51st SAAB Annual Conference 2026

South African Association of Botanists

"Biodiversity and Resilience for Future Livelihoods and Health"

6 – 10 July 2026

University of Mpumalanga, Mbombela Campus

51st SAAB Conference 2026

"Thriving with Change"

UNIVERSITY OF MPUMALANGA

Creating Opportunities

SAGP SAAB

Welcome Message

Dear Colleagues and Students,

It is with great pleasure that we welcome you to the **51st Annual Conference of the South African Association of Botanists (SAAB)**, hosted by the University of Mpumalanga at its Mbombela Campus.

This gathering brings together botanists, plant scientists, ecologists and related disciplines, and students from across South Africa and beyond to share research, build collaborations, and celebrate the richness of our botanical heritage — particularly the remarkable biodiversity of the Lowveld region.

We look forward to stimulating discussions, inspiring presentations, and memorable experiences in Mpumalanga.

Conference Chair
Prof Ndiko Ludidi
(University of Mpumalanga)

Conference Co-Chair
Dr Terence Suinyuy
(University of Mpumalanga)

SAAB President
Prof Kelsey Glennon
(University of the Witwatersrand)

Host Institution
University of Mpumalanga

Acknowledgements

Local Organizing Committee

Prof Ndiko Ludidi – University of Mpumalanga
Dr Terence Suinyuy – University of Mpumalanga
Dr Salmina Mokgehle – University of Mpumalanga
Dr Arun Gokul – University of Mpumalanga
Dr Ali Ali – University of Mpumalanga
Dr Lee-Ann Niekerk – University of Mpumalanga
Dr Adele Barker – University of Mpumalanga
Dr Tshepiso Ndhlovu – University of Mpumalanga
Prof Mduduzi Ndlovu – University of Mpumalanga
Dr Elizabeth Kola – University of Mpumalanga
Ms Thubelihle Mathonsi – University of Mpumalanga
Ms Thobile Khoza – University of Mpumalanga

SAAB

SAAB Council
SAAB Executive Secretary (Ms Elisabeth Geerts)

Mpumalanga Promotion Events

Ms Jackey Deacon

University of Mpumalanga

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Creating Opportunities

science, technology & innovation

Department:
Science, Technology and Innovation
REPUBLIC OF SOUTH AFRICA

Conference Overview: 6-10 July 2026

Mon 6 Jul	Tue 7 Jul	Wed 8 Jul	Thu 9 Jul	Fri 10 Jul
Arrival Day	**Conference Day 1**	**Conference Day 2**	**Conference Day 3**	**Field Trip Day**
Welcome Function & Registration	Opening Ceremony Plenary & Sessions Poster Session	Plenary & Sessions SAJB Meeting Student Function	Plenary & Sessions SAAB AGM Gala Dinner	Field Trip (Optional)

Day 1 | **Monday, 6 July 2026** — Arrival & Welcome

TIME	EVENT	VENUE
12:00 – 18:00	Delegate Registration	Great Hall Registration Room
14:00 – 17:00	Organising Committee Meeting	Committee Room A
14:00 – 17:00	SAAB Council Meeting	Nature Conservation Building Rm. 116 (Boardroom)
18:00 – 20:00	Welcome Function, Informal Networking, Poster Set-Up	Great Hall Foyer
20:00	Buses Depart to Hotels	Designated Hotels in Mbombela

Note: Registration desk opens from 12:00. Accommodation self-arranged by delegates.

Day 2 | Tuesday, 7 July 2026 — Conference Day 1

TIME	EVENT / SESSION	VENUE
07:30 – 08:40	Registration	Great Hall Foyer Registration Room
08:40– 08:50 08:50 – 09:00	Welcoming Addresses – Deputy-Vice Chancellor: RII (Prof Aldo Stroebel) Welcoming Address – SAAB President (Prof Kelsey Glennon)	Main Auditorium
09:00 – 09:50	**Keynote Address 1: [Prof Ben-Erik Van Wyk]** Historical and scientific perspectives on the development of commercial plant products in South Africa	Main Auditorium
09:50 – 10:50	Tea / Coffee Break & Poster Viewing	Great Hall Foyer
11:00 – 13:00	Concurrent Oral Sessions (Track A: Ecology | Track B: Evolution & Systematics | Track C: Biotechnology and Ethnobotany)	TA: Century Plant (*Boophone disticha*) TB: Calla lily (*Zantedeschia aethiopica*) TC: Candelabra aloe (*Aloe arborescens*)
13:00 – 14:00	Lunch Break	Dining Hall
14:00 – 16:00	Concurrent Oral Sessions (Track A: Physiology | Track B: Ethnobotany and Ecology)	TA: Candelabra aloe (*Aloe arborescens*) TB: Bush lily (*Clivia miniata*)
16:00 – 16:30	Tea / Coffee Break & Poster Viewing	Foyer / Poster Hall
16:30 – 18:00	Concurrent Oral Sessions (Track A: Ethnobotany | Track B: Biotechnology)	TA: Century Plant (*Boophone disticha*) TB: Calla lily (*Zantedeschia aethiopica*)
18:00 – 20:00	Poster Session	Great Hall Foyer

7 July 2026 Conference Day 1

Parallel Session 1								
Ecology **Venue: Century Plant (*Boophone disticha*)** **Chair: Dr. Terence Suinyuy**			**Evolution & Systematics** **Venue: Calla lily (*Zantedeschia aethiopica)*** **Chair: Ms. Thubelihle Mathonsi**			**Plant Biotechnology** **Medicinal Plants & Ethnobotany** **Venue: Candelabra aloe (*Aloe arborescens*)** **Chair: Prof. Ashwil Klein**		
Time	**Speaker**	**Title**	**Time**	**Speaker**	**Title**	**Times**	**Speaker**	**Title**
11:00–11:15	Mr. Vincent Clarke	Plant–microbe interactions in degraded soils: PLFA-based assessment of microbial community structure associated with *Crinum bulbispermum*	11:00–11:15	Prof. Muthama Muasya	Investigating spatial phylogenetic and functional diversity in Africa, with focus on the *Cyperaceae* (Poales)	11:00–11:15	Mr. Thubelihle Khawula **(BYS candidate)** **(Best MSc candidate)**	In silico analysis of wheat infecting *Puccinia spp*. mannanases/mannosidases: towards understanding their functions as pathogenic or effector proteins
11:15-11:30	Ms. Nkhathutsheleni Maureen **(Best PhD candidate)**	Stable and high-yielding chickpea (*Cicer arietinum* L.) genotypes across environments	11:15-11:30	Prof. James Boatwright	A new generic classification for the subfamily Thymelaeoideae (Thymelaeaceae): resolving the polyphyly of *Gnidia*	11:15-11:30	Mr. Khomotso Kekana **(Best MSc candidate)**	Effects of Aloe vera formulations as natural seed priming agents on tomato seed germination and seedling vigour.
11:30–11:45	Mr. Kabo Sebaetse **(BYS candidate)** **(Best PhD candidate)**	Climate warming may disrupt plant-insect phenological synchrony	11:30–11:45	Ms. Prudance Seroka **(Best MSc candidate)**	Investigating the phylogenetic relationship, genetic diversity, and secondary metabolites of *Cleome gynandra*	11:30–11:45	Ms. Precious Magwele **(BYS candidate)**	Characterization of Fibre Length Parameters in Bast and Hurd Fibres of Localized Hemp Strains for Industrial Applications.

Parallel Session 1								
Ecology **Venue: Century Plant (*Boophone disticha*)** **Chair: Dr. Terence Suinyuy**			**Evolution & Systematics** **Venue: Calla lily (*Zantedeschia aethiopica)*** **Chair: Ms. Thubelihle Mathonsi**			**Plant Biotechnology** **Medicinal Plants & Ethnobotany** **Venue: Candelabra aloe (*Aloe arborescens*)** **Chair: Prof. Ashwil Klein**		
					L.(Cleomaceae) haplotypes in South Africa.			
11:45–12:00	Mr. Lesibana Sedibana **(BYS candidate) Best PhD candidate)**	Extending island biogeography theory to urban systems: city area drives global patterns of alien species richness	11:45–12:00	Mr. Pikolomzi Kapa **(Best MSc candidate)**	Disentangling Gnidia: Systematics of the Epichroxantha group (Thymelaeiodeae, Thymelaeaceae)	11:45–12:00	Rev. Tshegofatso Thopola **(Best PhD candidate)**	Comparative Evaluation of Cold-Pressed Oil Yield Potential of Five Moringa oleifera Cultivars from Various Regions, Cultivated in South Africa for Industrial Applications
12:00–12:15	Dr. Shandry Tebele **(BYS candidate)**	Spatial variation of *Pinus sylvestris* mycobiome across root regions	12:00–12:15	Ms. Khanyisile Shabangu **(Best PhD candidate)**	Towards a Revised Infrageneric Classification of Lasiosiphon Based on Phylogenetic and Morphological Evidence	12:00–12:15	Ms. Mmakoma Letsoalo **(Best PhD)**	In Vitro α-Glucosidase inhibitory activity and metabolomic profiling of five indigenous leafy vegetables used as food as medicine in Ga-Molepo, Limpopo province.
12:15–12:30	Dr. Mmatladi Tesia Mataboge	Genetic diversity of native rhizobia isolates nodulating soybean in uncultivated virgin soils of Ghana	12:15–12:30	Prof. Kevin Balkwill	Revision of Dyschoriste (Acanthaceae) in South Africa	12:15–12:30	Ms. Faith Mnisi **(Best PhD)**	Effects of Alternaria leaf spot (*Alternaria alternata*) on growth, yield, and phytochemical profile of *Moringa oleifera.*
12:30-12:45	Dr Anatoliy Levanets	Nomenclatural no tes on desmids (*Desmidiaceae*, Charophyta) described	12:30-12:45	Ms. Lebogang Mokwatsi **(BYS candidate)**	A hairy business: unexpected morphological variation blurs species	12:30-12:45	Dr. Mokgaetji Mokganya	Integrating Nutrition and Medicine: Documentation of Food Plants in Disease Management within the

Parallel Session 1								
Ecology **Venue: Century Plant (*Boophone disticha*)** **Chair: Dr. Terence Suinyuy**			**Evolution & Systematics** **Venue: Calla lily (*Zantedeschia aethiopica)*** **Chair: Ms. Thubelihle Mathonsi**			**Plant Biotechnology** **Medicinal Plants & Ethnobotany** **Venue: Candelabra aloe (*Aloe arborescens*)** **Chair: Prof. Ashwil Klein**		
		by Paul van Oye from the former Belgian Congo in the mid-20th century		**(Best MSc candidate)**	boundaries in two *Thesium species* (Santalaceae)			Indian community of Thulamela Municipality
12:45-13:00	Ms. Anika Botha **(BYS candidate) (Best MSc candidate)**	Surviving The Chill: Grass-Forb Interactions Through a Dry, Cold Season	12:45-13:00	Prof. Dave Berger	The "promiscuous" *Greyia* (bottlebrush) genus – evaluating post-zygotic barriers between the three species	12:45-13:00	Prof. Ashwell Ndhlala	Commercialization of African Natural Products and Indigenous Knowledge Systems: A Fair Story versus a Fairy Tale

Parallel Session 2					
Physiology **Venue: Candelabra aloe (*Aloe arborescens*)** **Chair: Dr. Adele Barker-Ali**			**Medicinal Plants & Ethnobotany** **Ecology** **Venue: Bush lily (*Clivia miniata*)** **Chair: Dr. Ryan Rattray**		
Time	**Speaker**	**Title**	**Time**	**Speaker**	**Title**
14:00–14:15	Prof. Samson Chimphango	Growing while defending in abiotic stress-tolerant chickpea (*Cicer arietinum* L.; Fabaceae) genotypes	14:00–14:15	Ms. Ndzalama Shikwambana **(Best MSc candidate)**	Metabolite and nutritional profile of plants used in ethnoveterinary medicine
14:15-14:30	Dr. Nqobile Motsomane **(BYS candidate)**	*Eragrostis curvula*: Friend or Foe? Balancing benefits and ecological risks	14:15-14:30	Ms. Takalani Nenungwi **(Best PhD candidate)**	Assessing Geographical Variation in Metabolomic and Molecular Traits of *Sutherlandia frutescens* From Different Populations
14:30–14:45	Prof. Anathi Magadlela	Salt-tolerant *Canavalia Rosea,* a sustainable solution for soil sodicity in irrigated sugarcane plantations	14:30–14:45	Ms. Xoliswa Bawa **(Best MSc candidate)**	Utilization of botanicals for livestock management in Eastern Cape Province: A review
14:45–15:00	Ms. Thandeka Khuzwayo **(Best MSc candidate)**	A combination of light and moderate heat stress can enhance non-photochemical quenching in Afromontane lichens	14:45–15:00	Mr. Bahati Kandolo **(Best PhD candidate)**	Climate-Driven Shifts in Flowering Phenology Across the Congo Basin: Evidence from Historical Records
15:00–15:15	Mr. Sergio da Silva **(BYS candidate)** **(Best MSc candidate)**	Stomatal-photosynthetic coordination and rhizosphere metabolic diversity during progressive drought and early recovery in soybean	15:00–15:15	Ms. Fortunate Mathebula **(Best MSc candidate)**	Assessing leaf litter decomposition rates of *Encephalartos lanatus* under varying invertebrate access conditions.
15:15–15:30	Mrs. Mpaballeng Ramangoele	Evaluation of Seed Germinability and Seedlings Performance in Amaranthus	15:15–15:30	Mr. De Wet Meyer **(Best MSc candidate)**	Preliminary insights: The effects of fire and frost on community-weighted

Parallel Session 2					
Physiology **Venue: Candelabra aloe (*Aloe arborescens*)** **Chair: Dr. Adele Barker-Ali**			**Medicinal Plants & Ethnobotany** **Ecology** **Venue: Bush lily (*Clivia miniata*)** **Chair: Dr. Ryan Rattray**		
Time	**Speaker**	**Title**	**Time**	**Speaker**	**Title**
		Accessions Collected in the Eastern Cape, South Africa			genome size in tropical grassy biomes within South Africa
15:30-15:45	Ms. Maria Rampedi **(Best Honours candidate)**	Effects of different concentrations of Kelpak biostimulant on the growth and yield of Swiss chard (*Beta vulgaris* L. var. cicla) cv. Fordhook Giant under greenhouse conditions	15:30-15:45	Ms. Tebogo Mocheki	The Response of *Populus Alba* L. to Multiple Disturbances in the Nylsvley Nature Reserve, Limpopo, South Africa.
15:45-16:00	Ms. Karla Steyn **(BYS candidate)** **(Best MSc candidate)**	Turn up the heat: *Aspalathus linearis* (Burm.f.) R. Dahlgren (rooibos) shift metabolism in response to heat shock.	15:45-16:00	Ms. Vrishthi Rambaran **(Best PhD candidate)**	The impact of aminochitosan on the rhizosphere

Parallel Session 3					
Medicinal Plants & Ethnobotany **Venue: Century Plant (*Boophone disticha*)** **Chair: Prof. Nqobile Masondo**			**Plant Biotechnology** **Venue: Calla lily (*Zantedeschia aethiopica)*** **Chair: Prof. Keyster**		
Time	**Speaker**	**Title**	**Time**	**Speaker**	**Title**
16:30-16:45	Ms. Nobuhle Buthelezi **(Best MSc candidate)**	Ethnomedicinal plants for *candida* infection treatment in South Africa: evidence from a systematic review	16:30-16:45	Mr. Unathi Dladla **(BYS candidate)**	Physiological & Metabolomic effect of foliar application of Ecklonia maxima-derived biostimulant on Tomato plants in ameliorating the effects of heat shock
16:45-17:00	Ms. Palesa Mohlopi **(Best Honours candidate)**	Phylogeny, biomes and space jointly structure plant-use diversity across Eurasia.	16:45-17:00	Mr. Enriquay Smith **(BYS candidate)**	*Pantoea eucrina* as a sustainable biological alternative against *Alternaria alternata*
17:00–17:15	Ms Seolebaleng Khosana,	The phytochemical profile and biological activities of *Aloe arborescens* whole fruits	17:00–17:15	Mr. Khothatso Lebesana **(Best MSc candidate)**	Redox Modulation by Ascorbic Acid Under Salinity Stress in *Marchantia polymorpha*
17:15–17:30	Dr. Sihle Ngxabi **(Best PhD candidate)**	Metabolite profiling, cytotoxicity, liver ROS detoxifiers and acetylcholinesterase inhibitors from *Trachyandra ciliata* L.F. (Kunth) (wild cabbage)	17:15–17:30	Dr. Avela Sogoni	Halophytic extract priming as a promising strategy for optimising yield quality and mitigating salinity stress in lettuce
17:30–17:45	Dr. Nana Buthelezi	Abscisic acid enriched with cancer bush leaf extract enhanced the yield, essential oil and bioactive compounds of oregano under heat stress	17:30–17:45	Dr. Llewelyn van der Pas	*Eragrostis nindensis*: the African lovegrass worth loving
17:45–18:00	Mr K. Mabija	A comparison of the phytochemical profiles, antioxidant, and antimicrobial activities of field-grown and *in vitro*-grown *Gymnanthemum amygdalinum* Delile (Asteraceae)	17:45–18:00	Prof. Saheed Sabiu	Integrated computational bioprospection for

Parallel Session 3					
Medicinal Plants & Ethnobotany **Venue: Century Plant (*Boophone disticha*)** **Chair: Prof. Nqobile Masondo**			**Plant Biotechnology** **Venue: Calla lily (*Zantedeschia aethiopica)*** **Chair: Prof. Keyster**		
Time	**Speaker**	**Title**	**Time**	**Speaker**	**Title**
					active pharmaceutical ingredients from South African medicinal plants

Day 3 | Wednesday, 8 July 2026 — Conference Day 2

TIME	EVENT / SESSION	VENUE
08:00 – 09:00	Registration	Great Hall Registration Room
09:00 – 09:50	**Keynote Address 2: [Prof Mounawer Badri]** Enhancing forage crop resilience to climate change: integrating genetic resources, phenomics and multi-omics approaches	Main Auditorium
09:50 – 10:40	**Keynote Address 3: [Prof Nokwanda Makunga]** Molecular insights into plant stress regulation: case studies from SA medicinal plants	Main Auditorium
10:30 – 11:00	Tea / Coffee Break & Poster Viewing	Foyer / Poster Hall
11:00 – 11:45	**Plenary Speaker: Ms. Jana Botes** White-flowering *Greyia radlkoferi* mutant reveals functionally important second-coordination sphere histidine residue in leucoanthocyanidin dioxygenase	Main Auditorium
11:45 – 13:00	Concurrent Oral Sessions (Track A: Invasion Biology and Ecology | Track B: Ethnobotany | Track C: Physiology)	TA: Century Plant (*Boophone disticha*) TB: Calla lily (*Zantedeschia aethiopica*) TC: Candelabra aloe (*Aloe arborescens*)
13:00 – 14:00	Lunch Break SAJB meeting	Great Hall Veranda Seminar Room (Nature Conservation Building)
14:00 – 16:00	Concurrent Oral Sessions (Track A: Biotechnology and Pollination| Track B: Ethnobotany and Physiology)	TA: Candelabra aloe (*Aloe arborescens*) TB: Bush lily (*Clivia miniata*)
16:00 – 17:00	Tea / Coffee Break & Poster Viewing	Foyer / Poster Hall
17:00 – 20:00	Student Function (optional)	Great Hall Veranda

8 July 2026 Conference Day 2

Parallel Session 4								
Invasive Plant Biology Ecology **Venue: Century Plant (*Boophone disticha*)** **Chair: Dr. Lee-Ann Niekerk**			**Medicinal Plant & Ethnobotany** **Venue: Calla lily (*Zantedeschia aethiopica)*** **Chair: Prof. Nomali Ngobese**			**Physiology** **Venue: Candelabra aloe (*Aloe arborescens*)** **Chair: Prof. Anathi Magadlela**		
Time	**Speaker**	**Title**	**Time**	**Speaker**	**Title**	**Time**	**Speaker**	**Title**
11:45-12:00	Mr. Tlhandlukani Ndlovu	Assessing the distribution of Lagerstroemia indica in Northeastern South Africa: Limpopo and Mpumalanga provinces	11:45-12:00	Ms. Sinorita Chauke **(Best PhD candidate)**	Ethnobotanical Diversity and Use of Medicinal Plants for Childhood Diarrhoea in Sub-Saharan Africa	11:45-12:00	Mr. Alfred Ntjabane **(Best MSc candidate)**	Integrated enzymatic and proteomic analysis reveals a coordinated deployment of carbohydrate-active enzymes involved in cell wall degradation and nutrient acquisition during wheat–Puccinia triticina interactions
12:00-12:15	Dr. Claude Moshobane	Impacts of alien invasive plants on aquatic macroinvertebrates in South Africa: With emphasis on Iris pseudacorus	12:00-12:15	Ms. Umphambili Simamane **(Best MSc candidate)**	From biodiversity to brain health: NF-κB modulation by *Mentha longifolia* L. and *Leonotis leonurus* in neuroinflammation	12:00-12:15	Mr. Gift Thoka **(Best MSc candidate)**	Characterizing the antioxidant potential of indigenous leafy vegetables with medicinal significance in Ga-molepo, Limpopo Province

