. At 0mg/L of glucose concentration, a negative removal efficiency was observed (-19.58%) reflecting an accumulation of NO_3^- throughout the course of the experiment. Thus highlighting the importance of a carbon source to drive denitrification. Spent barley from beer brew was explored as an economical alternative carbon source, although it sustained bacterial growth, a surge of dissolved NO_3^- levels in the cultures were observed. Data from this study contributes to greater efforts

aimed at reducing NO_3^- contamination and N_2O emissions by WWTPs in KZN which will benefit both environmental and human health.

Keywords: Bacterial consortia, bioremediation, denitrification, environmental health, nitrate pollution and wastewater treatment plants

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LS-F-47

EVALUATION OF THE PHYTOCHEMICAL, ANTIBACTERIAL, AND ANTIOXIDANT ACTIVITY OF THE LEAVES AND STEM OF RHOICISSUS TOMENTOSA

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Rhoicissus tomentosa (Lam.) Wild & Drummond is an evergreen vine that is indigenous to South Africa. Genus *Rhoicissus* represents several species that are reported to be of great phyto-medicinal and ethnopharmacological value. However, *R. tomentosa* is relatively understudied. This study aimed to investigate the phytochemical composition and biological activity of the leaf and stem crude extracts of *R. tomentosa*.

Results revealed that leaf extracts had a greater percentage phytochemical yield than stem. Phytochemical screening of the extracts showed positive results for various phytochemicals: alkaloids, tannins, phenols, naphthoquinones, flavonoids, saponins, steroids, proteins, carbohydrates, mucilage, gum and resin. The agar well diffusion method was used to evaluate the antibacterial activity against *Pseudomonas aeruginosa* and methicillin-resistant *Staphylococcus aureus.* The leaf extract was distinguished for its potential antibacterial activity against both bacterial strains with an inhibition zone (mm) of 12.17± 1.04 and 8.83 ± 0.58 at 10 mg/ mL. The 2, 2′-diphenyl-1-picrylhydrazyl (DPPH) assay was used to evaluate the antioxidant activity. The percentage scavenging activity of the extracts were significantly greater than the control. Furthermore, at 15, 30, 60,120 and 240 µg/ mL, the percentage scavenging activity of leaf extract was 74.65, 78.31, 85.45, 90.02, 95.68% and for stem was 71.66, 73.57, 84.05, 88.22, 90.28% respectively, indicating that the leaf extracts had greater percentage scavenging activity than stem. Also, the IC_{50} value for the leaf extracts (0.67 µg/ mL) was

lower than the ascorbic acid (8.26µg/ mL) (control). Indicating that the leaf extracts had good antioxidant activity.

It was concluded that the best part of the plant to harvest for its medicinal use, would be the leaves. Results from this study suggest that extracts of *R. tomentosa* could have medicinal potential, thus these results are expected to stimulate interest and open the possibility of clinically effective drugs from this plant species.

Keywords: *R. tomentosa*, indigenous, phytochemical, antibacterial, antioxidant, medicinal.