Parallel Session 4								
Invasive Plant Biology Ecology **Venue: Century Plant (*Boophone disticha*)** **Chair: Dr. Lee-Ann Niekerk**			**Medicinal Plant & Ethnobotany** **Venue: Calla lily (*Zantedeschia aethiopica)*** **Chair: Prof. Nomali Ngobese**			**Physiology** **Venue: Candelabra aloe (*Aloe arborescens*)** **Chair: Prof. Anathi Magadlela**		
12:15-12:30	Mrs. Annika Theron **(Best PhD candidate)**	Do nutrient-poor soils filter out large genome sizes?	12:15-12:30	Ms. Caroline Mooki	Metabolomic profiling of *Mentha longifolia* L. in healthy Sprague-Dawley Rats as evidence of its neuroprotective and neuromodulatory potential	12:15-12:30	Ms. Mokgadi Sethole **(Best MSc candidate)**	Effect of the application of Moringa-leaf extract on the growth and yield of Bambara groundnut
12:30-12:45	Mr. Kyle van Wyk **(BYS candidate) (Best MSc)**	Dietary strategies of savanna herbivores: a comparative metabarcoding analysis of elephants and impalas	12:30-12:45	Mr. Ntsikelelo Lester **(Best PhD candidate)**	What's cooking underground?: An ethnobotanical appraisal of African potato *(Hypoxis hemerocallidea*) and Devil's claw (*Harpagophytum procumbens*)	12:30-12:45	Ms. Mapula Nkosinkulu **(Best Honours candidate)**	Evaluation of unimproved local cowpea landraces for qualitative and quantitative characters in Capricorn district, Mankweng
12:45-13:00	Dr. João Silva	Parent soil mediates spatiotemporal nutrient enrichment and plant community structure following elephant megacarcass decomposition in an African savanna.	12:45-13:00	Ms. Keloabetswe Mokgau **(Best MSc candidate)**	Ethnobotanical uses of wild edible plants and their multi-functional roles in rural communities within Dr Ruth Segomotsi Mompati District, South Africa	12:45-13:00	Ms. Charmaine Nyathi **(BYS candidate) (Best Honours candidate)**	Effects of different concentrations of Moringa-based biostimulants on the growth and yield of Swiss chard (*Beta vulgaris* L. Var. Fordhook giant) under greenhouse conditions

Parallel Session 5					
Plant Biotechnology Pollination Biology Venue: Candelabra aloe (*Aloe arborescens*) Chair: Dr. Ali Ali			**Medicinal Plants & Ethnobotany Physiology Venue: Bush lily (*Clivia miniata*) Chair: Prof. John Asong**		
Time	**Speaker**	**Title**	**Time**	**Speaker**	**Title**
14:00–14:15	Ms. Chelsey Smith **(Best MSc candidate)**	Exploring the Role of Methylglyoxal in *Marchantia polymorpha* under Cadmium Stress	14:00–14:15	Mr. Akshay Raghoonanadan **(BYS candidate)** **(Best PhD candidate)**	The Chemistry of the Cape: Antifungal Insights from Pelargoniums
14:15-114:30	Mrs. Palesa Lebenya **(Best PhD candidate)**	Developing bacterial biofertilizers for improving common bean tolerance to manganese toxicity	14:15-114:30	Mrs. Sibulele Fili **(BYS candidate)** **(Best MSc candidate)**	Medicinal ethnobotany of the Bizana, Flagstaff and Lusikisiki areas of Eastern Pondoland, South Africa
14:30–14:45	Mr. Lungelo Masondo **(BYS candidate)** **(Best MSc candidate)**	From Single Isolates to *Synthetic Consortia*: Enhancing Biocontrol of *Macrophomina phaseolina* in *Phaseolus vulgaris* L.	14:30–14:45	Mrs. Erika Oberholzer (**Best PhD candidate)**	Profiling of salicylates in edible *Viola cornuta* and Viola × wittrockiana flowers in relation to EU novel food exposure assessment
14:45–15:00	Ms. Ntebogeng Choma **(BYS candidate)** **(Best MSc candidate)**	Antifungal efficacy of Moringa oleifera leaf extract against *Alternaria alternata*	14:45–15:00	Ms. Tumelo Matlou **(BYS candidate)** **(Best MSc candidate)**	Nutritional and functional evaluation of underutilised, wild-type *Corchorus olitorius* L. fruits from Limpopo: implications for dietary diversity and food safety
15:00–15:15	Ms. Kacey Hattingh	The identification of potential fungal biocontrol agents against *Fusarium oxysporum* f. sp. phaseoli infection in Phaseolus vulgaris	15:00–15:15	Dr. Dashnie Naidoo-Maharaj	From Plant to Product: Advancing Inclusive Innovation and Botanical Value Chains in South Africa
15:15–15:30	Ms. Tebogo Masetlana **(BYS candidate)** **Best MSc candidate)**	Host-specific effects of fynbos soil microbiota on drought tolerance and secondary	15:15–15:30	Prof. Annah Moteetee	Insecticidal activity of compounds isolated from *Cassytha ciliolata*

Parallel Session 5					
Plant Biotechnology Pollination Biology Venue: Candelabra aloe (*Aloe arborescens*) Chair: Dr. Ali Ali			**Medicinal Plants & Ethnobotany Physiology Venue: Bush lily (*Clivia miniata*) Chair: Prof. John Asong**		
Time	**Speaker**	**Title**	**Time**	**Speaker**	**Title**
		metabolism in *Lessertia frutescens* and *Glycine max*			Nees (Lauraceae) against *Spodoptera frugiperda* (Lepidoptera: Noctuidae)
15:30-15:45	Mr. Darin Holman **(BYS candidate) (Best PhD candidate)**	Evaluation of marine bacterial isolates for alleviation of vanadium stress in *Brassica napus*	15:30-15:45	Dr. Robert Skelton	Hydraulic safety margins in diverse South African plant communities
15:45-16:00	Prof. Sjirk Geerts	An experimental assessment of sterility in cultivars of the invasive ornamental plant *Duranta erecta*	15:45-16:00	Prof. Mack Moyo	Responses to low soil moisture provide insights into vulnerability of common ornamental plant species

Day 4 | Thursday, 9 July 2026 — Conference Day 3

TIME	EVENT / SESSION	VENUE
09:00 – 09:50	**Keynote Address 4: [Dr Paul Hills]** Biostimulants: Redefining growth, regulating for resilience	Main Auditorium
09:50 – 10:50	SAAB AGM	Main Auditorium
10:50 – 11:20	Tea / Coffee Break & Poster Removal	Great Hall Foyer
11:20 – 13:00	Concurrent Oral Sessions (Track A: Ethnobotany| Track B: Ethnobotany)	TA: Candelabra aloe (*Aloe arborescens*) TB: Bush lily (*Clivia miniata*)
13:00 – 14:00	Lunch Break	Great Hall Veranda
14:00 – 15:00	Concurrent Oral Sessions (Track A: Biotechnology| Track B: Natural Resource Management & Conservation)	TA: Century Plant (*Boophone disticha*) TB: Calla lily (*Zantedeschia aethiopica*)
15:00-15:45	Concurrent Oral Sessions (Track A: Invasion Biology and Ecology | Track B: Ethnobotany | Track C: Physiology)	TA: Century Plant (*Boophone disticha*) TB: Calla lily (*Zantedeschia aethiopica*) TC: Candelabra aloe (*Aloe arborescens*)
15:45	Departure to Hotels	Designated Hotels
17:30	Hotel Transport to Great Hall	Designated Hotels
18:30 – 21:30	**GALA DINNER, AWARDS AND ANNOUNCEMENTS**	**Great Hall Foyer**

9 July 2026 Conference Day 3

Parallel Session 6					
Medicinal Plants & Ethnobotany Venue: Candelabra aloe (*Aloe arborescens*) Chair: Dr. Tshepiso Ndhlovu			**Medicinal Plants & Ethnobotany Venue: Bush lily (*Clivia miniata*) Chair: Dr. Salmina Mokgehle**		
Time	**Speaker**	**Title**	**Time**	**Speaker**	**Title**
11:20-11:35	Ms. Hlengiwe Khumalo **(Best MSc candidate)**	Botanical pathways to wellness: traditional uses, phytochemistry, and health-promoting properties of wild edible plants	11:20-11:35	Ms. Peninah Mulaudzi **(Best PhD candidate)**	Harnessing indigenous plants for sustainable crop production in South Africa: A review of *Lippia javanica* and *Aloe ferox* in crop production systems
11:35-11:50	Ms. Thembeni Khumalo **(Best PhD candidate)**	Medicinal plants as an alternative to postharvest chemical treatments in tomato pest and disease management: A systematic review covering 2000 to 2026	11:35-11:50	Ms. Mathabe Maake **(Best MSc candidate)**	Roots of knowledge, seeds of opportunity: ethnobotany and economic perspective of wild edible plants in Limpopo province
11:50-12:05	Mr. Siyonela Quvile **(BYS candidate) Best MSc candidate)**	Chemical diversity of genus *Oftia* (Scrophulariaceae)	11:50-12:05	Ms. Andiswa Motshele **(Best MSc candidate)**	Assessing the Economic Viability of Medicinal Plant Cultivation ThrOptimized Nitrogen Fertilization: A Literature-Based Analysis
12:05-12:20	Mr. Thato Moloi **(BYS candidate) (Best PhD candidate)**	The traditional uses and chemistry of annual *Oncosiphon* species (Asteraceae)	12:05-12:20	Dr. Bernard Mabotja	Antioxidant and antimicrobial activities of in vitro regenerated *Thymus vulgaris*
12:20-12:35	Dr. Christelda Mkhonto **(BYS candidate)**	Nutritional and Phytochemical Composition of Leaves and Nuts of *Mimusops zeyheri*	12:20-12:35	Dr. Ryan Rattray	Chemical diversity in the genus *Diosma* (Rutaceae)

Parallel Session 6					
Medicinal Plants & Ethnobotany **Venue: Candelabra aloe (*Aloe arborescens*)** **Chair: Dr. Tshepiso Ndhlovu**			**Medicinal Plants & Ethnobotany** **Venue: Bush lily (*Clivia miniata*)** **Chair: Dr. Salmina Mokgehle**		
Time	**Speaker**	**Title**	**Time**	**Speaker**	**Title**
		Across Two Agro-Ecological Zones in South Africa			
12:35-12:50	Prof. John Asong	Antimicrobial and phytochemical evaluation of *Bulbine abyssinica* A. Rich used for managing skin diseases by indigenous health practitioners in the North West Province of South Africa	12:35-12:50	Prof. Nqobile Masondo	Bioactive phytochemicals and antioxidant activities of selected medicinal plants used in ethnoveterinary practices

Parallel Session 7					
Plant Biotechnology **Venue: Century Plant (*Boophone disticha*)** **Chair: Dr. Arun Gokul**			**Natural Resource Management & Conservation** **Venue: Calla lily (*Zantedeschia aethiopica)*** **Chair: Dr. Elizabeth Kola**		
Time	**Speaker**	**Title**	**Time**	**Speaker**	**Title**
14:00-14:15	Mr. Liyabona Mula **(Best MSc candidate)**	Metabolic Responses Associated with *Rhizobacteria*-Mediated Salinity Tolerance in Wheat Seedlings	14:00-14:15	Ms. Balbine Alindekon **(Best MSc candidate)**	Urban vegetation mediates thermal environments and human well-being across Africa
14:15-14:30	Dr. Lee-Ann Niekerk	Seed-Associated Microbiomes Enhance Soybean Tolerance to Salinity Stress	14:15-14:30	Prof. Dave Thompson	Recovery of herbaceous diversity and community structure following targeted clearing of invasive bracken in a critically endangered Woodbush Granite grassland
14:30-14:45	Dr. Mbukeni Nkomo	The physiological and biochemical impact on maize seedlings exposed to *Fusarium* sp. and drought stress combinations.	14:30-14:45	Prof. Nomali Ngobese	Climate-Smart Pasta Innovations: Advancing Sustainable Food Systems in developing countries: a case of KwaZulu-Natal, South Africa
14:45-15:00	Prof. Marshall Keyster	*Bacillus firmus* CP5 from *Echium plantagineum* roots confer Antimony stress tolerance in Brassica napus	14:45-15:00	Prof. Sipho Maseko	Aspect-induced variation in concentration of nutrient elements in leaves and shoots of *litiya lesiganga* (*Senecio inornatus* DC.) tea harvested from the Lubhedze Mountain, Mpumalanga Province, South Africa

Parallel Session 8								
Invasive Plant Biology Ecology **Venue: Century Plant (*Boophone disticha*)** **Chair: Dr. Lee-Ann Niekerk**			**Medicinal Plant & Ethnobotany** **Venue: Calla lily (*Zantedeschia aethiopica)*** **Chair: Prof. Nomali Ngobese**			**Physiology** **Venue: Candelabra aloe (*Aloe arborescens*)** **Chair: Prof. Anathi Magadlela**		
Time	**Speaker**	**Title**	**Time**	**Speaker**	**Title**	**Time**	**Speaker**	**Title**
15:00-15:15	Dr. Nanette van Staden	Hierarchical filtering shapes woody communities of Griqualand West	15:00-15:15	Mr. Neo Bebeile **(BYS candidate) Best PhD candidate)**	Assessing the phytochemical profile and bioactive activities of the Southern African *Cyperus laevigatus*	15:00-15:15	Mr. Tummy Mashakeni **(Best MSc candidate)**	Effects of Phytostim® biostimulant forlia application on the growth and yield attributes of cowpea (*Vigna unguiculata* L. Walp)
15:15-15:30	Dr. Sutapa Adhikari	Ornamental plants: Pollution interception and implications for sustainable urbanism in southern Africa	15:15-15:30	Dr. Luambo Ramarumo	Plants Utilization for Making Edible Carbonate Salts in the Vhembe Biosphere Reserve, South Africa	15:15-15:30	Mr. Tyson Mokgalabone (Best PhD candidate)	From fruit to absorption: Integrative metabolomics and in vitro digestion model for assessing intraspecific diversity and nutrient bio-accessibility in *Strychnos spinosa* Lam. fruit accessions
			15:30-15:45	Dr. Mapula Rawinani	Investigating the Anti-Inflammatory and Regenerative Effects of Pterocarpus angolensis Extracts: Implications for Type 1 Diabetes Mellitus-Associated Wound Healing			

Day 5 | **Friday, 10 July 2026** — Field Trip Day

TIME	ACTIVITY	NOTES
06:30 – 07:30	Breakfast / Departure Preparation	Hotel / Accommodation
07:30	Bus Departure to Field Kruger National Park	Designated Hotels
09:45	Bus Departure to Lowveld Botanical Gardens	Designated Hotels
10:00 – 11:30	Lowveld Botanical Gardens Guided Tour	Lowveld Botanical Gardens
11:30	Own Leisure and Departure from Lowveld Botanical Garden	Own Arrangements
16:00 – 17:30	Return Journey to Mbombela Hotels	Bus
17:30 onwards	Delegate Departures	Own arrangements

Field trip participation is optional. Advance registration required. Appropriate footwear and sun protection recommended.

Keynote Speakers & Awards

Keynote Speakers

Keynote 1 — Tue 7 Jul
[Prof Ben-Erik Van Wyk] | [University of Johannesburg, South Africa]
[Historical and scientific perspectives on the development of commercial plant products in South Africa]

Keynote 2 — Wed 8 Jul
[Prof Nokwanda Makunga] | [Stellenbosch University, South Africa]
[Molecular insights into plant stress regulation: case studies from SA medicinal plants]

Keynote 3 — Wed 8 Jul
[Prof Mounawer Badri] | [Centre of Biotechnology of Borj Cedria, Tunisia]
[Enhancing forage crop resilience to climate change: integrating genetic resources, phenomics and multi-omics approaches]

Keynote 4 — Thu 9 Jul
[Dr Paul Hills] | [Kelp Products (Pty) Ltd, South Africa]
[Biostimulants: Redefining growth, regulating for resilience]

Student Awards

Best Oral Presentation
(MSc/Honours Category)

Best Oral Presentation
(MSc/Honours Category)

Best Oral Presentation
(PhD Category)

Best Poster Presentation
(Per Category)

SAAB Young Botanist
Award

Practical Information

Venue
University of Mpumalanga, Mbombela Campus
Mbombela (Nelspruit), Mpumalanga, South Africa

Registration
Registration: Closed (deadline was 31 May 2026)
Full Delegate | Student (includes SAAB membership)
Contact: [registration@saab2026.ac.za]

Accommodation
Delegates arrange their own accommodation. A list of nearby accommodation options is available on the SAAB website.

Abstract Submission
Submissions: Closed (deadline was 15 May 2026)
Oral and Poster presentations accepted.
See the SAAB conference website for details.

Getting There
Nearest airport: Kruger Mpumalanga International Airport (MQP).
Transfer arrangements available via conference website.

Conference Website
Full programme, abstract submission, accommodation:
https://sabotanyblog.wordpress.com

PLENARY SPEAKERS

BIOGRAPHY: PROF. BEN-ERIK VAN

Ben-Erik Van Wyk was appointed in the **Department of Botany and Plant Biotechnology at the University of Johannesburg** in 1985 and was promoted to full professor in 1990. He has supervised 33 MSc and 26 PhD student projects at UJ and has been a visiting professor in Mexico since 2014. As a plant taxonomist with a research interest in ethnobotany and economic botany, he has authored more than 400 scientific papers, 25 books, 30 taxonomic revisions, and more than 80 new plant species. He is best known for his international full-colour reference books on useful plants, co-produced by leading international publishers and translated into several languages. These include global reviews of Medicinal Plants, Food Plants, Herbs and Spices, Mind-altering and Poisonous Plants, Phytomedicines, Cut Flowers and Garden Succulents.

In 2013, he was awarded the **NRF/SARChI National Research Chair in Indigenous Plant Use** (renewed twice, until 2027) to focus on ethnobotanical research. He was a recipient of the SAAB Gold Medal (2015), the M.T. Steyn Award for Natural Sciences and Technology (2020), and the Lifetime Award (all sciences, the "Science Oscars of South Africa") from the National Science and Technology Forum (2024). He is an editorial member of the South African Journal of Botany (Elsevier) and Subeditor-in-Chief of Diversity (MDPI), and regularly reviews manuscripts, theses, and grant applications. He served on various NRF committees, contributed to the research and development of natural products, and government policy. Organized conferences include three international conferences and 27 annual conferences of the Indigenous Plant Use Forum since 1996.

ABSTRACT

Historical and scientific perspectives on the development of commercial plant products in South Africa

Prof Ben-Erik Van Wyk[1]

[1]*South African Research Chair in Indigenous Plant Use, Department of Botany and Plant Biotechnology, University of Johannesburg, South Africa*

The rich South African flora with its high level of endemism represents a precious asset with tremendous potential for new product development. Progress towards maximizing the potential commercial benefits of innovative new products has been remarkably slow, but

research and development have gained considerable momentum in recent years. The aim of this review is to provide new insights into historical and contemporary publications and events that have contributed to the progress of new product development. Commercialization requires traditional wisdom and scientific data to inform and guide the intricate steps that are necessary for marketing success. These include accurate information on the taxonomy and identification of target species, population-level morphological, chemical and genetic diversity, relevant ethnobotanical data, potential safety, sustainable sourcing and a market-driven approach. Several well-known indigenous South African plant species have already been commercialized (with variable levels of success), as medicinal, cosmetic or food products. These include *Adansonia digitata*, *Agathosma betulina*, *Aizoon africanum*, *Aloe ferox*, *Aponogeton distachyos*, *Artemisia afra*, *Aspalathus linearis*, *Athrixia phylicoides*, *Bulbine frutescens*, *Carpobrotus edulis*, *Centella asiatica*, *Citrullus lanatus*, *Cucumis metuliferus*, *Cyclopia genistoides, Eriocephalus punctulatus*, *Harpagophytum procumbens*, *Helichrysum odoratissimum*, *Hoodia gordonii*, *Hypoxis hemerocallidea*, *Lessertia frutescens*, *Lippia javanica*, *Mesembryanthemum crystallinum, Mesembryanthemum tortuosum, Pelargonium graveolens, Pelargonium sidoides, Pennisetum glaucum, Sclerocarya birrea, Siphonochilus aethiopicus, Sorghum bicolor, Trichilia emetica, Vigna subterranea, Vigna unguiculata, Warburgia salutaris* and *Xysmalobium undulatum.* There are, however, numerous other species that may be considered for new product development as natural products. Indigenous examples will be provided in several categories of use, including fruits, vegetables, beverages, medicines, perfumes, cosmetics, repellents, and dyes and tans. This review of publications and historical developments supports the notion that many species with commercial potential has not yet been developed to any extent. It also shows that there is considerable scope for expanding the market share of successful products.

BIOGRAPHY: DR PAUL HILLS

Paul Hills is the **Head of Research, Development and Innovation** at Kelpak, where he is involved in advancing the development and application of plant biostimulant technologies. He retains an **Extraordinary Research Fellowship** in the **Institute for Plant Breeding and Biotechnology** at **Stellenbosch University**, where he previously held an academic position between 2008 and 2025, with extensive **undergraduate and Honours level teaching experience** in Plant Biotechnology and Genetics. His university research program focused on **plant molecular physiology**, investigating **plant growth-promoting substances** associated with plant rhizosphere symbionts, as well as **plant biostimulants**, with a particular emphasis on understanding their effects on plant physiology and their **modes of action**. His work bridges fundamental plant science and applied agricultural innovation.

He has also contributed to the broader plant science community through his service as **Treasurer** and *ex officio* Council member (2011-2016) and later **President** of the **South African Association of Botanists (**2017-2018). In addition, he served on the **editorial board** of the ***South African Journal of Botany***, including acting as the Overseeing Editor for the Special Edition "The Role of Melatonin in the Regulation of Abiotic Stress in Plants" (2023), from 2009 until leaving academia in 2025. He also sits on the Technical Reference Committee for the Stellenbosch University Botanical gardens.

ABSTRACT

Biostimulants: Redefining growth, regulating for resilience

PN Hills[1, 2] and L Greyling[3]

[1]*Kelp Products (Pty) Ltd, 2 Link Road, Capricorn Business Park, Muizenberg, 7945*

[2]*Institute for Plant Breeding and Biotechnology, Department of Genetics, Stellenbosch University, Private Bag X1, Stellenbosch 7599*

[3]*Kelp Products International (Pty) Ltd, 2 Link Road, Capricorn Business Park, Muizenberg, 7945*

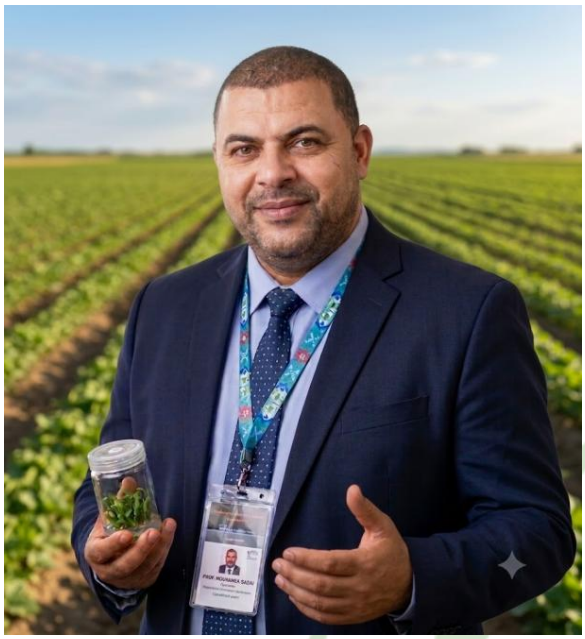
Biostimulants have long occupied an ambiguous position within agricultural science, characterized by substantial agricultural use but limited integration into mainstream scientific frameworks. Although a growing body of research has demonstrated their potential to enhance plant growth and stress tolerance, the field has historically lacked a widely-accepted definition and robust mechanistic understanding. Only recently have efforts been made to establish clear conceptual boundaries and investigate the underlying biological processes governing biostimulants' modes of action. This shift, supported by advances in analytical

technologies, marks a critical transition from descriptive to mechanistic research, with the potential to redefine longstanding assumptions within the field.

The scientific uncertainty surrounding biostimulants has also contributed to significant regulatory and commercial challenges. In many jurisdictions, biostimulants are not formally recognized, leading to inconsistent or absent regulatory frameworks. Where frameworks do exist, classification systems are often extremely complex and can result in products being redefined as pesticides or plant growth regulators based on efficacy claims. Furthermore, regulatory requirements are often poorly aligned with biological reality, sometimes mandating the presence of specific metabolites regardless of their relevance to the source material. These inconsistencies not only hinder innovation but also create barriers to market entry.

Compounding these issues is the proliferation of commercially available products with unverified or inconsistent efficacy. This has eroded farmer confidence and undermined the credibility of the biostimulant sector as a whole. Despite these challenges, biostimulant research is entering a period of rapid evolution, with strong potential for significant paradigm shifts and innovation. In the context of escalating climate change pressures and the need for sustainable agricultural practices, biostimulants offer a promising avenue to enhance crop resilience while minimizing ecological impact. Countries such as South Africa are particularly well positioned to contribute to and lead this emerging paradigm, given their biodiversity, agricultural diversity, and growing research capacity.

BIOGRAPHY: PROF. MOUNAWER BADRI



Prof. Mounawer Badri is a Professor of **Plant Genetics** and **Molecular Biology** at the Centre of Biotechnology of Borj-Cedria, Tunisia, and President of the Tunisian Association of Genetic Resources (ATRG). He is internationally recognized for his pioneering contributions to **plant genetic resources**, **forage crop improvement**, and **climate-resilient agriculture**.

Over the past two decades, Prof. Badri has established and led research programs that are widely regarded as a reference in the Mediterranean and North African regions for the exploration, conservation, and utilization of **Mediterranean and North African germplasm**. His work integrates **plant breeding**, **plant physiology**, **genomics**, **proteomics**, and **multi-omics approaches** to improve crop productivity, nutritional quality, and resilience to **abiotic stress tolerance** and **biotic stress resistance**.

His research has been particularly influential on **forage legumes**, especially **Medicago species**, as well as on key stress-adapted crops such as **pearl millet**, **sorghum**, **maize**, and **halophytic species**. These studies have contributed to the identification of **elite germplasm** and **high-performing genotypes** adapted to **drought tolerance**, **salinity tolerance**, **soil degradation**, and emerging plant diseases.

Prof. Badri has maintained a long-standing **international research collaboration** of more than twenty years with researchers in South Africa, strengthening scientific links between the two regions. This collaboration has led, together with Prof. Ndiko Ludidi, to the successful coordination and funding of two major **Tunisia–South Africa cooperation** projects (2015–2017 and 2019–2024), reinforcing joint work in **plant biotechnology** and environmental stress adaptation.

He has coordinated and participated in numerous international research projects across Africa, Europe, the United States, and the Mediterranean region, and has served as an expert evaluator for several funding agencies. He has also contributed significantly to **capacity building** in **plant biotechnology** and **sustainable agriculture**.

Through his scientific leadership and impactful research, he continues to advance **climate-smart agriculture**, strengthening **food security**, **forage security**, and the sustainable use of plant genetic resources in vulnerable environments.

ABSTRACT

Enhancing forage crop resilience to climate change: integrating genetic resources, phenomics and multi-omics approaches

Mounawer Badri

Laboratory of Extremophile Plants, Centre of Biotechnology of Borj-Cedria, B.P. 901, Hammam-Lif 2050, Tunisia

Climate change exacerbates salinity, drought and heat stresses, threatening forage crop productivity and thus food and water security in semi-arid regions. Enhancing forage resilience is therefore a critical priority for sustainable agriculture.

This invited review presents our recent work on the integrated use of plant genetic resources and multi-approaches to accelerate climate resilience. We evaluated genetic resources of three key forage species: *Hordeum marinum* (salinity tolerance), pearl millet (*Pennisetum glaucum*, salinity stress) and alfalfa (*Medicago sativa*, drought, salinity, disease and iron deficiency). Field evaluation of selected accessions is ongoing. Initial characterization of these resources was performed using phenotypic markers and SSR molecular markers.

To improve stress responses, we tested several complementary approaches, including seedling pre-treatment, biostimulants, fabaceae–poaceae intercropping, and nanoparticle application. These strategies showed promising effects on growth and physiological performance under stress conditions.

To explore the molecular determinants of resilience, we adopted a candidate gene approach combining expression studies and proteomic analysis. Key candidate genes involved in stress tolerance were identified and functionally validated using CRISPR-Cas9 genome editing. This integrated pipeline, from genetic resource evaluation to functional validation, provides a framework for understanding and enhancing stress resilience in forage species.

Despite progress, challenges remain, including the translation of laboratory findings to breeding programmes and field conditions. Strategic priorities include expanding field evaluations, optimizing intercropping protocols, and developing marker-assisted selection tools based on validated candidate genes.

Integrating genetic resources, physiological interventions and molecular tools offers realistic pathways to climate-resilient forage cultivars, directly supporting sustainable agriculture and water security in marginal environments.

BIOGRAPHY: PROF. NOKWANDA MAKUNGA

Nokwanda (Nox) Makunga is a Full Professor of Botany in the Department of Botany and Zoology at Stellenbosch University. Her research is centred around using multi-omics technologies to study how plants function in relation to the production of specialized metabolites that impart health-beneficiating properties to medicinal plants. This work also aims to better characterize responses of medicinal plants to the environment to assist with the production of quality assured, economically suitable phytopharmaceutics. Several current projects employ in vitro plant propagation methods as a scientific tool to resolve genetic-to-metabolome effects on various plant species. Exploitation of such technologies also provides a tool that allows the conservation of indigenous medicinal plants.

In 2025, she was the recipient of the silver medal from the South African Association of Botanists. She serves on several international editorial boards and is recognized as one of the most prominent science communicators in South Africa.

ABSTRACT

Molecular insights into plant stress regulation: case studies from SA medicinal plants

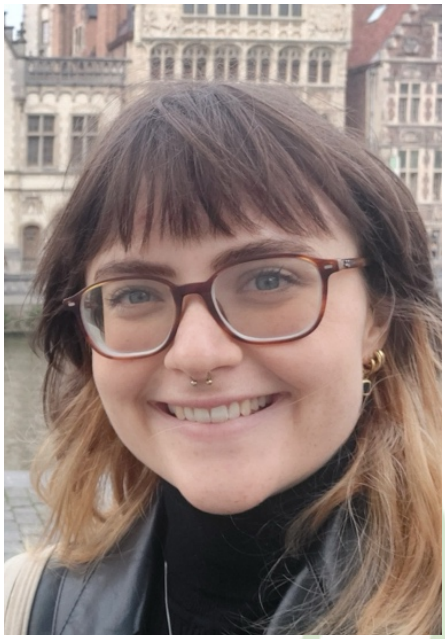
Nokwanda P Makunga

Department of Botany and Zoology, Stellenbosch University, South Africa

Plants utilise a diverse range of mechanisms to cope with abiotic and biotic stresses. Some of these responses are shared amongst plants from different plant lineages but environmental stresses may also lead to species-specific mechanisms to cope with stress conditions. Depending on the dose, stresses may stimulate various metabolic activities that lead to higher accumulation of metabolites that are desirable in medicinal plants. Molecular mechanisms that underpin growth-trade offs for many South African medicinal plants remain largely unknown as plant stress biology research has largely focused on model species. Such studies are highly relevant for many South African medicinal plants that are commercialised in different industries that exploit indigenous species. Using case studies from various medicinal plants (*Aspalathus linearis*, *Dodonaea viscosa*, *Lessertia frutescens*, and *Mesembryanthemum tortuosum*), the application of systems biology and omics approaches has been used to elucidate key mechanisms that these plants use to mitigate stress conditions. For example, overall plant performance is compromised by heat shock, limiting healthy growth and development whilst negatively impacting the metabolic potential for the synthesis of unique phenolics that are associated with *A. linearis*. However, *D. viscosa* adopts distinctive physiological and biochemical adaptation strategies depending on the stress elicitor. In this species, a reduction in carbon-based storage and structural components such as sucrose and

lignin suggests reallocation of resources to the production of osmoprotectants and increases in reactive oxygen species scavenging also leads to changes in flavonoid production. Metabolomic changes in *L. frutescens* and *M. tortuosum* illustrate how nutrient and light stresses could potentially be used for the mass cultivation of these plants. These studies also build fundamental information that is important for understanding the impact of environmental stresses on medicinal floral under changing climate scenarios.

BIOGRAPHY: JANA BOTES



Ms Jana Botes was the winner of the Best Young Botanist Award at the 50th annual SAAB conference. She has been working under the supervision of Prof Dave Berger and Prof Yves Van de Peer at the MPPI research group at the University of Pretoria since her Honours project in 2023. Her postgraduate studies have focussed on flavonoid biosynthesis in the near-endemic *Greyia* genus, which has allowed her to explore many techniques in molecular biology and bioinformatics. Currently, she is pursuing her PhD, which involves assembling and annotating a *Greyia sutherlandii* genome; analysing the full set of flavonoid biosynthesis genes across the three *Greyia* species; identifying the genes responsible for the anti-tyrosinase activity of the leaves; characterising the mutation underlying the white-flowering *G. radlkoferi* phenotype; and validating the impact of this mutation on the well-characterised leucoanthocyanidin dioxygenase enzyme.

ABSTRACT

White-flowering *Greyia radlkoferi* mutant reveals functionally important second-coordination sphere histidine residue in leucoanthocyanidin dioxygenase

J. Botes[1,2], Y. Van de Peer[3,4,5,6], D.K. Berger[1,2]

[1]*Department of Plant and Soil Sciences, University of Pretoria, Pretoria, South Africa*

[2]*Forestry and Agricultural Biotechnology Institute, University of Pretoria, Pretoria, South Africa*

[3]*Department of Plant Biotechnology and Bioinformatics, Ghent University, Ghent, Belgium.*

[4]*Centre for Plant Systems Biology, VIB, Ghent, Belgium*

[5]*Department of Biochemistry, Genetics and Microbiology, University of Pretoria, 0028 Pretoria, South-Africa.*

[6]*College of Horticulture, Academy for Advanced Interdisciplinary Studies, Nanjing Agricultural University, 210095 Nanjing, China.*

White-flowering mutant plants have long been used to study the genetics and biochemistry of the flavonoid biosynthesis pathway. In this study, two independent white-flowering mutants of the *Greyia* genus belonging to *G. sutherlandii* and *G. radlkoferi* respectively were investigated to characterise the nature of the mutant phenotype. Metabolite analysis through LC-MS/MS indicated the wild-type plants accumulated primarily cyanidin and pelargonidin derivatives in foliar and floral tissues respectively, and these were absent throughout the mutant tissues. RNA-Seq analysis revealed a homozygous two-base deletion in the iron-binding domain of leucoanthocyanidin dioxygenase (LDOX) of *G. sutherlandii*. This would

result in a truncated, non-functional protein, consistent with other anthocyanin-deficient mutants characterised in the past. The *G. radlkoferi* mutant, on the other hand, did not show clear signs of downregulation of an anthocyanin biosynthesis gene, and was homozygous for a missense mutation in LDOX (H273R) not affecting the iron-coordinating facial triad. Crosses between the mutants of the two species yielded anthocyanin-deficient offspring, indicating non-functional LDOX in *G. radlkoferi* which fails to complement the truncated *G. sutherlandii* protein. This mutation affects a pocket-oriented residue in the conserved structure of 2-oxoglutarate-dependent dioxygenases. Older members of this superfamily generally possess non-polar inward-facing residues that do not directly participate in substrate or ligand interactions. In contrast, specialized plant members possess a few conserved polar residues that likely contribute to the second coordination sphere and expand its catalytic capabilities. The functionality of the mutant *G. radlkoferi* protein will be assessed by transformation of anthocyanin-deficient *tds4-1 Arabidopsis thaliana*, as well as the impact of other mutations in the same position. This study shows that studying plants with well-characterised mutant phenotypes can continue to expand our understanding of protein functionality and highlight features which were previously overlooked.

EVOLUTION AND SYSTEMATICS

A new generic classification for the subfamily Thymelaeoideae (Thymelaeaceae): resolving the polyphyly of *Gnidia*

O. D. Olaniyan[1,6], J. S. Boatwright[2], A. R. Magee[3,4], J. C. Manning[4,5], M. Van der Bank[1]

[1]*The African Centre for DNA Barcoding (ACDB), Department of Botany and Plant Biotechnology, University of Johannesburg, Johannesburg, South Africa*
[2]*Department of Biodiversity and Conservation Biology, University of the Western Cape, Cape Town, South Africa*
[3]*Department of Botany and Plant Biotechnology, University of Johannesburg, Johannesburg, South Africa*
[4]*Compton Herbarium, South African National Biodiversity Institute, Cape Town, South Africa*
[5]*Research Centre for Plant Growth and Development, University of KwaZulu-Natal, Pietermaritzburg, South Africa*
[6]*Department of Biological and Environmental Sciences, Kampala International University, Kampala, Uganda*

It has been known for more than 20 years that the African-Malagasy genus *Gnidia* L. is extensively polyphyletic. Phylogenetic analyses based on combined nuclear and plastid DNA sequence data indicated the polyphyly of the genus in relation to the southern African genera *Lachnaea* L. Passerina Meisn. and *Struthiola* L., as well as to other Southern Hemisphere genera such as *Drapetes* Banks ex Lam., *Kelleria* Endl. and *Pimelea* Banks ex Gaertn. We present a robust, well-sampled phylogenetic analysis of the subfamily Thymelaeoideae, with sampling of *Gnidia* increased to 76% of the species compared to previous studies. Our analyses retrieved seven lineages of *Gnidia* nested in four independent evolutionary clades within the '*Gnidia* group' of the Thymelaeiodeae. Several options were considered for re-circumscribing *Gnidia* as a monophyletic genus, with further considerations of nomenclatural stability, phylogenetic and biogeographic information, as well as ease of identification. The option that we present retains the traditionally recognised *Drapetes*, *Kelleria*, *Lachnaea*, *Passerina*, *Pimelea* and *Struthiola* through the recognition of six lineages of *Gnidia* at the generic level. We propose that *Gnidia* be retained as a monotypic genus, including only the type species *G. pinifolia* L. Four previously recognised genera are reinstated, while two are described as new. In addition, a third new genus is described for an anomalous Malagasy species of unknown placement. An overview of the new generic classification will be presented, including the characters supporting the lineages recognised at the generic level.

Investigating the phylogenetic relationship, genetic diversity, and secondary metabolites of *Cleome gynandra* L.(Cleomaceae) haplotypes in South Africa

P. L. Seroka[1] & S Mayonde[1,2]

[1]*Department of Agricultural Sciences, Faculty of Science, Nelson Mandela University, PO Box: 7700, Gqeberha, South Africa*

[2]*School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, PBag X3 Johannesburg 2050, South Africa*

Cleome gynandra is a nutrient-dense indigenous leafy vegetable rich in bioactive secondary metabolites, yet the genetic factors governing phytochemical variation among its geographically diverse populations remain underexplored. This study aims to investigate phylogenetic relationships and genetic diversity within C. gynandra and to determine how genetic structure influences the composition of key secondary metabolites and nutritional components. Accessions will be collected across five South African provinces to capture regional genetic and phytochemical variation. Phylogenetic reconstruction will employ multi-locus DNA barcoding, screening four coding chloroplast regions (matK, ndhF, rbcL, trnL-trnF), three non-coding chloroplast regions (atpF-atpH, trnH-psbA, psbK-psbI), and three nuclear ITS regions (ITS1, ITS2, ITS4), with loci demonstrating >50% amplification success advanced for bi-directional Sanger sequencing on an ABI 3500 Genetic Analyzer. Genetic diversity and population structure will be assessed using polymorphic Simple Sequence Repeat (SSR) markers. Concurrently, secondary metabolites, including total phenolics, flavonoids, condensed tannins, alkaloids, saponins, terpenoids, and glucosinolates, will be quantified using validated spectrophotometric and chromatographic methods. By integrating phylogenetic, population genetic, and phytochemical datasets, this research will elucidate genotype-chemotype associations, providing foundational knowledge to guide conservation strategies and inform marker-assisted selection for C. gynandra cultivars with enhanced bioactive compounds.

Disentangling *Gnidia*: Systematics of the *Epichroxantha* group (Thymelaeiodeae, Thymelaeaceae)

P.M. Kapa [1,4], A. R. Magee [2,4,5], J.C. Manning [3,4], S. J. Boatwright [1]

[1] *Department of Biodiversity and Conservation Biology, University of the Western Cape, South Africa*
[2] *Department of Botany and Plant Biotechnology, University of Johannesburg, South Africa*
[3] *Research Centre for Plant Growth and Development, University of KwaZulu-Natal, Private Bag X01, Pietermaritzburg, Scottsville 3209, South Africa*
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The genus *Gnidia* has been shown to be polyphyletic in recent phylogenetic studies, necessitating a reassessment of generic circumscriptions and the identification of diagnostic characters. Progress is hindered by limited taxonomic knowledge of many species, making *Gnidia* a priority for revision in South Africa. Given the size and complexity of the genus in a broad sense, a clade-based revisionary approach was adopted. This study focuses on the *Gnidia juniperifolia* group, a lineage of small, winter-rainfall species characterised by a canary-yellow, funnel-shaped hypanthium, leathery leaves, and four large, membranous petaloid scales. These species correspond to the historically recognised genus *Epichroxantha* Eckl. &

Zeyh., that has been reinstated for this clade. The study aimed to produce a comprehensive revision of the group, including nomenclatural clarification, typification, species delimitations, description, geographical distribution, diagnostic characters, and an identification key to the species. Morphological data were obtained from herbarium collections and field studies across the Western and Eastern Cape. A phylogenetic analysis including all the recognised species was generated using nrITS, *rps16*, *rbcL*, *trnL-F*, and *matK* sequence data. These data were used to assess the monophyly, species relationships, and morphological character evolution of the lineage. Ten species are recognised in our revised treatment, with *G. decurrens* and *G. myrtifolia* reduced to synonymy, one undescribed species formalised (previously included under the manuscript name *G. foucadei*), and *G. variegata* excluded from the genus due to having eight tiny finger-like petals and a multicoloured notched hypanthium. This species corresponds to *G. squarrosa*. Previously recognised infraspecific taxa were not retained.