LS-F-48

LARVAL FISH ASSEMBLAGES ASSOCIATED WITH MESOPHOTIC REEFS IN THE UTHUKELA BANKS MPA, SOUTH AFRICA

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The uThukela Banks MPA is a newly established marine protected area (MPA) on the east coast of South Africa that aims to protect fish spawning and nursery grounds. Larval fish can serve as indicators of hatching and nursery areas as population connectivity of fishes is largely driven by the dispersal of their larval stages. This study aimed to generate baseline data on species composition, diversity and density of larval fishes amongst the different regions inside (inshore and offshore) and outside (control) the MPA. Plankton samples were collected in June/ July 2023 from 14 reefs in the different regions of the uThukela MPA and outside the MPA. A total of 6911 individuals, comprising 309 species representing 82 families, were recorded. Larval density and diversity differed significantly amongst the regions sampled. The highest density as well as diversity was found in the offshore region, while the lowest was found in the inshore region. Larval density and diversity were driven by changes in temperature and salinity. The offshore region had significantly lower temperatures, resulting in high larval densities. Density gradients in the uThukela MPA were also directly proportional to the size gradients of the larval fishes; larvae in the inshore region had significantly lower mean body lengths compared to the other regions. The dominant species included Spratelloides delicatulus, Pegallus bellottii, Sillago chondropus, Bregmaceros nectabanus, Caffrogobius natalensis, and Bregmaceros atlanticus. The flexion stage, associated with caudal fin formation and increased mobility, was the dominant developmental stage in all three regions. This may indicate that the fish are hatching in nearby areas and using the MPA as an interim nursery. This study contributes to the baseline data on larval fishes and can aid in future monitoring of fish stock recovery in the new MPA.

LS-F-49

Synthesis of carbon quantum dot nanocomposites as potential Antimicrobial and Antioxidant agents

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Carbon quantum dots (CQDs) are a unique and emerging family of carbon nanoparticles that possess prominent optical properties due to quantum confinement effects. These nanoparticles have also gained a lot of interest in biomedical applications such as cellular imaging, drug delivery as well as acting as antioxidant and antimicrobial agent. In this study, CQDs were synthesized via the hydrothermal method using citric acid and urea. The synthesized CQDs were characterized for their optical properties using UV-light emission, and UV-Vis spectroscopy, and their structural properties were determined using high resolution transmission electron microscopy (HR-TEM) and dynamic light scattering (DLS). Characterisation of CQDs shows spherical nanoparticles with sizes of 2.33±0.4nm possessing a violet colour in solution with blue fluorescence emission corresponding to an excitation peak of 335nm. Functionalized CQD nanocomposites were found to be spherical with sizes of 28.35±1.39nm and 20.78±1.01nm for silver and cerium respectively. Both nanocomposites had quenched fluorescence, and a colour change from violet to brown. The synthesized CQDs were found to have potent antioxidant potential comparable to the vitamin C standard with an IC_{50} concentration of 12.5µg.ml^{-1} against free radicals as ascertained from the 2,2-diphenyl-1-picrylhydrazyl (DPPH) scavenging assay. Preliminary testing of unfunctionalized CQDs against four bacterial stains showed insignificant inhibitory effects. In order to improve the bioactivity of the CQDs, functionalization was conducted with silver or cerium. Silver and cerium were the two metals chosen for functionalisation due to them showing excellent antibacterial activity from previous studies. Testing of the metal CQD nanocomposites is still being conducted and is anticipated to produce promising results.

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LS-F-50

Phyto-fabricated Silver Nanoparticles: A platform for Therapeutic Applications

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Green synthesis of nanoparticles has emerged as a sustainable and biocompatible approach for developing nanoparticles with promising therapeutic potential. In this study, silver nanoparticles (AgNPs) were synthesized using *Siphonochilus aethiopicus*, a South African plant known for its traditional medicinal value, offering an eco-friendly alternative to conventional physicochemical methods. The synthesized AgNPs were characterized via Ultraviolet-Visible spectroscopy (UV-vis), transmission electron microscopy (TEM), energy dispersive x-ray spectroscopy (EDX), dynamic light scattering (DLS) and zeta-potential (ZP) analysis. The AgNPs had a distinctive surface plasmon resonance at a wavelength of around 440 nm via UV-vis analysis, a negatively charged ZP value of -40.8 indicating good stability, and a polydispersity index (PDI) of 0.228 indicating moderate polydispersity. TEM and EDX analysis also confirmed successful silver nanoparticle formation.