Towards a Revised Infrageneric Classification of *Lasiosiphon* Based on Phylogenetic and Morphological Evidence

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Lasiosiphon Fresen. (Thymelaeaceae: Thymelaeoideae) was resurrected from the large, polyphyletic genus *Gnidia* L. based on molecular phylogenetic analysis of the Thymelaeoideae. As currently circumscribed, the genus comprises approximately 78 species from Africa, Madagascar and Asia. A comprehensive taxonomic revision of *Lasiosiphon* is urgently needed to reflect the revised circumscription of the genus and to improve species identification. Here, we performed a combined phylogenetic analysis of nuclear and plastid molecular datasets to assess relationships within the genus. Representatives of 52 of the 78 species accepted in *Lasiosiphon* were included. We evaluate the taxonomic importance of ten morphological traits that might be used to infer subgeneric classification within the genus. Two major clades were recovered within *Lasiosiphon*, each strongly supported (PP ≥ 0.97). These clades correspond to differences in floral merosity and are here recognised as subgenera.

Nomenclatural notes on desmids (Desmidiaceae, Charophyta) described by Paul van Oye from the former Belgian Congo in the mid-20th century

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Several new desmids from the former Belgian Congo were described between 1943 and 1959 by Prof Paul van Oye (1886–1969), a prominent Belgian biologist and a leading world authority on desmids, rotifers, and rhizopods. These desmid taxa were illustrated using pen drawings. Here, we aim to document these species more thoroughly by translating into English the original descriptions and, where possible, adding images taken through light microscopy (LM). Materials used by van Oye to describe the new desmid taxa from the Belgian Congo, housed in the invertebrate collections of the Royal Belgian Institute of Natural Sciences, Belgium, were studied using LM and photographs/images taken. The original descriptions were freely translated into English and provided with comments where appropriate. For each taxon, available information was added on the ecology and distribution. Of the fourteen desmid taxa (five species and nine varieties), van Oye described from the Congo, we could document three species and six varieties and illustrate those with light microscope images: three *Cosmarium* (*C. kufferathii*, *C. obsoletum* var. *glabra*, *C. pseudopyramidatum* var. *glabrum*), one *Euastrum* (*E. securiformiceps* var. *punctulatum*), two *Micrasterias* (*M. apiculata* var. *evensii*, *M. lebrunii*), two *Pleurotaenium* (*P. congolense*, *P. subcoronulatum* var. *maximum*), and one *Staurastrum* (*S. orbiculare* var. *maxima*) taxon. The invalidly described *Cosmarium symoensii* is validated. The documentation by LM photographs/images of van Oye's Desmidiaceae types of the Congo will be useful for future studies of these algae in tropical Africa. It can be expected that these taxa were more easily recognizable, resulting in more observations, other than from the type localities, thereby enabling their distribution in tropical Africa.

A hairy business: unexpected morphological variation blurs species boundaries in two Thesium species (Santalaceae)

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Thesium L. (Santalaceae) is a taxonomically problematic hemi-parasitic plant genus with substantial morphological variation. This variation complicates species identification, by both experts and amateurs, and subsequently impacts the accuracy of conservation threat assessments. Here, a case study of morphological variation in two hairy *Thesium* species is presented. As part of the ongoing taxonomic study of *Thesium,* fieldwork was carried out to observe the species in their natural habitat. *Thesium* transvaalense is found across the Northwest Province eastwards to Mpumalanga Province and reaching into the south of the Limpopo Province while *T. hispidifructum* is restricted to the western Soutpansberg in

Limpopo Province. Collections from the Magaliesberg in Gauteng Province (South Africa) appeared to be an intermediate form between *T. transvaalense Schltr.* and *T. hispidifructum* N.Lombard & M.M.le Roux. These two species have been considered well-defined, with little morphological variation and disjunct geographical distributions. An additional atypical gathering of *T. hispidifructum,* ca. 200 km from the species known distribution range, also resembled the Magaliesberg intermediate forms. A detailed study of morphological characters, geographical distribution and habitat was conducted. Substantial, and previously unknown, morphological variation in *T. transvaalense* was revealed as the confounding factor. *Thesium transvaalense* and *T. hispidifructum* are confirmed to be two separate species, but revised morphological circumscriptions, geographical ranges and threat assessments are necessary and provided here. This study highlights taxonomic implications in conservation studies and the importance of field observations in accurately defining species boundaries, even in supposed well-defined taxa.

The "promiscuous" Greyia (bottlebrush) genus – evaluating post-zygotic barriers between the three species

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The endemic southern African tree genus *Greyia* comprises three species distributed across the grassland biome: *Greyia flanaganii* (Kei bottlebrush), *G. sutherlandii* (Natal bottlebrush) and *G. radlkoferi* (Woolly bottlebrush). The evergreen Kei bottlebrush has an isolated range west of the Kei River in the Eastern Cape. The Woolly and Natal bottlebrush are deciduous montane species with core populations in Limpopo and KwaZulu-Natal, respectively. Species boundaries in the genus have become uncertain because the deciduous species have overlapping distributions in Mpumalanga and similar floral morphology, while recent genomic studies indicate divergence within the past two million years together with admixture between populations. This study therefore tested whether *Greyia* species are reproductively isolated or still undergoing speciation. Controlled interspecific crosses were performed between cultivated trees at the Manie van der Schijff Botanical Garden using pollen from natural populations where necessary. Fruit and seed developed successfully from all interspecific combinations, including crosses between the two deciduous species and between each deciduous species and *G. flanaganii.* Seed viability percentages were high (84–96%; n > 90 per cross) and germination rates ranged from 92–98% (n = 150 per cross), producing healthy seedlings comparable to within-species pollinations. To confirm hybrid origin, diagnostic SNP markers were developed from a previously established 23 SNP species identification panel. PCR and Sanger sequencing assays targeting species-specific SNPs demonstrated heterozygosity in all tested F1 progeny (n = 3 per cross), confirming successful hybridization between all species pairs. These results show that the three *Greyia* species do not exhibit strong post-zygotic reproductive barriers up to the seedling stage and support the hypothesis of ongoing speciation within the genus. Future work will assess fertility of F1 hybrids and evaluate pre-zygotic barriers such as geographical isolation and pollinator specialization.

Revision of *Dyschoriste* (Acanthaceae) in South Africa

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There are two groups in the genus: those with four stamens and calyces that are fused for most of their length and those that usually have two stamens, usually with two staminodes and with calyces fused for less than half of their length. The latter group was previously known as *Chaetacanthus* and was a near endemic genus to South Africa. Because there are some individuals that have both two and four stamens on the same plant, *Chaetacanthus was subsumed into Dyschoriste*. Within the group with four stamens, six species occur in South Africa all of which were recognised previously, but some names are later synonyms and will need to be replaced. Within the species with two stamens, there has been over-emphasis on the types of hairs that occur on the calyx lobes and insufficient recognition of other characters. Previously four species were recognised, but as a consequence of this revision, another 18 are likely to be described.

Investigating spatial phylogenetic and functional diversity in Africa, with focus on the Cyperaceae (Poales)

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Understanding the mechanisms that influence the patterns of diversification and spatiotemporal distribution of biodiversity requires integrating species, functional, and phylogenetic data. We assembled 261,029 occurrence records for 643 species of Cyperaceae in Africa, represented on a chronogram phylogeny, and compiled 10 functional traits for these species. We calculated taxonomic and phylogenetic alpha and beta diversity measures, mapped centres of neo- and paleo-endemism, and four functional diversity measures using a grid of 1× 1-degree cells. The spatial beta diversity pattern was used to generate regionalization maps using K-means and hierarchical dendrogram clustering. Our study found areas of high species and phylogenetic diversity in the Okavango Basin, while endemism was

the highest in the Mediterranean northern and southern Africa and Madagascar. We also observed centres of paleo-endemism in closed habitats of Western and Central Africa, while mixed and super-endemism hotspots are pronounced in the Cape and Madagascar. Beta diversity identified three clusters spatially distributed along climatic zones, thus indicating shared lineages. Centres of endemism were mostly restricted to the northern and southern tips of the continent, Madagascar and the Congolian region. In contrast, functional richness was the highest in the Congolian region, while evenness, divergence, and dispersion were mostly high and broadly distributed across the continent. Spatial patterns of phylogenetic clustering and overdispersion of sedges and beta diversity suggest different biogeographical processes in different parts of Africa, resulting in species with different evolutionary histories on the continent. High endemism coupled with low functional richness in the southern region indicates higher *in situ* diversification with habitat filtering producing locally adapted Cyperaceae to extreme climatic conditions, thus resulting in functional redundancy. In contrast, high functional richness in the rainforest region could be related to the varying habitat.

Towards a taxonomic revision of *Dianthus* L. (Caryophyllaceae) in South Africa

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The genus *Dianthus* L. (Caryophyllaceae) in South Africa is characterised by complex species circumscriptions, extensive morphological variation, and inconsistent application of infraspecific taxa. Despite regional treatments by earlier authors, no modern synthesis integrating morphology, distribution, and nomenclatural has been undertaken for the South African representatives of the genus. This study is working toward a taxonomic revision of *Dianthus* in South Africa based on herbarium studies, field observations, and comparative morphological analyses. The genus is currently represented by approximately fifteen species in South Africa, occurring across habitats ranging from the Cape Floristic Region to the grasslands of the interior escarpment. Several taxa exhibit marked geographic and ecological differentiation, particularly within the *Dianthus basuticus*, *D. mooiensis*, *D. namaensis*, and *D. zeyheri* complexes, where subspecies and varieties have historically been described based on floral size, leaf morphology, indumentum, and growth form. Ongoing analyses are assessing the taxonomic significance of these characters and evaluating the validity of currently accepted infraspecific taxa. Preliminary observations suggested that some traditionally recognised varieties and subspecies may represent environmentally induced forms rather than evolutionarily distinct entities, while other geographically restricted populations warrant recognition at the species or subspecies level. Morphological overlap among several taxa, especially among grassland species, suggests that diagnostic characters used in earlier treatments require reassessment based on broader population sampling. Conversely, taxa endemic to the Cape Floristic Region displays stronger morphological cohesion and regional endemism. This revision provides updated descriptions, nomenclatural clarification,

identification keys, and revised distribution data for South African *Dianthus*. The study contributes to improved species delimitation within the genus and a modern framework for future studies of African Caryophyllaceae.

Phylogenetic relationships and morphological evolution in *Prismatocarpus*, and allies (Campanulaceae: Wahlenbergieae)

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Recent phylogenetic analyses of the southern African Campanulaceae reveal complex relationships among *Prismatocarpus*, *Roella*, *Merciera*, and allied genera. Using an ITS-based phylogeny integrated with morphological character mapping, we investigated the evolution of floral and fruit characters across these lineages to identify key synapomorphies and instances of homoplasy. Our results recover *Merciera* as a distinct clade supported by the synapomorphies related to capsules. In contrast, species of *Prismatocarpus* and *Roella* form an interconnected assemblage with repeated transitions in floral morphology and capsule dehiscence patterns. Several traditionally diagnostic characters appear evolutionarily labile (easily changed/altered), particularly capsule dehiscence involving an apical plug, which shows evidence of homoplasy across the phylogeny. Within the broader *Roella*–*Prismatocarpus* clade, a suite of floral traits supports major subclades, corolla shape, filament shape, and glands on stigmas. These characters provide a stronger phylogenetic signal than fruit morphology alone and suggest convergent evolution in capsule traits. Species currently placed in *Prismatocarpus* are distributed across multiple clades, indicating the non-monophyly of the genus as presently circumscribed. The integration of molecular phylogenetics with detailed morphological character optimisation highlights the importance of floral synapomorphies in delimiting evolutionary lineages within the Campanulaceae. Our findings contribute to a clearer understanding of character evolution in the group and provide a framework for future taxonomic revision of these predominantly Cape Floristic Region taxa.

Palynotaxonomy of Malagasy *Acridocarpus* (Malpighiaceae): evidence for an *A. excelsus* species complex and evolutionary insights into 3-parasyncolporate pollen

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The Malagasy representatives of *Acridocarpus* subg. *Madagascariensis* (Malpighiaceae) comprise a morphologically distinctive but taxonomically poorly understood lineage of trees endemic to Madagascar and New Caledonia. Among them, the widespread *Acridocarpus excelsus* complex has not undergone a critical reassessment since the mid-twentieth century. Because pollen morphology has proven highly informative for species delimitation and evolutionary studies in Malpighiaceae, we conducted the first comprehensive palynotaxonomic investigation of all Malagasy taxa of *Acridocarpus*. Pollen grains from herbarium specimens were examined using light microscopy and scanning electron microscopy (SEM), and fourteen quantitative variables together with categorical indices were analysed using principal component analysis (PCA). All examined taxa possess small, 3-(irregularly)-parasyncolporate pollen grains characterised by a previously undocumented, extremely small apocolpial field. SEM analyses revealed novel ultrastructural features for the genus, including nanoreticulate to fossulate-cristate ornamentation, supratectal cristae, variable endexine structure, and granulate colporus membranes. Multivariate analyses recovered two major pollen types corresponding to the *A. excelsus* and *A. adenophorus* lineages. Species associated with the *A. excelsus* complex consistently grouped together by their smaller pollen dimensions, supporting the interpretation of *A. excelsus* as a morphologically cohesive yet heterogeneous species complex. Rare abnormal pollen grains, including diploporate and 2-colporate forms, were also documented. These results demonstrate that pollen morphology provides robust diagnostic characters for species delimitation within Malagasy *Acridocarpus* and significantly expands our understanding of aperture evolution in Malpighiaceae. The recognition of distinct pollen types and the discovery of previously undescribed ultrasculptural traits contribute new insights into the evolution of parasyncolporate apertures and provide an important framework for future taxonomic, ecological, palaeobotanical, and conservation studies involving Malagasy Malpighiaceae

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Diploneis latissima **and** ***Witkowskia apicalicostata*** **(Bacillariophyta): first records outside their type localities**

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In Africa, although there is a significant diversity of algal species, studies on algae (particularly diatoms) remain limited in many countries. Diatom diversity in Angolan freshwaters was completely unknown until very recently when diatom assemblages on the Humpata Plateau (Southwestern Angola) were studied. Ninety-one taxa from 43 genera were documented from this region; the paper presents SEM photographs of some of the most common diatoms found. The present study of fresh and some brackish waters of central Angola has added 12 new genera to the existing list of the diatoms, including several extremely interesting taxa from biogeographical point of view. Two of these diatoms were recorded for the first time

outside of their *loci classici*: *Diploneis latissima* Jovanovska, M.C.Wilson, P.B.Hamilton & J.Stone (Bacillariophyceae, Diploneidaceae), initially described from Mulungushi River in Republic of Zambia, and *Witkowskia apicalicostata* (Metzeltin & Lange-Bertalot) Kulikovskiy, Glushchenko, Mironov & Kociolek (*Placoneis apicalicostata* Metzeltin & Lange-Bertalot) (Bacillariophyceae, Witkowskiaceae), described from Zambezi River near Katima Mulilo in Republic of Namibia.
We present detailed morphological descriptions of both discovered species based on numerous high quality SEM images/photographs characterizing both external and internal valve structure. It is important to note that all previously known SEM images of *D. latissima* are of cells partially or significantly covered by debris obscuring many important morphological characteristics. Of the only two known SEM images of *W. apicalicostata* cells one also depicts cell obscured by debris. Our SEM images provide very clear documentation of cell structure of these extremely rare, possibly endemical tropical African diatom species.

Nananthus (Aizoaceae) in South Africa: Revisiting what we know from systematics and ethnobotanical perspective

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Nananthus N.E.Br. (Aizoaceae) is a small group of dwarf succulent plants native to the dry areas of southern Africa, namely South Africa, Botswana, and Namibia. In South Africa, *Nananthus* is found mainly in the North West, Free State, Northern Cape, and Eastern Cape provinces. Although the genus occurs in an area that is biodiversity-rich, it remains poorly studied. Its taxonomy remains unclear because many species within the genus look similar and lack reliable identifying features. Molecular data are scarce, and ethnobotanical information is largely undocumented. This poster reviews the taxonomy, distribution, morphology, and ethnobotanical importance of *Nananthus* in South Africa. Existing literature was collected from online databases (Scopus, Google Scholar, and Web of Science) and books to assess current knowledge of the genus and its species richness. The gaps in molecular and ethnobotanical data will also be highlighted, and will explain how species identification, conservation assessment, and possible uses are affected. The limited information shows that *Nananthus* has received little attention in scientific and traditional knowledge studies. This review will highlight taxonomic challenges using existing evidence, identify key research gaps, and provide a basis for future molecular, ecological, and ethnobotanical investigations. Therefore, a focused research project is needed to improve species identification, promote biodiversity conservation, and document indigenous knowledge in South Africa.

Spatial variation of *Pinus sylvestris* mycobiome across root regions

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Forest tree roots engage in complex interactions with fungal communities. Fungi species play a vital role of nutrient cycling and contribute to overall tree growth. Individual roots of Scots pine (Pinus sylvestris) undergo anatomical change during maturation, yet spatial colonisation of associated fungal microbiomes along discrete root zones remain poorly understood. Here, we characterised fungal diversity and community composition across three functionally distinct root regions namely, root tips, lateral roots, and mature region. Pine seedlings were grown for 60 days in non-fertilized (control) soil and soil from a long term fertilized boreal forest site. We performed internal transcribed spacer (ITS) DNA profiling to identify fungal communities across root regions. Fungal operational taxonomic units (OTU) richness and diversity di ered significantly between control and fertilized soil. Each root region was significantly colonised by unique fungal species under each treatment. However, ericoid mycorrhizal fungi were shared between lateral roots under control and fertilized treatment, while ectomycorrhizal fungi were shared between lateral and mature regions under fertilized treatment. Our findings highlight that fungal colonisation in Scot pine is influenced by root architectural heterogeneity. These findings provide new insight into how root developmental stages and soil nutrient availability influences the tree root mycobiomes. Keywords: Pinus sylvestris, fungal species, fertilization, lateral roots, root zones.

A conditional link between biodiversity and formal economic activity in South Africa

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Understanding how biodiversity relates to formal economic activity is key to linking ecosystem functioning with human economic sustainability. Here, we examine the relationship between vegetation productivity (Enhanced Vegetation Index, EVI), used as a proxy for biodiversity, and formal business establishment across South Africa. Fitting different statistical models, we test the effects of EVI alongside population density and road infrastructure on both the probability of business establishment and business density. While biodiversity shows a positive association with business probability in models including interactions, its independent effect is weaker than that of road infrastructure variables. Specifically, road density and total road length consistently emerge as the strongest predictors, suggesting that accessibility may mediate the biodiversity-economy relationship. These findings suggest that biodiversity alone does not directly structure formal economic activity but may enhance economic potential

where road infrastructure enables market access. Our study highlights the importance of integrating ecological and infrastructural perspectives to better understand the spatial coupling between biodiversity and economic development.

Surviving The Chill: Grass-Forb Interactions Through a Dry, Cold Season

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Vegetation dynamics in the Highveld Grassland Region of South Africa are strongly driven by grazing, fire, and climate variability. Seasonal drought and frost further shape grassland community structure by shifting the balance between facilitation and competition among plant functional groups. However, little is known about grass-forb dominance shifts under seasonal stress. Understanding how these interacting mechanisms mediate stress tolerance is essential for predicting plant community responses under changing climatic conditions. This study investigated the effects of seasonal drought and cold stress on grass-forb coexistence dynamics within the Highveld Grassland, with particular emphasis on the potential facilitative role of grasses in protecting forbs from frost during the non-growing season. Field data were collected across three seasons (summer, winter, and spring) using 0.25m2 quadrats established in fixed control (unclipped) and treatment (grass-clipped) plots. Species composition, forb cover, and forb height were quantified. The results showed that community composition remained stable across seasons and treatments, indicating minimal compositional turnover. In contrast, forb cover and height declined markedly in winter and partially recovered in spring, reflecting strong seasonal effects. In spring, forb cover was significantly higher in clipped plots (20%) than in control plots (8%), suggesting short-term competitive release following grass removal rather than facilitation. No significant treatment effect on forb height was detected. Facilitative effects of grasses under winter stress were minimal, whereas reduced grass biomass temporarily benefited forb performance during early regrowth. These findings demonstrate that grass-forb interactions in the Highveld Grassland are highly seasonal and responsive to stress, with competition dominating during the growing season and limited evidence for facilitation under cold and dry conditions. This study provided important insights for grassland management and improves our ability to predict vegetation responses under future climate variability.

Plant-microbe interactions in degraded soils: PLFA-based assessment of microbial community structure associated with *Crinum bulbispermum*

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Soil microbial communities are central to ecosystem functioning and play a key role in the recovery of degraded and metal-contaminated grasslands. This study tested how soil type and plant establishment influence microbial community structure associated with *Crinum bulbispermum* using phospholipid fatty acid (PLFA) analysis. A greenhouse experiment employed a factorial design including undisturbed grassland soil, degraded grassland soils, and mine tailings, each with and without plant establishment.
Microbial community composition differed significantly among soil types ($p < 0.05$), with undisturbed soils supporting the highest microbial biomass and mine tailings the lowest, while degraded soils were intermediate. Plant establishment significantly increased total microbial biomass across all soil types and shifted the relative abundance of key functional groups, including Gram-positive bacteria, Gram-negative bacteria, and fungi. Soil degradation was associated with reduced fungal-to-bacterial ratios and pronounced shifts in community structure, particularly in mine tailings, indicating impaired microbial functioning. However, planted treatments showed a shift toward more functionally balanced communities, suggesting partial recovery mediated by plant-soil interactions. This pattern is consistent with a rhizosphere-mediated trajectory of microbial recovery across a soil disturbance gradient. Although temporal variation between sampling periods was observed, the effects of soil type and plant presence remained consistent. These findings demonstrate that *C. bulbispermum* can actively modulate soil microbial communities and facilitate the recovery of microbial structure in degraded systems. This highlights the importance of plant–microbe interactions as a mechanism underpinning restoration in disturbed and mine-impacted grasslands.

Climate-Driven Shifts in Flowering Phenology Across the Congo Basin: Evidence from Historical Records

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African Centre for DNA Barcoding, Department of Botany & Plant Biotechnology, University of Johannesburg, P.O. Box 524 Auckland Park, 2006.

Tropical forests of the Congo Basin are increasingly exposed to climate change, yet the consequences for plant phenology remain poorly resolved due to limited long-term datasets. Understanding how flowering dynamics respond to climatic variability is critical for predicting ecosystem resilience and maintaining forest stability. Here, we investigate temporal shifts in flowering phenology, their climatic drivers, community-level synchrony, and the extent to which these patterns are constrained by phylogeny. We compiled an extensive historical dataset of phenological observations collected between 1937 and 1957 across central Congo Basin forests and the Atlantic Mayombe region, comprising approximately 10 million records from 876 species and 6,339 individual trees. Climatic variables were derived from the Climate Research Unit database. We applied linear mixed-effects models to quantify temporal trends and climate-phenology relationships, incorporating species and site as random effects. Community synchrony was assessed using variance-based metrics, while phylogenetic signal in phenological traits was evaluated using Blomberg's K and Pagel's λ. Our results reveal pronounced shifts in flowering dynamics over time. Flowering onset advanced substantially, while flowering cessation occurred slightly earlier, resulting in an overall expansion of flowering duration. Temperature emerged as a dominant driver, promoting earlier onset and longer flowering periods, whereas increased precipitation delayed onset and shortened

duration. Despite these changes, community-level synchrony remained stable, and phylogenetic signal was weak, indicating limited evolutionary constraint. Together, these findings highlight strong, climate-sensitive but species-specific phenological responses, suggesting considerable ecological flexibility within tropical tree communities. The expansion of flowering windows alongside stable synchrony points to a reorganization of reproductive timing without disruption of community structure, with important implications for forecasting tropical forest responses to ongoing climate change.

Genetic diversity of native rhizobia isolates nodulating soybean in uncultivated virgin soils of Ghana

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Characterization of native rhizobial isolates is the first step towards the selection of strains to produce inoculants, which are much needed for sustainable increase in grain legume yields. So far, however, the symbiotic effectiveness and genetic diversity of rhizobia nodulating soybean in the Upper West Region of Ghana, have not been assessed. This study screened 31 indigenous rhizobial isolates obtained from root nodules of soybean planted in previously uncultivated virgin soil at Da in the Upper West Region using ERIC-PCR fingerprinting, and the sequence analysis of 16S rRNA, protein-coding housekeeping genes atpD, glnII, gyrB, recA, and rpoB, and symbiotic nifH gene. The results showed very high symbiotic effectiveness and genetic diversity among the test isolates, with the ERIC-PCR fingerprinting grouping the test rhizobia into four major clusters. The isolates also revealed 99.8 - 100% genetic relatedness to the reference type strain of Bradyrhizobium diazoefficiens USDA 110T based on 16S rRNA. However, three isolates (namely, TUT-GMGH11, TUTGMGH13, and TUTGMGH29 obtained originally from soybean) were genetically related to the reference type strains of *Bradyrhizobium japonicum* LMF 6138T and *Bradyrhizobium zhanjaingese* CCBAU 51778T in the 16S rRNA gene phylogeny. The maximum likelihood sequence analysis of housekeeping genes atpD, gyrB, recA, glnll, rpoB, and concatenated (rpoB+gyrB+atpD) genes also assigned the test isolates to Bradyrhizobium diazoefficiens. The isolates however formed a monophyletic group with seven reference type strains in the nifH gene sequence analysis. Some isolates such as TUTGMGH11, TUTGMGH13 and TUTGMGH29 showed inconsistent grouping between the 16S rRNA, the individual housekeeping genes, and the concatenated (rpoB+gyrB+atpD) gene phylogenies. *Bradyrhizobium diazoefficiens* and *Bradyrhizobium japonicum* were the dominant microsymbionts nodulating soybean in the uncultivated virgin soils at Da in the Upper West Region. Additionally, these soybean rhizobia were unusually very effective in N2 fixation, and should be explored and tapped as bacterial inoculants for increased soybean production in Ghana.

Assessing leaf litter decomposition rates of *Encephalartos lanatus* under varying invertebrate access conditions

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Leaf litter decomposition is a crucial ecological process that enhances nutrient cycling in terrestrial ecosystems. Encephalartos species are among the most threatened plant groups worldwide, yet their contribution to nutrient cycling through litter decomposition remains poorly understood. This study assessed leaf litter decomposition rates of Encephalartos lanatus under contrasting macroinvertebrate-access and placement conditions. Leaf litter was enclosed in coarse mesh bags with 5 mm apertures to allow macroinvertebrate and microbial activity, and in fine mesh bags with 0.5 mm apertures to restrict macroinvertebrates and allow mainly microbial activity. Litterbags were placed either on the soil surface or below ground and retrieved after 60, 90, and 120 days. Samples were washed, dried at 70 °C for 84 hours, weighed, and then ashed at 500 °C for 5 hours to determine ash-free dry mass remaining. Decomposition rates were calculated using a first-order exponential decay model, and differences among treatments were analysed using two-way ANOVA and paired t-test in SPSS. Coarse mesh bags showed higher decomposition rates than fine mesh bags, indicating that macroinvertebrates enhanced decomposition. Below-ground litter decomposed significantly faster ($p \leq 0.05$) than surface litter, with mean rates of 0.00296 ± 0.00212 day^{-1} and 0.00125 ± 0.00135 day^{-1}, respectively. Decomposition was highest during the first 60 days and declined at 90 and 120 days. These findings show that restricted macroinvertebrate access and surface placement reduce decomposition rates. The relatively slow decomposition of E. lanatus may reflect nutrient-retention strategies in nutrient-poor grasslands. This study contributes to understanding decomposition dynamics in African cycads and supports improved conservation planning. For future research, longer-term decomposition studies are recommended to capture later-stage decomposition processes.

Stable and high yielding chickpea (*Cicer arietinum* L.) genotypes across environments in Northeastern South Africa identified by AMMI and GGE biplot analyses

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Chickpea is a nutrient dense legume, high in proteins and minerals. In South Africa, it is a new crop and largely imported, highlighting the need for local production. However, information on the stability and performance of genotypes across environments in South Africa is limited. The study aimed to (i) identify stable and high yielding genotypes for northeastern South Africa (SA) in a G × E interaction analysis, and (ii) evaluate the extent to which biomass and maximum quantum yield efficiency of PSII (Fv/Fm) can substitute grain yield in the selection

of desirable genotypes. The experiment was conducted using a randomized complete design with twelve genotypes, across six environments (E1-E6: Polokwane 2024, Hazyview 2024, Thohoyandou 2024, Nkomazi 2024, Thohoyandou 2023 and Nkomazi 2023) during 2023 and 2024 winter seasons. Data was collected at 50% flowering for biomass and Fv/Fm and grain yield at harvest maturity. Data was analysed using additive main effect and multiplicative interaction (AMMI), genotype main effect and genotype × environment interaction (GGE) biplot, and AMMI stability value (ASV). Results showed a significant ($P < 0.001$) effect of environment, genotypes, and G × E interaction on all traits. The effect of the environment explained the highest proportion of variation in grain yield (52.31%), biomass (46.77%), and Fv/Fm (45.09%), indicating strong environmental influence. Overall, one genotype (G2) showed stability across all environments with above average yield from both grain yield and biomass at 50% flowering. Different genotypes (G3 and G7) were high yielding with specific adaptation to Polokwane that was identified as the most favourable environment. The use of biomass at 50% flowering stage has potential for identifying stable genotypes, while Fv/Fm was less reliable. The three identified genotypes are recommended for chickpea improvement programmes for developing stable, high yielding genotypes for cultivation in the multi-environments of Northeastern South Africa.

Preliminary insights: The effects of fire and frost on community-weighted genome size in tropical grassy biomes within South Africa

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An important trait for all organisms is their genome size (GS), which dictates cellular, anatomical, physiological, and ecological functioning. Angiosperm genome size varies 2400-fold and in part determines a plants success in its environment. Polyploidy, the result of whole genome duplication (WGD), leads to an instantaneous increase in plant GS and therefore, alters plant functioning. Smaller GS plants require less nutrients for DNA synthesis and allow for rapid life cycles and regrowth. Larger GS plants require more nutrients for DNA synthesis, which tend to grow slower under nutrient limitation and environmental stress. Temperature plays a role in polyploid formation as high temperatures (36°C) and chemicals could induce meiotic error, resulting in unreduced gamete formation with potential for polyploid establishment. The effects of extreme temperatures on polyploid formation and GS filtering in South African fire-prone tropical grassy biomes (TGB) remain under-studied. Additionally, whether herbaceous community composition could be governed by plant GS remains underexplored. The aim of this project is to survey whether fire contributes to 1) polyploid formation and 2) GS filtering within TGB communities. Specifically, whether polyploids form through mechanisms related to heat and chemicals present after fires. The survey was conducted in the Satara experimental burn plots (Kruger National Park), which experience different fire-return interval treatments. Leaves were sampled from nine widely occurring grass species from three plots experiencing infrequent, annual, and triennial burns. Batch flow

cytometry was done to evaluate for differences in GS of each species per plot. Preliminary results suggests larger genomes are filtered out in annual and triennial burn plots, with species experiencing infrequent fire typically having a larger mean GS. Although, fires release chemicals that induce WGD in plants; however, frequent fires might filter out larger GS species as establishment is limited through rate of recovery after fires and competition.

The Response of *Populus Alba L.* to Multiple Disturbances in the Nylsvley Nature Reserve, Limpopo, South Africa

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Populus alba (white poplar) is a fast-growing, ecologically significant species widely used in forestry. This study examines its response to disturbances, including stem cutting, root cutting, and combined treatments with fire exposure in the Nylsvley Nature Reserve, Limpopo Province, South Africa. Ninety individuals were treated with these disturbances, and regrowth metrics such as resprouting and root sucker development were assessed four months later. Results indicate that *P. alba* shows notable resilience, with roots playing a critical role in recovery. Root cutting combined with fire yielded the highest number of resprouts, whereas combined stem and root cutting led to the lowest, revealing the compounded impact of multiple stressors. Fire acted both as a growth stimulant by enriching soil nutrients and as a stressor when paired with severe mechanical damage. The tallest resprouts were observed in stem-only treatments, likely due to reduced competition for resources. This study highlights the importance of disturbance type in shaping regrowth dynamics. The findings inform sustainable management practices for balancing productivity and ecosystem health in forestry and conservation settings. Further research is needed to understand the long-term implications of combined disturbances on *P. alba* populations and associated ecosystems.

The impact of aminochitosan on the rhizosphere

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The rhizosphere is the area of soil influenced by the secretions from the roots of plants. This area of soil also includes microorganisms that are attracted to the roots of plants and assist with ecosystem functioning, soil nutrient cycles, overall plant growth and health. This is facilitated by microorganisms breaking down various carbon sources within the soil, allowing for more nutrient availability. The effects of bio-stimulants on plants have generally focused on the ability of the bio-stimulant to protect the plant against stress conditions. The focus of

this study was to determine the effect of two bio-stimulants on the rhizosphere namely, aminochitosan (6-deoxy-6-aminochitosan) and chitosan. Tomato plants were grown in commercial potting soil for a period of 4 months with bi-weekly applications of bio-stimulants and nutrients respectively. After 4 months the soil was collected from the roots of the plants of the respective treatments. DNA was extracted from the soil and sent for 16S and ITS sequencing to identify microbial species. In parallel, EcoPlate assays were also conducted on the soil rhizosphere to assess carbon utilization. The results from the analysis of the 16S and ITS sequences showed varied microbial composition for the different treatments. The alpha diversity for the aminochitosan treatment was more clustered with more beneficial microbes suggesting increased microbial diversity. Though the water treatment had a higher alpha diversity compared to aminochitosan, it had less beneficial microbes. The beta diversity showed a faster change in microbial composition in the presence of aminochitosan compared to other treatments. The EcoPlate assays showed improved carbon source utilization with the aminochitosan treatment. These results show that bio-stimulants have a positive impact on the composition of the rhizosphere which may ultimately improve plant health and functioning. Though there was a reduction in microbial diversity for aminochitosan, there was an increase in beneficial microbes.

Climate warming may disrupt plant-insect phenological synchrony

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Vegetation phenology regulates ecosystem processes by shaping primary productivity and resource availability, while insects often synchronise their life cycles with plant phenophases to optimise resource use. Climate variability, however, can disrupt this synchrony, thus threatening ecosystem stability. Here, we assessed the temporal alignment between vegetation phenology and insect abundance over 12 months at the Pretoria National Botanical Garden, South Africa. To this end, insects were sampled biweekly using Malaise traps and identified via DNA barcoding, while vegetation phenology was quantified using Sentinel-2 NDVI data. Climate data were obtained from the South Africa's Agricultural Research Council. We found a strong synchrony between vegetation and insect dynamics. However, climatic drivers differed, with temperature primarily influencing insect abundance whereas precipitation and minimum temperature drove vegetation phenology. Using simulations, we predicted that a +1.5°C warming would reduce insect abundance while enhancing vegetation greenness during mid-growing seasons. Put together, our results highlight the sensitivity of plant-insect synchrony to climate change and highlight potential risks to ecosystem functioning under climate change.

Extending island biogeography theory to urban systems: city area drives global patterns of alien species richness

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Understanding how island biogeography theory applies to urban systems is critical for explaining the global distribution of alien species. Cities function as anthropogenic "islands" where area, isolation, and introduction pathways may jointly shape patterns of biological invasions. Here, we tested core predictions of island biogeography theory using a global dataset of alien species richness across cities, integrating city area, spatial connectivity, and introduction sources by fitting a negative binomial generalized linear mixed-effects model. We found a strong and consistent positive effect of city area on alien species richness, supporting the species-area relationship in urban ecosystems. This relationship remains robust across multiple introduction sources, with no significant differences in slope among introduction sources, indicating generality in how urban area structures invasion success. However, geographic distance also shows a marginally significant but unexpectedly positive effect, suggesting that spatial processes might contribute to variation in richness. Critically, we also found a significant interaction between area and distance, suggesting that the influence of city size on alien richness is modulated by spatial connectivity. Overall, our results extend island biogeography theory to global urban systems, demonstrating that city area is the dominant driver of alien species richness, while spatial context refines this relationship.

Parent soil mediates spatiotemporal nutrient enrichment and plant community structure following elephant megacarcass decomposition in an African savanna

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Elephant carcasses represent significant nutrient pulses that can alter savanna biogeochemistry and ecosystem processes. Yet, the persistence and spatial extent of this nutrient enrichment, as well as its impact over the plant community depend not only on carcass decay but also on the underlying soil parent material. In African savannas, basaltic and granitic soils differ sharply in biogeochemistry, providing background for understanding how soil mediates megacarcass effects. Here, we assessed soil nutrients (i.e. PO4, SO4, NO3, NH4, HCO3, Ca, Mg, K, Na, Cl, Fe, Mn, Cu, Zn, B), plant community structure (i.e. species diversity, richness, dominance and evenness) in distances of 0, 2,5, 5, 10 and 15 meters from the center of these carcasses, and over periods ranging from 8 to 2814 days post-mortem on nutrient-rich basaltic and nutrient-poor granitic soils in the Kruger National Park, South Africa. Uni- and multivariate analyses revealed soil nutrients showing distinct spatiotemporal patterns of concentrations across different soil types. Nutrients were significantly more abundant closer to the carcasses in the shortest decomposition period on both granite and basalt soil. Conversely, plant species diversity, richness and dominance were the lowest closer to the carcasses centers (mostly bare soils) and in the shortest decomposition period, generally also under the influence of soil nutrients. The opposite trend was observed for evenness, especially on the granites. These findings highlight the influence of the underlying soil template on the distribution of soil nutrients and plant community composition over both time and space. Decomposition of elephant megacarcasses are unique biogeochemical events that result in significant short-term pulse, but also in longer-term (> 5 years) sources of local nutrient enrichment, especially in nutrient-poor savannas.

Do nutrient-poor soils filter out large genome sizes?

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Genome size varies widely among plant species and is linked to key ecological and evolutionary traits. Genome size differs across species and functional groups and even within genera. Globally, genome size is shaped by climate and latitude, with soil nutrients such as nitrogen and phosphorus thought to play an important role. Given that nitrogen and phosphorus are key structural elements in nucleic acids, plants with larger genomes should require higher levels of these nutrients to support their larger genomes. Consequently, nutrient-limited environments may impose selective pressures against organisms with large

genomes, potentially constraining their establishment. However, the extent to which soil nutrients shape genome size distribution, especially at a local scale, remains unclear. This study compared the genome sizes of genera found in the nutrient-rich soils of the Drakensberg with those of sister genera found in nutrient-poor Renosterveld soils. Genome size was measured for a range of perennial herbs, grasses, and geophytes across these areas, and soil nutrients at collection sites were analysed for plant-available nitrogen and phosphorus. Both nitrogen and phosphorus levels were in the Drakensberg than in the Renosterveld, and more than 70% of the Drakensberg genera had higher genome sizes than their Renosterveld sister genera, with the average Drakensberg genome size 1.5 pg larger than the Renosterveld average. These data suggest that soil nitrogen and phosphorus concentrations are likely responsible for genome size filtering in South African biomes.

Hierarchical filtering shapes woody communities of Griqualand West

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Abiotic factors such as climate, soil, and topography act as environmental filters that shape vegetation patterns in semi-arid savannas. These filters operate across spatial scales, generating environmental heterogeneity and distinct species assemblages. However, relative roles of regional climatic versus landscape-level edaphic filters remain unresolved in the heterogeneous semi-arid savanna of Griqualand West (GW). This study evaluates how hierarchical environmental filtering shapes woody community composition across multiple spatial scales. We hypothesised that community assembly reflects hierarchical filtering across regional and landscape scales. Woody vegetation was sampled using the point-intercept method across four mountain systems representing contrasting geological substrates (dolomite, ironstone, quartzite) and climatic conditions. Species frequency was quantified along transects, and soil properties were analysed per site. A woody abundance dataset, derived from frequency values, was used to investigate woody community composition using ordinations, permutational tests and indicator species analysis. To identify environmental drivers of compositional differences, nineteen bioclimatic variables were extracted from WorldClim and fourteen soil variables obtained from soil laboratory analysis. Woody communities showed clear compositional separation among mountain systems, reflecting distinct assemblages structured along environmental gradients. This variation was driven by key climatic (temperature seasonality, temperature extremes, and precipitation) and edaphic factors (soil pH, texture, Mg and Fe concentrations), highlighting the combined influence of regional climate and landscape-level edaphic filters. Indicator species distributions corresponded closely with these gradients, with stress-tolerant taxa associated with resource limiting quartzitic and ironstone substrates, whereas more favourable dolomitic conditions supported competitively dominant species. We conclude that regional climate constrains the woody species pool of GW, while local soil conditions refine species occurrence. These findings support hierarchical environmental filtering as a key mechanism structuring woody communities in GW, highlighting the need for conservation and management strategies tailored to geological and climatic variation across the region.