Their biological activity was evaluated to explore potential biomedical applications, particularly in the context of wound healing. Antioxidant activity was assessed using the DPPH assay, with the AgNPs demonstrating a free radical scavenging potential of around 60-65% at concentrations of 6.25 – 200 µg/ml suggesting a capacity to mitigate oxidative stress, a key factor in wound repair. Additionally, preliminary antibacterial efficacy was tested against clinically relevant strains specifically, *Acinetobacter baumannii, Enterococcus faecalis, Pseudomonas aeruginosa* and *Staphylococcus aureus.* The silver nanoparticles showed % toxicity values of > 80% at the highest concentration used which was 200 µg/ml, against all four strains evaluated, indicating strong antibacterial potential.

The dual bioactivities position these green-synthesized AgNPs as promising candidates for wound management applications, where control of oxidative stress and microbial load are critical. Importantly, the use of plant-derived reducing and stabilizing agents supports the development of cost-effective and scalable therapeutic materials. Overall, this work highlights the potential of biogenically synthesized AgNPs as multifunctional agents for biomedical use.

LS-F-51

Investigating the antidiabetic, anti-obesogenic, and antioxidant properties of *Laminaria japonica* extracts

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The global surge in type 2 diabetes mellitus and obesity has prompted the search for sustainable, natural therapeutic alternatives. These metabolic disorders are interconnected through shared mechanisms, including insulin resistance, oxidative stress, chronic inflammation, and hormonal imbalance. Conventional treatments often face limitations such as inflated costs, adverse effects, and reduced long-term efficacy, driving interest in marine-derived natural therapeutics. Brown seaweeds like *Laminaria japonica* are known to be rich in polyphenols, flavonoids, and polysaccharides, known for their antioxidant and metabolic regulatory properties. This study explores the therapeutic potential of solvent-partitioned fractions of *L. japonica* collected from South African coastal regions. Fractions were prepared using methanol, hexane, butanol, dichloromethane (DCM), and ethyl acetate, and evaluated through antioxidant assays including DPPH radical scavenging, nitric oxide inhibition, as well as the determination of total phenolic content (TPC), and total flavonoid content (TFC). Pancreatic lipase inhibition assays were also conducted to assess anti-obesogenic potential. The methanol and ethyl acetate fractions demonstrated the highest antioxidant activity, with DPPH radical scavenging exceeding 80% at 60 µg/mL. Additionally, ethyl acetate showed elevated levels of total phenolic content (TPC) and total flavonoid content (TFC), indicating strong antioxidant potential.

In the pancreatic lipase inhibition assay, methanol and butanol fractions exhibited the most significant activity, with inhibition rates of 78.4% and 74.2%, respectively at 480 µg/mL, and IC_{50} values of 202.5 µg/mL and 218.7 µg/mL, respectively. Hexane and DCM fractions showed moderate inhibition, while ethyl acetate displayed minimal activity.

These findings highlight *Laminaria japonica* as a promising source of natural compounds with potent antioxidant and anti-metabolic syndrome effects. Further ex vivo and in vivo studies in animal models are needed to confirm some of the results of this study.

LS-F-52

Isolation and preliminary characterization of lytic phages infecting an extended-spectrum β-lactamase-producing multidrug-resistant *Escherichia coli*

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Extended-spectrum beta-lactamase (ESBL) producing pathogenic strains of *E. coli* are a health concern. If released into receiving water bodies via wastewater treatment plant effluent or raw sewage, they might put people at risk using such water for domestic, recreational, or irrigation purposes. Lytic bacteriophages (phages) are a promising, environmentally friendly alternative to the traditional chlorination treatment.

Therefore, lytic phages were isolated from wastewater using an extraintestinal pathogenic *Escherichia coli* (ExPEC) strain of sequence type 131 as host, using spot testing and double-layer assays. The appearance and size of plaques formed by the phage isolates were assessed. In addition, the morphology and size of the isolated and purified phages were analysed using Transmission Electron Microscopy (TEM).