Dietary strategies of savanna herbivores: a comparative metabarcoding analysis of elephants and impalas

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Mixed-feeding large herbivores in African savannas face pronounced nutritional stress during the dry season as grasses senesce and forage quality declines. These herbivores shift from grazing to browsing and incorporate non-graminoid fallback plants to offset nutritional deficits. While this flexibility buffers seasonal shortages, it may intensify competition between specialists. Yet mixed feeders commonly coexist. Previous coexistence studies have mostly focused on broad grazer-browser seasonal shifts and single-locus metabarcoding, potentially underestimating fine-scale taxonomic selection within the herbaceous layer. We used dual-locus DNA metabarcoding (rbcL and trnL) to characterise the dry-season diets of African elephants (*Loxodonta africana*) and impalas (*Aepyceros melampus*) in a South African savanna. We focused primarily on taxonomic composition and the contribution of forbs as critical fallback forage structuring niche partitioning between these two species. Although dietary alpha diversity (Shannon index) did not differ significantly between consumers, beta diversity revealed significant compositional separation with minimal overlap. NMDS ordinations (Bray-Curtis and Jaccard) showed clear separation for both markers, supported by very low Pianka's niche overlap indices (rbcL: 0.16; trnL: 0.009; $p < 0.001$). Both species relied primarily on woody browse but selected distinct taxa: elephants were dominated by Grewia, Dichrostachys and Vachellia, while impalas consumed a broader mix of browse, graminoids and forbs. Forbs contributed substantially more to impala diets (RRA: rbcL ~9%; trnL ~5%) than to elephants (RRA <1%). Both relative read abundance (RRA) and frequency-of-occurrence (FOO) data showed the same pattern, with key forbs consistently detected across impala samples. Differential abundance analyses also confirmed that forbs (e.g., *Asparagus* and Melhania) were significantly enriched in impala diets. These findings suggest that dry-season coexistence between elephants and impalas is facilitated by fine-scale taxonomic partitioning, linked to physiological and foraging-strategy differences. Loss of key fallback plants, particularly forbs, due to anthropogenic pressures may increase niche overlap and competition.

***Eragrostis nindensis*: the African lovegrass worth loving**

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Vegetative desiccation tolerance, the ability of plants to survive extreme cellular dehydration and recover upon rehydration, is exceedingly rare among angiosperms. Resurrection plants therefore offer a unique window into biological strategies for surviving water loss well beyond

conventional drought tolerance. We present *Eragrostis nindensis*, a poikilochlorophyllous resurrection grass native to southern Africa, as a model system for understanding how plants avoid damage during extreme dehydration and how these mechanisms may be translated to crops.
Using a systems-level approach, we have integrated classical physiology and ultrastructural analyses with genome sequencing and multi-omics profiling across dehydration and rehydration. These studies reveal that desiccation tolerance in *E. nindensis* is not a passive consequence of stress, but an actively regulated cellular state. As tissues dry, the plant undergoes coordinated reprogramming at the chromatin, transcript, protein, and metabolite levels, deploying molecular strategies that closely mirror those used during late seed maturation. More recent work has expanded this framework beyond the plant itself. We have explored the rhizobacteria associated with natural populations of *E. nindensis* as potential contributors to stress resilience. In greenhouse trials in Ethiopia, selected bacterial isolates improved drought tolerance and growth in tef, a closely related crop. In parallel, and in collaboration with partners in the EU BOOSTER programme, we are investigating transcription factor occupancy at defined physiological water contents to better understand how regulatory decisions are executed as tissues approach desiccation.
Together, these studies position *E. nindensis* as a powerful system for dissecting the biological logic of extreme stress tolerance and for bridging fundamental discovery with translational opportunities in agriculture.

Phylogeny and soil chemistry as predictors of nickel hyperaccumulation in a South African ultramafic flora

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Ultramafic-derived soils of the Barberton Greenstone Belt are characterised by elevated concentrations of nickel (Ni), cobalt (Co), and chromium (Cr), supporting a specialised metallophyte flora. Although several species, particularly within the *Asteraceae*, are confirmed Ni hyperaccumulators, many co-occurring taxa remain untested, and the extent to which hyperaccumulation is phylogenetically strucutred and driven by soil chemistry remains unresolved. This study integrates herbarium-based screening, field validation, and phylogenetic analysis to identify new Ni hyperaccumulator species and evaluate the predictability of hyperaccumulation from lineage and soil chemistry. A database of known and candidate hyperaccumulator species is compiled through a systematic literature review. Herbarium specimens from major South African collections are screened non-destructively using portable X-ray fluorescence (pXRF) to identify candidate species, which are subsequently verified through field sampling and Inductively Coupled Plasma Mass Spectrometry (ICP-MS) analysis of leaf and associated soil samples. We test whether the trait of Ni hyperaccumulation exhibits phylogenetic expression and clustering within specific lineages, and if variation in leaf Ni concentration can be predicted from soil properties,

including extractable Ni, Mg:Ca ratio, and pH. The validity of pXRF as a proxy for ICP-MS in herbarium-based screening is also evaluated. We expect to identify previously unreported Ni hyperaccumulator species and to demonstrate that hyperaccumulation is non-randomly distributed across the phylogeny, indicating lineage-specific adaptation to ultramafic environments. Significant correlations between soil chemistry and leaf Ni concentration are anticipated, supporting a predictive framework for hyperaccumulation. By combining phylogenetic and edaphic perspectives with a scalable screening approach, this study provides mechanistic insight into metallophyte evolution and a foundation for targeted applications in phytoremediation and phytomining.

Checklist and Conservation of Land Plants in the Egoli Granite Grasslands, Gauteng, South Africa

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A preliminary checklist of land plants from the Egoli Granite Grassland, Gauteng, South Africa, highlights the exceptional floristic diversity of this critically endangered urban grassland ecosystem. The checklist, compiled from SANBI databases and J herbarium records, documents approximately 1,939 taxa spanning bryophytes, pteridophytes, gymnosperms, and angiosperms. Angiosperms dominate the flora, representing more than 94% of all recorded taxa, while hornworts, liverworts, and mosses contribute approximately 3%, ferns and lycophytes 2.6%, and gymnosperms less than 1%. Within the angiosperms, eudicots constitute the largest proportion of species richness, accounting for an estimated three-quarters of the flora, largely driven by species-rich families such as Asteraceae, Apocynaceae, and Fabaceae. Monocots form a substantial secondary component, comprising roughly one-fifth of the flora and represented prominently by geophytic and graminoid families, including Asparagaceae, Amaryllidaceae, and Asphodelaceae. In contrast, magnoliids and ANA-grade angiosperms are poorly represented, together contributing less than 1% of recorded taxa, reflecting the ecological and evolutionary composition typical of mesic Highveld grasslands. Most species recorded are currently classified as Least Concern, indicating the persistence of significant indigenous diversity despite extensive urban transformation. However, several taxa are listed as Vulnerable, Near Threatened, Rare, Endangered, or Data Deficient, including *Helichrysum lesliei, Bowiea volubilis*, *Dicliptera magaliesbergensis*, and *Warburgia salutaris*. A notable proportion of taxa also remain Not Evaluated, particularly among bryophytes and introduced species, highlighting persistent conservation assessment gaps. The checklist demonstrates that the Egoli Granite Grassland supports considerable phylogenetic and functional diversity despite fragmentation and habitat loss. These findings emphasise the conservation significance of remnant grassland patches within Gauteng and provide an essential baseline for future biodiversity

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Trees of Wits East Campus: taxonomy, abundance, distribution, origin, and their ecosystem services

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Johannesburg is home to the largest man-made urban forest in the world, yet its ecological composition remains underexplored. This study investigated the taxonomy, abundance, distribution, origins, and ecosystem services of trees on the University of the Witwatersrand's East Campus. Using data from the 2024 Wits internal tree survey, supplemented by field verification, iNaturalist identifications, and QGIS mapping, a dataset of 1,141 individual trees was compiled. A total of 150 species, representing 99 genera and 52 families, were recorded, with angiosperms overwhelmingly dominant. Fabaceae and Myrtaceae were the most speciose families, while *Celtis africana* was the most abundant species.
Exotic taxa comprised 57% of species, reflecting Johannesburg's colonial planting legacy, although resilient indigenous taxa such as *Olea europaea* subsp. *africana* remain ecologically significant. Pollination was dominated by biotic interactions, particularly insect pollination, while dispersal was largely *zoochorous*, with birds as primary agents. Spatial analysis revealed uneven tree distribution, shaped by historical landscaping and infrastructural changes. Comparison with historical records demonstrated a striking transformation: from open grassland in the 1920s to a taxonomically diverse urban forest in the 2020s. East Campus was richer in species diversity than West Campus, which is dominated by indigenous taxa. These findings highlight both vulnerabilities and opportunities within Johannesburg's urban forest, underscoring the need for management strategies that enhance diversity, prioritize indigenous planting, and safeguard ecological processes such as pollination and dispersal.

Diversity and composition of epiphytic *corticolous lichens* along an urban–rural gradient of three cities

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Urbanisation is a major driver of biodiversity change, restructuring communities through environmental filtering, habitat modification and pollution. Epiphytic lichens are sensitive bioindicators of these changes, yet most studies rely on simple urban–rural contrasts, limiting understanding of how lichen communities respond across heterogeneous land-use mosaics, particularly in the Global South. This study quantifies patterns of diversity, community composition, and indicator species turnover of *corticolous lichens* across a multi-category urban–rural gradient in three cities within South Africa's Highveld Grassland Bioregion of the Grassland Biome (Klerksdorp, Potchefstroom, and Vanderbijlpark). By incorporating

protected, agricultural, residential, commercial, and industrial land uses, the study provides a replicated, multi-city framework for assessing lichen responses to land-use intensity. We (1) assess changes in lichen diversity and community composition along the gradient, (2) quantify community turnover and compositional shifts associated with increasing urban intensity, and (3) identify indicator species linked to specific land-use categories and evaluate their potential for biomonitoring. Suitable host trees are selected based on bark condition and minimum diameter of 15 cm. Lichens are sampled using a standardised ladder-quadrat method at 1.3 m and analysed using diversity metrics, community composition analyses and indicator species approached. We hypothesise that increasing land-use intensity acts as an environmental filter, reducing diversity and driving compositional turnover toward pollution-tolerant and disturbance-adapted taxa. We further expect that lichen communities will exhibit non-random restructuring across land-use types, enabling the identification of reliable indicator species. By moving beyond binary urban–rural comparisons, this study advances urban lichen ecology and provides a scalable, indicator-based framework for monitoring land-use impacts on biodiversity.

Lichen diversity, community composition, and habitat associations in Grootbos Private Nature Reserve, South Africa

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The Grootbos Private Nature Reserve (GPNR) is a privately owned reserve within the Cape Floristic Region. Although the faunal and floral diversity of the reserve has been relatively well documented, its lichen biota remains poorly known. This poster presents the first characterization of the lichen diversity at GPNR, using a functional trait-based, morphospecies approach to assess diversity, rarity, community composition, and associations with environmental variables. Lichen communities were surveyed in Afromontane and Milkwood forests as well as on Agulhas limestone and Table Mountain Sandstone outcrops. Morphospecies, together with functional traits including growth form, reproductive structures, and photobiont type, were recorded in quadrats placed along a 100 m transect within each of the four habitat types. A total of 322 individual lichens were recorded, representing at least 89 morphospecies, most of which were locally rare as they were only recorded in a single quadrat. Results indicate that forest habitats support greater

morphospecies richness than rock outcrop sites. Certain lichen growth forms were restricted to specific substrates. Crustose lichens occurred on both bark and rock substrates, whereas foliose and fruticose forms were recorded only on bark. Across all four habitats, most lichens were sexually reproducing crustose lichens with green algal photobionts. Elevation, substrate texture, and aspect were important drivers of community differentiation among sites. These findings indicate strong habitat specificity in lichen assemblages, with richness and rarity patterns in corticolous communities likely influenced by elevation and forest type, while those of saxicolous communities appear to be shaped primarily by aspect. Our baseline study revealed high lichen morphospecies diversity in an ecosystem with hyperdiverse flora and identified important considerations for future work, such as studying bark and rock dwelling lichens separately, as their environmental drivers appear to differ.

Invasion of Johnson grass (*Sorghum helepense*): Narrative Review

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Johnson grass (*Sorghum helepense*) is one of the world's most noxious invasive weeds. Climate change is expected to worsen its spread and competitive ability. This review aimed to examine published literature on the botanical description, distribution patterns, impact on livestock and possible control measures of *S. helepense.* As a result, thirty-two online articles have been reviewed from google schooler. The literature revealed that Jonhson grass is regarded as noxious weed across five continents namely Africa, South America, North America, Europe, and Australia. However, the earliest introduction of Johnsongrass occurred around 1830 through contaminated cotton seeds from Egypt to United States. Abundance of species grazing lands have been shown to suppress native species years late in Unite State. In terms of description Johsongrass is a narrow-leaved perennial grass that can grow up to 2.5m height and stems diameter ranging from 0.5m and 2.0cm. This plant has been reported in South Africa (Western Cape Province, Gauteng, KwaZulu Natal, Mpumalanga, Limpopo, and Eastern Cape). Johsongrass contains high concentrations of prussic acid (commonly known as hydrocyanic acid), particularly during early growing stages. High concentration of prussic acid may interfere with oxygen supply, animal may die from asphyxiation. Due to high seed production and extensive underground stems, a single control method is often ineffective, necessitates an integrated management strategy.

Urban vegetation mediates thermal environments and human well-being across Africa

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We are losing biodiversity in an unprecedented manner particularly in cities. This has tremendous consequences on human wellbeing in urban settings, largely due to urban heat island (UHI). This study provides a continent-wide assessment of UHI across 1,010 African cities and evaluates how urban vegetation mediates thermal environments and human well-being. Using remotely sensed ecological data and socio-economic indicators, we quantified differences between urban and surrounding temperatures and modelled their drivers with linear mixed-effects approaches. We show that nighttime land surface temperatures are significantly higher within urban areas, with UHI detected in approximately 63% of cities. Urban areas consistently exhibited reduced vegetation cover, measured using the enhanced vegetation index (EVI), pointing to widespread greening deficits. However, the cooling effect of vegetation is not uniform. Increased vegetation is associated with significant reductions in UHI intensity primarily in coastal and inland capital cities, while no clear effect is observed in other inland cities. Extending the analysis to human well-being, we found that elevated urban temperatures are consistently linked to lower well-being, whereas environmental performance tends to enhance it. Importantly, vegetation and biomass interact with environmental quality to buffer negative heat effects and amplify positive outcomes. Higher-order interactions further indicate that well-being emerges from complex, context-dependent relationships among ecological and environmental factors rather than single drivers. These findings underscore the critical but spatially variable role of urban vegetation in mitigating heat exposure and shaping human well-being in African cities. Our study highlights the need for steady investment in urban forestry for human wellbeing across Africa.

Recovery of herbaceous diversity and community structure following targeted clearing of invasive bracken in a critically endangered Woodbush Granite grassland

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Bracken (*Pteridium aquilinum*) is a cosmopolitan species capable of forming dense, persistent stands. Reduced subcanopy light, dense litter production and allelopathic exudates increase mortality in, and suppress recruitment of, co-occurring flora. Its ability to spread via extensive rhizome networks, tolerance of frequent and intense fire, and low palatability reinforce its dominance, making control difficult and costly. In South Africa bracken invasion is a management concern in grasslands, forest margins, fynbos and mesic savannas.
In 2020 SAEON, North West University, a local NGO, and the Department of Forestry, Fisheries and the Environment, initiated targeted mechanical clearing of bracken in a heavily invaded fragment of hyper-diverse critically endangered Woodbush Granite grassland. Clearing involved the periodic removal of fronds through the growing seasons of 2020-2025, based on the premise that forced resprouting depletes bracken nutrient reserves and reduces competitive advantage. We aimed to 1) document the negative effects of bracken on local plant diversity, and 2) track plant diversity and community composition post-clearing. Clearing effects were determined by comparing three replicated treatments: cleared areas, uncleared controls, and open, un-invaded controls.
After five years the end-of-season bracken regrowth (% cover) in treatment plots decreased from >75% to <10%. In year 0 cleared areas had lower overall and especially for richness relative to the open control. By year 3 species' richness had increased in cleared areas, and by year 5 richness and diversity here were equal to the open control, with both being significantly higher than in uncleared areas. This recovery was driven primarily by increases in forb abundance and cover. If unmanaged, bracken can transform diverse ecosystems into depauperate communities. However, the mechanical control of bracken allowed for recovery of the herbaceous layer as demonstrated in this trial by convergence in the community composition of previously invaded and un-invaded grassland.

Climate-Smart Pasta Innovations: Advancing Sustainable Food Systems in developing countries: a case of KwaZulu-Natal, South Africa

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Despite their nutrient-dense profiles and resilience to adverse climatic conditions such as drought and floods, traditional cereal grains and legumes remain underutilized compared to wheat and maize. This study aims to produce climate-smart pasta formulations using pearl millet fortified with cowpeas and sorghum fortified with cowpeas. The objective is to create nutritious and sustainable pasta options that reduce reliance on low-nutrient, resource-intensive crops, thus addressing the dual challenges of nutritional deficiencies and climate change. Integrating cowpeas into cereal pasta enhances nutritional quality by providing complete protein and essential amino acids while contributing to soil health through nitrogen fixation. Moreover, the crops' inherent drought tolerance and low input requirements make

them suitable for resource-efficient food production with potentially lower water consumption and greenhouse gas emissions than conventional wheat pasta. Technological inventions, including sprouting cowpeas to reduce anti-nutritional factors, pre-gelatinisation of 10% of the flour to improve cooking efficiency, and the addition of hydrocolloids to mimic gluten structure, contribute to producing high-quality, nutritionally balanced, gluten-free pasta that performs similarly to traditional wheat pasta. This approach supports resilient food systems and climate adaptation strategies pertinent to the ideals of healthier communities. Future studies could quantify the environmental benefits of such studies, such as reduction of water use and greenhouse gas emissions. Adopting climate pasta formulations can support sustainable agricultural practices, improve food security, and foster resilient local food systems. Policy makers can incorporate such innovations into national food and climate policies. Fostering trans-national collaborations among developing countries can facilitate knowledge exchange and technology transfer and expand efforts for broader implementation. The research presents the possibility of combining crop resilience, food processing techniques, and sustainable agricultural practices to develop climate-smart pasta products that can contribute to climate change mitigation and promote sustainable food systems in developing countries.

Growth dynamics and nutritional composition of *Mimusops zeyheri*: A case of Makhado and Mbombela local municipalities

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Mimusops zeyheri, known as the Transvaal red milkwood, is a fruit tree species of the Sapotaceae family natively occurring in the southern African region. Transvaal red milkwood is a multi-use plant species essential for its fruit, leaves, bark, and roots, which are used in ethnobotanical medicine by local communities. Ethnomedicinal uses include the treatment of diabetes and non-communicable diseases such as cancer and hypertension. The study aimed to assess the growth and nutritional composition of *Mimusops zeyheri* from two Agroecologies. Growth dynamics parameters such as morphological characteristics and nutritional composition (vitamins and minerals) from Makhado and Mbombela. The growth parameters included stem diameter, tree height, crown width, crown health, fruiting observation, distance between trees, and leaf size, chlorophyll content. For water use efficiency stomatal conductance and soil moisture content were measured. The nutritional composition was analysed using ICP-OES, β-carotene and vitamins were quantified using HPLC. The statistical data was analysed using the one-way by means were separated using Duncans multiple range test p005. The results showed a higher mean stomatal conductance (45.65 mmol/(m²·s)) in Mpumalanga compared to Limpopo (25.69 mmol/(m²·s). Mpumalanga was found to have larger, healthier and more fruitful trees as far as growth parameters are

concerned as observed through physiological and morphological characteristics. β-carotene content, measured with HPLC, was at 17.38 mg/100g and 13.93 mg/100g in Limpopo and Mpumalanga respectively. Mpumalanga tree leaves had higher vitamin C content 119.05 mg/100g compared to 66.47 mg/100g in Limpopo. In the leaf samples, Limpopo had higher Ca, Cu, Fe, Mg, Na, content and Mpumalanga had higher K, P, Zn content. The results of the study indicate that Mimusops zeyheri can be viable as a source of nutrition from a scientific standpoint. In conclusion, the plant species does well in both locations but Mbombela would significantly be better for cultivation.

A century of cycad research in Africa: patterns, progress and challenges

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Africa hosts a rich diversity of cycads, comprising 65 *Encephalartos* species, as well as *Cycas thouarsii* and the monotypic *Stangeria eriopus*. Over the past century, research on African cycads have progressed from basic taxonomic description to robust and detailed multidisciplinary studies, with advances in molecular tools for identification and management, reproductive ecology and pollination, and trade-related conservation work. However, African cycads continue to decline, with knowledge unevenly distributed across disciplines, taxa and regions. Using PRISMA, this systematic review synthesises over a century of research on African cycads through qualitative thematic approach. We integrate findings on cone biology and seed development, reproductive ecology and pollination systems, chemical ecology and thermogenesis, plant-insect interactions, root-microbe symbioses, biotechnology, genetics, ethnobotany and toxicity. Across these themes, synthesis highlights three key findings: (i) recruitment limitation typically arises from interacting ecological, developmental, and multi-trophic constraints; (ii) cycad reproduction depends on specialised interactions between chemical signalling, cone phenology and pollinator behaviour; (iii) anthropogenic pressures, particularly illegal removal of adult plants for horticultural and traditional medicine trades, remain dominant drivers of decline. The evidence base is taxonomically biased, with a small subset of species dominating literature, while many threatened taxa receive little or no empirical attention. There is also a strong geographic bias towards South Africa, with approximately 85% of studies involving South African species, meaning that much of the current understanding is derived from South African systems and may not fully capture patterns across African. Addressing these gaps will require greater integration across disciplines, with priority areas including linking mechanistic processes to demographic outcomes, incorporating fire ecology into conservation planning, evaluating translocation and assisted-reproduction strategies in the context of local adaptation, species- and population-level tests of pollination limitation under disturbance.

Functional traits and nutritional quality variation among ecotypes of Themeda triandraacross KwaZulu-Natal grasslands

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Themeda triandra Forssk. (commonly known as Red grass or Rooigrass) is an ecologically important perennial grass species in the mesic grasslands of KwaZulu Natal, which contributes significantly to ecosystem functionality, biodiversity and livestock production. However, limited information exists on ecotype variation within the species across ecological zones of the Kwa-Zulu Natal. Understanding such variation is important for rangeland restoration, grazing value assessment, conservation and rangeland management. This study aims to identify and compare three ecotypes of *T. triandra* across Kwa-Zulu Natal grasslands, and to evaluate differences in their functional (morphological) traits, nutritional quality and ecological responses to along environmental gradients. The study will be conducted across multiple sites representing different rainfall and soil properties. Plants traits, including height, tuft dimeter, leaf lengths and above ground biomass will be measured. Nutrition quality will be assessed through analysis of key parameters such as crude protein, fibre content, and mineral composition. In addition, environmental variables such as soil parameters and climatic factors will be recorded. Statistical analysis will be used to determine among ecotypes and examine relationships between plant traits, nutritional quality and environmental drivers. The study is expected to reveal distinct ecotype patterns linked to local environmental condition. The findings will contribute to better understanding of intraspecific variation in *T. triandra* and its implication for rangeland functioning and livestock production. This knowledge will also assist with selection of suitable ecotypes for reseeding and restoration programmes.

A review phytochemical composition of *Toxicodendron succedaneum* and its efficacy as botanical insecticide of common maize pest in smallholder farming

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Toxicodendron succedanea, commonly known as Japanese wax tree, is a member of the Anacardiaceae family native to East Asia, has become invasive in parts of South Africa and is classified as a forbidden Category 1b species as per the Conservation of Agricultural Resource Act 43 of 1983. The classification prohibits its cultivation and mandates the strict management and control of the existing plants to further spread. Despite its invasive status, the species is rich in secondary metabolites, namely, urushiol, a bioactive compound known for their defensive, insecticidal and antimicrobial properties. The current global concerns regarding the negative impacts of synthetic pesticides on human and the environmental health, coupled with increasing demand for safer production practise, have renewed interest in the use of botanical pesticides, especially in organic farming systems. Hence, this review seeks to

comprehensively and systematically synthesize the existing literature on phytochemical diversity, of *T. succedaneum,* the distribution of its bioactive compounds within plant parts and its potential use as a botanical insecticide targeting key maize pest in smallholder farming systems. The review highlights the potential of *T. succedaneum* as a sustainable alternative insecticide for the control of several chewing insects, mainly in the orders Coleoptera, Lepidoptera and Orthoptera. However, challenges related to its toxicity, formulation, standardisation, and regulatory compliance remain a significant barrier to its practical application. Addressing these constraints will be critical for advancing the use of *T. succedaneum* extract as botanical pesticides in sustainable agriculture.

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University-owned field stations within biodiverse landscapes provide unique opportunities for long-term ecological monitoring, research, and student training. Pullen Nature Reserve, donated to the University of the Witwatersrand in 1985 and managed by the School of Animal, Plant and Environmental Sciences, is in Mpumalanga's Savanna Biome. Following limited use, a strategic five-year development plan is repositioning the reserve as an active biological field station. Systematic camera trap surveys are generating baseline mammal occupancy data, representing the first rigorous biodiversity assessments at the site. Planned surveys will expand to additional taxa, while active veld management is restoring ecological integrity to support repeatable monitoring. The reserve also offers work-integrated learning opportunities, including veld condition assessments, game counts, and ecological survey training, alongside research on small carnivores, antelope, and nocturnal fauna. Together, these initiatives establish Pullen as a platform for tracking the impacts of land management, bush encroachment, invasive alien plants, and savanna restoration on biodiversity. This case study highlights the responsibility and opportunity for academic institutions to convert ecologically significant assets into rigorously monitored research sites, advancing both conservation science and student training.

Maize Cultivar Performance under Conservation Agriculture Practices in OR Tambo District, Eastern Cape

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Maize production in the Eastern Cape is still largely based on conventional tillage systems, which have contributed to soil degradation, declining fertility and increased vulnerability to climate variability. Although Conservation Agriculture (CA), offers a sustainable alternative through minimum soil disturbance and improved soil cover, its adoption among smallholder farmers remains limited. One key barrier is the lack of localized information on which maize cultivars and cover crop systems perform best under no-till conditions. This study evaluated

the growth, grain moisture and yield responses of selected maize cultivars under CA practices to identify locally adapted production strategies for smallholder systems. Field trials were conducted during the 2024/25 season at Mgojweni (Ngqeleni) and Nkanga (Libode) using a factorial randomized complete block design. Four maize cultivars (P125W, PAN 5R-590R, P1788W and PAN 4R-528) were grown under no-till with vetch, oats, a vetch-oats mixture, and a no-cover control. Vegetative parameters were measured six weeks after planting, while grain moisture and yield were assessed at harvest. Vegetative parameters showed limited cultivar differences, although PAN 5R-590R consistently produced more leaves and taller. Grain moisture ranged from 15.2-23.8% at Mgojweni and 13.7-24.4% at Nkanga, with vetch and oats generally increasing moisture levels. Grain yield varied widely from 0.175-1.37 kg $plot^{-1}$ at Mgojweni and 0.045-1.415 kg $plot^{-1}$ at Nkanga, revealing strong site, cultivar and cover crop interactions. Mix and oats treatments supported higher yields at Mgojweni, particularly for P1788W and P125W, while Nkanga showed greater yield potential under vetch and mix systems, especially for P125W and PAN 5R-590R. Nkanga showed higher yield potential than Mgojweni. Results demonstrate the added value of cover crops for yield stability under CA. Vetch increased yields for some maize cultivars, while mixed cover crops gave the most consistent results across different fields. Choosing the right maize variety together with the right cover crop and getting good extension support, can help farmers grow more maize, cope better with dry seasons and farm more sustainably.

Digitisation of indigenous medicinal plant specimens in the herbarium: Optimising workflows and data accessibility

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Herbaria play an important role in preserving plant biodiversity records and supporting research, conservation, education, and species identification. Indigenous medicinal plants are especially valuable because they contribute to traditional healthcare systems, cultural knowledge, and local livelihoods. However, many herbarium collections remain underutilised when specimens exist only in physical form, where repeated handling can cause damage such as tearing, fading, pest infestation, and general deterioration. This project focuses on the digitisation of indigenous medicinal plant specimens in the herbarium to improve documentation, preservation, and future identification systems. The study examines the herbarium workflow from specimen collection to final storage. Field data such as locality, coordinates, habitat, collector details, and medicinal uses are recorded. In the herbarium, specimens are pressed, dried, mounted, labelled, and curated before digitisation through high-resolution scanning or photography. Associated metadata, including scientific name, family, collection date, and locality, are entered into a standardised digital database with quality control measures to ensure accuracy and consistency. Digitisation reduces excessive handling of fragile specimens, improving long-term preservation while increasing accessibility for researchers, students, and institutions globally. Digital collections also support faster species identification by providing reliable image references and verified specimen data. In

future, this dataset may contribute to advanced tools such as image recognition systems, artificial intelligence applications, and geographic information systems for biodiversity monitoring. The project demonstrates how traditional herbarium collections can be modernised through digitisation while safeguarding valuable indigenous medicinal plant knowledge for future generations.

Rhizosphere-mediated improvements in soil health and biological activity following *Vicia sativa* and *Vicia villosa* cultivation in nutrient-deficient sugarcane soils

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Declining soil fertility and biological activity remain major constraints in small-scale sugarcane production systems in KwaZulu-Natal, South Africa. Incorporating legume cover crops may improve soil quality by enhancing rhizosphere microbial activity and nutrient cycling. A greenhouse experiment was conducted to evaluate the effects of *Vicia sativa* and *Vicia villosa* on the chemical and biological properties of nutrient-deficient sugarcane plantation soils collected from five small-scale farming sites in KwaZulu-Natal. Soil chemical properties, extracellular enzyme activities, and rhizospheric bacterial populations were analysed before and after legume harvest. Post-harvest soils showed increased pH and improved concentrations of basic cations, particularly calcium and magnesium, across several sites. Both legume species increased the abundance of plant growth-promoting rhizobacteria, with bacteria closely related to *Arthrobacter*, *Burkholderia*, *Paraburkholderia*, and *Pseudomonas* among the dominant genera that was identified. There was a significant increase in acid phosphatase and β-glucosidase activities following legume growth, particularly in Mvutshini and Mzinto soils, indicating enhanced microbial-mediated nutrient cycling and soil biological functioning. Variations in nutrient dynamics and microbial responses across sites highlighted the influence of site-specific soil conditions on plant-microbe interactions. The findings demonstrate that *V. sativa* and *V. villosa* can improve rhizosphere functioning and contribute to the amelioration of nutrient-deficient sugarcane soils, supporting their potential use in sustainable soil rehabilitation and low-input agricultural systems.

An experimental assessment of sterility in cultivars of the invasive ornamental plant *Duranta erecta*

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In South Africa, *Duranta erecta* is a popular ornamental but regulated as an invasive plant, however there is provision for cultivars to be exempt from regulation on the basis of sterility. Here, the reproductive outputs of three *D. erecta* cultivars (Goldmine, Sapphire Showers, and Sheena's Gold) were compared to the naturally occurring (wild type) form to evaluate whether they present as sterile. The reproductive output was assessed using flower and fruit production, pollen viability, seed viability, seed germination, plant vigour, and vegetative reproduction success. Goldmine did not produce any flowers or seeds and therefore is considered sterile. Sapphire Showers was more prolific in flowering than Sheena's Gold but had lower pollen viability and produced fewer fruit. However, both cultivars had substantially lower seed viability and germination than the wild type- the relative reproductive output of the wild type was 1714 and 24000 times higher than Sheena's Gold and Sapphire Showers, respectively. In terms of vegetative reproduction, the survival of cuttings was very low (3/80) for wild type while higher for the cultivars (24 to 66/80). The cuttings of the cultivars grew more vigorously than the wild types for the first three to six months, but all taxa had similar root and shoot lengths after one year. However, the wild type generally had the highest growth rate after one year. If limiting viable seed production is effective to prevent and curb invasions from *D. erecta*, then, the sterility and/or substantially reduced fertility shown in the three studied cultivars is consistent with the current regulatory exemptions. The results are summarised in a guideline advising what should be included in a sterility assessment for cultivars or hybrids of invasive species.

Remote camera analysis reveals mixed pollination of *Protea venusta*

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Pollinators are crucial for plant reproduction and diversification. The plant genus *Protea* (family Proteaceae) of the Cape Floristic Region of South Africa, a global biodiversity hotspot, is an example of how evolutionary radiations can potentially be driven by transitions among primary pollinators. The sprawling shrub *Protea venusta* Compton has intermediate morphology and is listed as either mammal or bird pollinated, yet there is no empirical documentation of pollinators. Although it is difficult to document field observations of ground-dwelling mammal pollination events, remote motion-activated camera analysis has enhanced our ability to capture 24-hour pollinator activity. This technology allows us to both decipher temporal activity patterns and identify novel pollinators. We deployed six camera traps in a population of *P. venusta* at Swartberg Pass in the Western Cape to assess whether this species is predominantly bird pollinated, mammal pollinated, or whether it functions within a mixed pollination network. Preliminary evidence suggests that birds (primarily the Cape sugarbird, *Promerops cafer*, and fewer visits by three different sunbird species) are the most common floral visitors during the day, followed by nocturnally active rodents (such as the spectacled dormouse, *Graphiurus ocularis*). Most bird visits occurred between dawn (6:00) and dusk (20:00), indicative of primarily diurnal pollination by birds, however, unusual nocturnal activity of Cape sugarbirds was observed (21h00-03h00). Understanding the pollination system of an individual species such as *P. venusta* is crucial in providing insight into how unique plant-pollinator networks function, adapt, and persist in one of the world's most biodiverse hotspots.

PLANT BIOTECHNOLOGY

Investigating the Physiological & Metabolomic effect of foliar application of *Ecklonia maxima*-derived biostimulant on Tomato plants in ameliorating the effects of heat shock

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Heat shock severely impairs plant growth, viability, and productivity by disrupting cellular structures and inducing excessive production of reactive oxygen species (ROS), resulting in metabolic imbalance. *Solanum lycopersicum*, an economically important horticultural crop, is particularly susceptible to elevated temperatures. With increasing climate variability, sustainable strategies such as biostimulant application are gaining attention for enhancing crop resilience. Afrikelp, derived from *Ecklonia maxima*, is widely used to improve plant growth and stress tolerance. This study investigated whether foliar application of this biostimulant enhances heat shock tolerance in tomato plants and examined associated physiological, biochemical, and metabolic responses. Physiological assessments included measurements of photosynthetic pigments, electrolyte leakage, and chlorophyll fluorescence. Biochemical analyses involved ferric reducing antioxidant power (FRAP), DPPH radical scavenging activity, lipid peroxidation, and proline content. Gas chromatography–mass spectrometry (GC–MS) was used to profile primary metabolites and identify stress-associated metabolic pathways. Biostimulant-treated plants exposed to heat shock showed significantly higher photosynthetic pigment content and reduced electrolyte leakage, indicating improved

membrane stability. Treated plants also exhibited decreased lipid peroxidation and lower proline accumulation, suggesting enhanced antioxidant capacity and improved ROS scavenging. Metabolomic analysis revealed increased levels of amino acids (phenylalanine, isoleucine, threonine), sugars (myoinositol, xylose), and organic acids (citric, malic, and succinic acids), which are associated with improved stress tolerance. Overall, application of the Ecklonia maxima-derived biostimulant enhanced physiological performance and mitigated oxidative stress in tomato plants under heat shock, highlighting its potential as a sustainable strategy to improve crop resilience.

Halophytic extract priming as a promising strategy for optimising yield quality and mitigating salinity stress in lettuce

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Salt stress is a major factor that contributes to reduced vegetable productivity. A pot experiment was carried out to study the ameliorative role of seed priming with varying concentrations (50%, 25%, 12.5%) of the crude extract of the halophyte Tetragonia decumbens on lettuce plants grown under optimal saline condition (150 mM NaCl). Growth parameters, leaf ultrastructure, chlorophyll content, photosynthetic efficiency, oxidative stress markers and antioxidant defence mechanisms were determined. Results revealed that plants subjected to salinity without crude extract treatment had significantly lower growth indices, reduced chlorophyll pigments, and the epidermal cells were ruptured. Remarkably, plants treated with halophytic crude extract effectively ameliorated the salt stress-induced damage, with plants treated with 12.5% extract achieving similar growth indices and photosynthetic pigments as the control plants (no extract and no NaCl irrigation). This was due to high K+, Ca^{2+}, and Mg2+ uptake recorded in this treatment, which maintained ion homeostasis and protected cells against disruption. Moreover, saline irrigation without extract treatment caused a significant increase in oxidative stress, which was indicated by high levels of superoxide radicals and malondialdehyde activity, and these were significantly reduced in plants treated with 12.5% via enhanced superoxide dismutase. Based on these findings, the use of the halophytic crude extract of T. decumbens can be considered as an innovative strategy for alleviating salinity stress in vegetable production.

Redox Modulation by Ascorbic Acid Under Salinity Stress in Marchantia polymorpha

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Abiotic stresses such as salinity severely impair plant growth and survival by disrupting cellular redox homeostasis and inducing oxidative damage. Marchantia polymorpha, a model liverwort representing early land plants, provides a valuable model for investigating conserved stress response mechanisms. This study examined the role of exogenous ascorbic acid (AsA), a key antioxidant, in modulating redox balance in M. polymorpha under salinity stress. Thalli were exposed to 50 mM NaCl with or without AsA (2 mM) supplementation, and physiological and biochemical responses were evaluated. Salinity stress resulted in increased accumulation of reactive oxygen species (ROS), reduced photosynthetic efficiency, enhanced lipid peroxidation, and altered antioxidant enzyme activities. These changes indicate substantial oxidative stress and disruption of cellular integrity. Exogenous application of AsA significantly mitigated these effects by reducing ROS accumulation, decreasing lipid peroxidation, and enhancing the activities of key antioxidant enzymes, including superoxide dismutase, ascorbate peroxidase, and catalase. Furthermore, AsA treatment improved photosynthetic performance and promoted better growth and survival under saline conditions compared to untreated controls. Overall, these findings demonstrate that AsA plays a crucial role in maintaining redox homeostasis and enhancing salinity tolerance in M. polymorpha. This study highlights the importance of antioxidant-mediated defence mechanisms in early land plants and provides insight into conserved mechanisms of stress adaptation. Such knowledge may inform future approaches aimed at improving crop resilience to salinity stress.

Exploring the Role of Methylglyoxal in Marchantia polymorpha under Cadmium Stress

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Cadmium (Cd) is a toxic heavy metal that impairs plant growth by inducing oxidative and carbonyl stress, yet the role of methylglyoxal (MGO) in modulating Cd toxicity remains poorly understood, particularly in early land plants. This study investigated the combined effects of Cd and MGO on the physiological, biochemical and elemental responses of the model bryophyte Marchantia polymorpha. Gem malings were exposed to Cd alone or Cd supplemented with 0.1–0.4 µM MGO for two weeks. Growth was assessed by fresh biomass and chlorophyll content, while oxidative damage was evaluated through superoxide, hydrogen peroxide and malondialdehyde levels. Antioxidant responses were determined by superoxide dismutase and catalase activities, carbonyl stress by endogenous MGO and glyoxalase I activity, and elemental composition by inductively coupled plasma–atomic emission spectroscopy. Cadmium exposure caused pronounced growth inhibition, increased reactive oxygen species and lipid peroxidation, and substantial Cd accumulation in thallus tissues. Cd also disrupted the homeostasis of essential elements, including Mg, K, Ca and Na. MGO exerted concentration-dependent effects. Low concentrations (0.1–0.2 µM) did not alleviate Cd toxicity and were associated with greater oxidative damage, whereas moderate

concentrations (0.3–0.4 µM) partially restored growth, reduced superoxide accumulation, and stabilized antioxidant enzyme activities. Glyoxalase I activity was most strongly induced at intermediate MGO concentrations, indicating activation of detoxification pathways involved in stress acclimation. These findings demonstrate that MGO acts as a dual-function molecule, serving as both a toxic metabolite and a signalling compound that modulates Cd tolerance depending on its concentration. The study advances understanding of oxidative–carbonyl stress interactions in early land plants and highlights bryophytes as valuable model systems and bioindicators for metal pollution research.

From Single Isolates to Synthetic Consortia: Enhancing Biocontrol of *Macrophomina phaseolina in Phaseolus vulgaris* L.

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Biotic stress caused by soilborne pathogens remains a major constraint to crop productivity worldwide. Among these, *Macrophomina phaseolina*, the causal agent of charcoal rot disease, reduces the growth and productivity of Phaseolus vulgaris L., and conventional control strategies remain ineffective. Although individual bacterial endophytes have demonstrated biocontrol potential, their efficacy is often inconsistent due to limited functional capacity. This study evaluated the biocontrol and plant growth-promoting potential of individual bacterial endophytes and assessed whether their assembly into compatible synthetic consortia enhances pathogen suppression and plant stress tolerance. Individual bacterial isolates were initially screened for antagonistic activity and plant growth-promoting traits. Based on functional complementarity, selected isolates were assembled into synthetic consortia and assessed for compatibility using cross-streaking assays. Consortium efficacy was further evaluated through in vitro dual culture assays and in planta pathogen challenge experiments, followed by assessment of physiological and oxidative stress-related parameters. Among these, the consortium comprising isolates L1I9, P4I12, and PR5AI1 (designated ADE) exhibited superior compatibility and performance and was selected for further evaluation in comparison to individual isolates. In dual culture assays, the ADE consortium outperformed individual isolates, exhibiting the highest inhibition of *M. phaseolina* mycelial growth (78.4%). In planta experiments further showed that consortium-treated plants exhibited improved physiological responses and stress tolerance, including enhanced relative water content, reduced shoot water loss, increased chlorophyll content, and lower lipid peroxidation and cell death. These responses collectively indicate reduced oxidative damage and improved tolerance to pathogen-induced stress. These findings demonstrate that functionally compatible bacterial consortia outperform individual isolates in pathogen suppression and plant physiological responses, highlighting the importance of compatibility-driven consortium design for sustainable management of charcoal rot disease.