A total of three lytic phages were isolated from wastewater samples using the above ESBL *E. coli* strain after enrichment. When using the double-layer assay, all three phages produced a clear zone of lysis after incubation in the presence of the *E. coli* host at 37 °C for 24 hours, with the plaque sizes ranging from 0.7 to 1.7 mm. Transmission electron microscopy revealed that all three purified phages exhibited a "Siphovirus-like" head and tail morphology, indicating that these phage isolates belong to the class *Caudoviricetes*. All three had a hexagonal head of about 40 to 50 nm and a long tail ranging from about 85 to 120 nm. Active phages were recovered after storage in buffer at temperatures between 4 and 25 ˚C. The phage isolates adsorbed efficiently, displayed a short latent period, and caused a visible decrease in optical density of the host culture. All three bacteriophage isolates were highly specific to the host strain and efficiently lysed it at high phage titres.

Even though further characterization of these phages is ongoing, their ability to eliminate a multidrug-resistant pathogenic *E. coli* strain is promising.

LS-F-53

Investigating the effect of combined oxidative stress in Schizosaccharomyces pombe.

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Pathogenic fungi represent an emerging and serious threat to human health, leading the World Health Organisation to release a fungal priority pathogen list in 2022. Significantly, many of these fungi have developed resistance to the four major classes of antifungal drugs and there is an urgent need to develop novel antifungal therapeutic and prophylactic approaches. Redox stressors, such as hypochlorous acid, have long been used as surface disinfectants, and many antifungal drugs trigger oxidative stress as part of their activity mode. This study investigates the sensitivity of the model yeast *Schizosaccharomyces pombe* to the combination stress of hydrogen peroxide and the lipid peroxide analogue tert-butyl hydroperoxide. Preliminary work from our lab has shown that this combination stress exerts a more lethal effect at lower concentrations

than either hydrogen peroxide or tert-butyl hydroperoxide alone, and we will confirm this result using growth curve measurements, spot assays and CFU/ml enumerations. We hypothesise that the combination stress disables the adaptive response in yeast by inhibiting the activation of antioxidant transcriptional programs, which we will test with RT-qPCR and western blotting. This work will also be extended to include the pathogenic *Candida albicans* species. These findings will inform the development of novel antifungal surface disinfectants and provide further insights into the stress tolerance pathways essential for fungal survival.

LS-F-54

Detection of biodiversity in three estuarine lakes located within a marine protected area using eDNA Metagenomics

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Environmental DNA (eDNA) metagenomics has become a powerful tool for monitoring biodiversity across ecosystems, enabling the detection of organisms from microbes to macrofauna without direct sampling. This study used eDNA metagenomics to assess biodiversity in three estuarine lakes namely Kosi Bay, Mgobozeleni, and St Lucia located in the iSimangaliso Wetland Park. To ensure data integrity, strict decontamination protocols were implemented and negative controls were included during field and laboratory work. Three 2 L water samples per site were vacuum filtered through 0.45 µm nylon membranes. DNA was extracted from the membranes using the Qiagen DNeasy Blood and Tissue Kit and extracts were sent to Inqaba biotec for sequencing. Shotgun metagenomic sequencing produced 74,742,675 raw sequences, with 25,588,838 retained after quality filtering. Reads were assembled using MEGAHIT, and taxonomic assignments were performed using DIAMOND BLASTx against the NCBI nr database. MEGAN6 and RStudio were used for data analysis. Taxonomic binning grouped sequences into 39,015 bins with St Lucia contributing 39%, Kosi Bay 36%, and Mgobozeleni 25%. Bacteria dominated across sites, with viruses and eukaryotes present in smaller proportions. Eukaryotic taxa represented 17 phyla, 40 families, and 42 genera. Genus richness was highest in St Lucia (34.3%), followed by Kosi Bay (31.4%) and Mgobozeleni (28.6%). Seven genera were shared across all sites. This study demonstrates the effectiveness of eDNA metagenomics in revealing fine-scale biodiversity patterns and supports its use in long-term monitoring and estuarine conservation.

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