Antifungal efficacy of *Moringa oleifera* leaf extract against *Alternaria alternata*

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Alternaria alternata is an important fungal pathogen associated with head blight disease in wheat, resulting in reduced grain quality and economic losses. Disease management relies largely on chemical fungicides, which may negatively affect the environment and increase production costs. *Moringa oleifera* contains bioactive phytochemicals with known antimicrobial properties and may provide a sustainable alternative for fungal disease management. This study evaluated the antifungal activity of *M. oleifera* leaf extract (MOLE) against *A. alternata* and investigated its effect on fungal oxidative stress responses. *A. alternata* was isolated from diseased wheat (Triticum aestivum) and identified using ITS and species-specific markers. MOLE was prepared using distilled water and leaf powder. Phytochemical compounds, including phenols, flavonoids, alkaloids, saponins, and tannins, were quantified. Antifungal activity was evaluated on potato dextrose agar and broth amended with MOLE at 5, 10, and 20 mg/ml. Fungal growth inhibition and dry biomass reduction were determined. Oxidative stress and enzymatic responses of *A. alternata* exposed to MOLE were assessed using biochemical assays for H_2O_2, MDA, SOD, APX, glucanase, and lipase activity. Molecular analysis confirmed the fungal isolate as *A. alternata.* MOLE contained measurable levels of bioactive phytochemicals. The greatest mycelial growth inhibition occurred at 20 mg/ml, while the minimum inhibitory concentration was observed at 10 mg/ml. Fungal dry biomass in broth cultures was reduced following MOLE treatment. Compared to the control, 20 mg/ml MOLE significantly increased H_2O_2, MDA, SOD, APX, glucanase, and lipase activity, indicating induced oxidative stress and disruption of fungal physiological processes. Moringa oleifera leaf extract effectively inhibited the growth of *A. alternata* and induced oxidative stress-related biochemical responses in the fungus. These findings highlight the potential of MOLE as an environmentally friendly biocontrol agent for sustainable wheat disease management.

Bacillus firmus* CP5 from *Echium plantagineum* roots confer Antimony stress tolerance in *Brassica napus

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Plant growth-promoting endophytic bacteria (PGPE) have emerged as sustainable tools for improving crop productivity under abiotic stress conditions. This study investigated the potential of an endophytic bacterial isolate, *Bacillus firmus* CP5, obtained from the roots

of *Echium plantagineum*, to enhance antimony (Sb) stress tolerance in *Brassica napus*. Endophytic bacteria were isolated from surface-sterilized roots and screened for growth-promoting ability under greenhouse conditions. Among the isolates tested, CP5 produced the greatest enhancement in seed germination, root and shoot elongation, biomass accumulation, and vigor index in *B. napus* seedlings. The isolate was further evaluated for plant growth-promoting traits including phosphate solubilization, indole-3-acetic acid (IAA) production, ACC deaminase activity, and siderophore production. Bacillus firmus CP5 demonstrated strong phosphate-solubilizing ability, significant IAA production, and ACC deaminase activity, although siderophore production was not detected. To evaluate heavy metal stress tolerance, B. napus seedlings inoculated with CP5 were exposed to antimony stress under greenhouse conditions. Antimony exposure reduced plant growth, particularly root biomass and nutrient uptake, while increasing cellular damage. However, inoculation with CP5 significantly alleviated these inhibitory effects by improving root development, enhancing macroelement accumulation, reducing stress-induced tissue damage, and increasing Sb tolerance. The isolate also exhibited tolerance to increasing antimony concentrations in vitro. These findings demonstrate that Bacillus firmus CP5 possesses multiple plant growth-promoting mechanisms that contribute to enhanced growth and antimony stress tolerance in B. napus. The study highlights the potential application of endophytic bacteria as sustainable bioinoculants for improving crop performance and supporting phytoremediation strategies in heavy metal-contaminated soils.

The identification of potential fungal biocontrol agents against *Fusarium oxysporum* f. sp. phaseoli infection in *Phaseolus vulgaris*

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The common bean, *Phaseolus vulgaris*, is a major staple crop in many developing regions of Sub-Saharan Africa and South America. However, its production is severely affected by Fusarium wilt, caused by *Fusarium oxysporum* f. sp. phaseoli, and leads to significant yield losses worldwide. Existing management strategies, including fungicide application and the use of resistant cultivars, are increasingly challenged by environmental concerns and pathogen adaptation. Biological control therefore represents a promising alternative for sustainable disease management. This study aimed to identify and characterize fungal endophytes isolated from *Echium plantagineum* as potential biological control agents against F. *oxysporum* infection in common bean, and to investigate their possible mechanisms of action. Among the isolates evaluated, Penicillium steckii displayed strong in vitro antagonistic activity against *F. oxysporum* during dual culture assays. In addition, when applied alone as a seed treatment, *P. steckii* promoted seedling root growth. To investigate its potential biocontrol mechanisms, several qualitative assays were conducted, revealing the production of cellulase, protease,

and siderophores. In planta assays further demonstrated that seed priming with P. steckii significantly enhanced root growth, reduced cell death and superoxide accumulation, and increased superoxide dismutase activity in infected seedlings. Seedlings primed with this isolate also showed improved growth under *F. oxysporum* infection, as indicated by increased fresh root weight. These findings suggest that *P. steckii* employs multiple biocontrol mechanisms and has strong potential as an eco-friendly alternative for the management of Fusarium wilt in common bean. The study also supports the broader use of fungal endophytes in sustainable crop protection and highlights the need for further research under field conditions.

Host-specific effects of fynbos soil microbiota on drought tolerance and secondary metabolism in *Lessertia frutescens* and *Glycine max*

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Soil microbiome composition varies along aridity regimes and heterogenous fynbos vegetation units, yet whether stress-selected microbiota confer resilience to drought-stressed plants remains understudied. This study compares adaptive contributions of fynbos-sourced microbiomes to drought-stressed plants. Our study species, *Lessertia frutescens* (cancer bush), an anti-cancer and antioxidant medicinal plant native to southern Africa, and *Glycine max* (soybean), a nutrient-rich crop, are both legumes ideal for comparing holobiont drought responses between indigenous non-model and cultivated model species. We hypothesised that microbiota pre-selected through water limitation would enhance drought tolerance in both species. Soil inocula were sourced from two fynbos vegetation units differing in aridity (Wellington and Clanwilliam). Both species were inoculated with sourced microbiota and subjected to a controlled drought regime using reduced water holding capacity. Pre-drought and post-drought rhizosphere communities were characterised via Biolog EcoPlate™ assays (metabolic response, substrate richness, Shannon diversity), plant response via morphometry and oxidative stress assays, and metabolite profiles via LC-MS. Amplicon sequencing (16S rRNA, V3–V4 region) identified bacterial community composition and plant growth-promoting rhizobacteria (PGPR). Biolog EcoPlate™ profiling revealed that lower-aridity inoculant supported greater catabolic diversity, however post-drought stress, the higher-aridity inoculant promoted greater functional recovery in rhizosphere communities of both species. Contrary to our hypothesis, high-aridity inoculum benefits G. max while L. frutescens benefits from low-aridity inoculum. G. max protein content was greater in high-aridity treatment, and this translates to potential crop quality and yield improvements. LC-MS profiling indicated low-aridity treatment in L. frutescens promoted significantly higher antioxidant activity (radical scavenging) and accumulation of flavonol glycosides sutherlandins A, B and C. Overall, metabolite accumulation clustered by inoculant, suggesting soil microbiome provenance influences secondary metabolite profiles. Amplicon sequencing identified drought-enriched PGPR across both host species. These findings demonstrate that fynbos microbiomes

modulate drought responses with host specificity and have implications for sustainable agriculture and nutraceutical standardisation.

Evaluation of marine bacterial isolates for alleviation of vanadium stress in *Brassica napus*

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Heavy metal contamination poses a significant threat to agricultural productivity, with vanadium emerging as an underexplored but potentially toxic element affecting plant growth and development. Plant–microbe interactions offer a promising strategy for mitigating abiotic stress, yet the potential of marine-derived bacterial isolates in this context remains largely unexplored. This study aimed to evaluate the capacity of selected marine bacterial isolates to alleviate vanadium-induced stress in Brassica napus. Four bacterial isolates were screened for plant growth-promoting effects under controlled vanadium exposure. Plant responses were assessed across multiple experimental systems, including germination assays, automated root phenotyping (robot root trials), and greenhouse-based growth experiments. Preliminary results indicate that two isolates, I1.1 and I4.1, consistently improved plant performance under vanadium stress conditions. Treated plants exhibited enhanced germination rates, increased root development, and improved early growth compared to untreated controls exposed to vanadium. These findings suggest that specific marine bacterial isolates may play a role in mitigating the negative effects of vanadium toxicity, potentially through mechanisms such as stress modulation or improved nutrient acquisition. While the underlying biochemical and molecular mechanisms remain to be elucidated, this study establishes a foundational framework for the use of marine-derived bacteria in enhancing crop resilience to heavy metal stress. Ongoing work aims to further characterise the functional traits of these isolates and their interactions with host plants under stress conditions. Overall, this research highlights the potential application of marine microbial resources in sustainable agriculture and provides preliminary evidence supporting their role in alleviating vanadium stress in Brassica napus.

Seed-Associated Microbiomes Enhance Soybean Tolerance to Salinity Stress

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Harnessing seed-associated microbiomes is a promising strategy to improve soybean resilience to abiotic stress. In South Africa, increasing soil salinity is a major constraint to soybean production, leading to impaired growth, reduced nutrient uptake, and yield losses. This study aimed to identify and characterize seed-associated microbes contributing to salt-stress tolerance. A preliminary growth trial screened five commercially sourced soybean lines under 150 mM NaCl stress. Using a physiological tolerance index, two contrasting lines were selected: a partially tolerant line (P48) and a sensitive line (P71). These lines were investigated using culturable and unculturable (16S rRNA amplicon sequencing) approaches to assess the role of seed-associated microbes in stress tolerance. In the culturable analysis, seed-derived bacterial endophytes from control and salt-treated plants were isolated and screened for tolerance and traits, including zinc, phosphate, and iron solubilization. Several isolates exhibited high survival under salinity (Isolates 1, 23, 25, 26, 30, 33, and 40), while others showed enhanced nutrient solubilization under stress (Isolates 15, 19, 20, 23, 24, and 42). Isolate 23 showed both high survivability and retention of solubilizing capabilities, indicating potential as a bioinoculant under salt stress. The unculturable analysis revealed bacteriome shifts: both lines showed decreases in halotolerant taxa under stress, but P48 exhibited a smaller decline. These findings indicate that functional endophytes and adaptive shifts in the microbiome contribute to soybean tolerance. Importantly, leveraging the inherent seed microbiome helps overcome barriers: native microbes are adapted to the host and environment, improving colonization success and consistency; they reduce formulation challenges; and pose fewer regulatory and biosafety concerns than external inoculants. In conclusion, exploiting naturally associated seed microbiomes offers a sustainable and practical pathway to enhance soybean performance in saline soils. Future work should validate candidate microbes and develop seed-based microbiome interventions for scalable applications in salt-affected regions.

Metabolic Responses Associated with Rhizobacteria-Mediated Salinity Tolerance in Wheat Seedlings

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Soil salinity is a major abiotic stress limiting wheat germination, seedling establishment and production globally. This stressor has the most detrimental effects during seedling germination. Salt tolerance promoting rhizobacteria (STPR) have emerged as a promising sustainable tool for improving crop tolerance to salinity; however, the underlying metabolic mechanisms governing these interactions remain poorly understood. This study

investigated the influence of selected STPR isolates (Paenarthrobacter spp.,(3A) Pseudarthrobacter spp.(6A) and Arthrobacter spp.(9A)) from *Hordeum marinum*, as well as their consortium, on wheat germination and early seedling growth under varying salinity conditions (0-200 mM NaCl), whilst using metabolomics as a tool to explore stress-associated metabolic responses linked to bacterial inoculation. High salinity significantly reduced germination percentage, radicle length and seedling growth across treatments. Seeds inoculated with isolate 3A failed to germinate under all conditions. Inoculation with isolates 6A, 9A and the consortium did not significantly improve germination between 0 and 150 mM NaCl relative to the control (uninoculated seeds at 0mM NaCl), isolates 6A and 9A significantly enhanced germination percentage under severe salt stress (200 mM NaCl). Isolate 9A improved radicle length under low to moderate salinity (100 mM-150 mM), while isolate 6A significantly improved radicle growth at 200 mM NaCl. Metabolomic analyses revealed distinct stress-responsive metabolic alterations associated with bacterial inoculation under salinity stress. Features annotated as 4-benzamidosalicylic acid-like compounds, 1-methylguanine, 6-dimethylaminopurine, and 10-deacetylasperulosidic acid-like metabolites were distinctly over accumulated in the 6A salt treatment relative to uninoculated salt-stressed seedlings and the untreated control. These findings suggest that isolate 6A may enhance salinity tolerance through modulation of stress signalling, secondary metabolism, and nucleotide-associated metabolic pathways involved in osmotic adjustment and oxidative stress mitigation. Overall, this work highlight the potential of selected STPR isolates as bioinoculants for improving wheat tolerance to salinity and demonstrate the importance of metabolomics in understanding plant-microbe interactions under salt stress.

The physiological and biochemical impact on maize seedlings exposed to *Fusarium sp*. and drought stress combinations

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Food security has always been one of the most pressing concerns worldwide, and it is increasingly threatened by fungal pathogens and drought stress driven by climate change. Fusarium verticillioides is one of the most common worldwide diseases of maize, causing Fusarium ear rot, reducing yield and quality, and contaminating grain with fumonisins and other mycotoxins. Drought-induced stress is also a serious limiting factor in plant production, and both conditions are known to impose oxidative stress by excessive reactive oxygen species accumulation, leading to lipid peroxidation and increased cell death. Hence, this study investigates the combined physiological and biochemical effects of Fusarium sp. infection and drought stress on maize seedlings. Maize (Zea mays) seedlings were simultaneously exposed to Fusarium sp. and drought conditions to assess their effects on growth, biochemical markers, and physiological responses. Key parameters evaluated included plant biomass, relative water content, proline content, and reactive oxygen species levels. The results revealed that combined Fusarium sp. and drought stress significantly inhibited shoot and root

height, as well as the fresh and dry weight of the shoot and root, had negative effects on maize seedling growth compared to individual stresses, when compared to control plants. Increases in reactive oxygen species and oxidative stress were observed under dual stress conditions; this also showed a significant difference in maize seedling growth when compared with the experimental group, which is a control. The combined stress is becoming the most serious environmental stress for maize plants; Fusarium verticillioides and drought adversely affect plant growth and development, limiting crop production more than any other environmental factor. These findings underscore the need for integrated management strategies to enhance maize resilience against combined biotic and abiotic stresses, which is crucial for improving crop productivity and sustainability in the face of climate change.

Screening of *Tylosema fassoglense* genotypes for drought tolerance using growth responses and multivariate analysis

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Marama bean (*Tylosema fassoglense*) is an underutilized legume indigenous to the semi-arid regions of southern Africa. It survives under dry environmental conditions where conventional crops often fail, suggesting the evolution of strong drought-adaptive mechanisms. This resilience highlights its potential as a climate-smart crop and as a source of stress tolerance traits for future crop improvement. Despite these attributes, marama bean remains largely understudied, with limited genomic and physiological information available, and much of its reported drought tolerance remains empirical. Therefore, this study investigated the growth responses of marama bean seeds collected from ten locations across the South African Limpopo and Mpumalanga provinces under different water treatments. Locations were treated as harbouring different genotypes, which were evaluated in a randomized block design under well-watered and water deficit conditions. Growth responses were assessed using number of leaves, shoot weight, shoot length, and tuber diameter. Two-way ANOVA revealed significant effects of genotype, treatment and genotype × treatment interaction for most growth parameters, indicating differential drought responses among genotypes. Principal Component Analysis (PCA) further supported these findings by clustering genotypes according to their biomass reduction and adaptive growth traits under water deficit. PC1, which was strongly associated with shoot and root biomass as well as tuber diameter, corresponded with traits significantly affected by drought in the ANOVA. Genotypes identified as tolerant in the ANOVA clustered distinctly in the PCA, while sensitive genotypes grouped separately, confirming the consistency between univariate and multivariate analyses. These findings provide preliminary evidence of intraspecific variation in drought tolerance within marama bean populations and support its potential use in climate-resilient agriculture and

future crop improvement programs. Further multi-omics research aimed at elucidating the transcriptomic, metabolomic, and microbiome-mediated mechanisms associated with drought tolerance in *Tylosema fassoglense* may accelerate its utilization in future crop improvement strategies.

Investigating the potential mitigatory role of zinc oxide nanoparticles on sorghum plants growing under salt stress

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Sorghum bicolor L. (Moench) is the fifth most important cereal crop in the world, widely grown in the tropics. The crop serves as main staple for over 300 million lives in Africa and Asia. High salt stress decreases germination and growth in this cereal resulting in low productivity that negatively affects food security. Thus, considering that sorghum is an important crop for humans, animals and industries, and that a number of studies lately have reported that application of nanocomposites to plants, significantly improves their performance under salt stress, this study therefore, was set to assess the role of zinc oxide nanoparticles (ZnO-NPs) to alleviate salt stress in sorghum. The study focused on the ICSB 338 variety that is commonly cultivated in the tropics and on which this kind of a study has never been undertaken. To carry out the study, ZnO-NPs were formulated using the green synthesis method followed by their characterization with various physicochemical methods. The formulated NPs were then used (at 0.04%) to co-prime sorghum seeds with salt (600 mM) alongside 600 mM NaCl alone (+ve control) and water (-ve control), followed by germination of such seeds and maintenance of the resultant plants in a growth chamber or glasshouse. The probable role of the used ZnO-NPs to alleviate the effects of salt stress on sorghum were then assessed and determined through a series of evaluations on seed germination, early seedling development, morphology of seedlings and plants, and physiological processes and biochemical traits of plants. Findings showed that while salt stress affected all these attributes and processes negatively, ZnO-NPs counteracted the effects, alleviating challenges on the plants and improving their overall status. This study therefore, demonstrated that ZnO-NPs can be used as an effective agent to improve growth and the overall performance of sorghum under salt stress.

Physiological and Metabolic Responses to Drought Stress and Rehydration in Four Bambara Groundnut (*Vigna subterranea* L. Verdc.) Genotypes

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Bambara groundnut (*Vigna subterranea* L. Verdc.) is a nutritionally rich, underutilised African legume with significant potential for food security in sub-Saharan Africa. Despite its inherent resilience, the integrated physiological and metabolic mechanisms underpinning

drought tolerance remain poorly characterised. This study combined physiology with untargeted metabolomics to investigate drought tolerance mechanisms and potential breeding biomarkers in four Bambara groundnut genotypes S19 (drought-tolerant), Gresik (drought-susceptible), Black-eyed, and Redeyed. Plants were subjected to a 14-day progressive drought treatment, induced by withholding water, followed by rehydration monitored over 14 days. Physiological parameters included chlorophyll fluorescence (Fv/Fm), relative water content (RWC), chlorophyll content, and electrolyte leakage. Significant genotype-dependent divergence emerged by Day 14: Gresik exhibited the greatest decline in RWC and chlorophyll content alongside an increase in electrolyte leakage, indicating pronounced membrane damage and photosynthetic impairment. In contrast, S19, Black-eyed and Red-eyed maintained comparatively stable physiology under stress and showed greater recovery by Day 28. Metabolic profiling via GC-MS identified 25 significantly altered metabolites under drought, comprising 10 amino acids, 6 organic acids, 5 sugars, 2 sugar alcohols, inorganic and organic compounds. Drought-tolerant genotypes accumulated protective sugars (sucrose, fructose) and osmoprotectants (D-sorbitol, erythritol), supporting osmotic adjustment consistent with their maintained RWC and chlorophyll integrity. Susceptible Gresik showed elevated amino acid accumulation alongside severely depleted sugars, suggestive of protein degradation rather than adaptive tolerance. During rehydration, the tolerant S19 genotypeuniquely upregulated indoleacetic acid and D-sorbitol, suggesting superior hormonal re-engagement of growth. The physiological and metabolomic data identifies sucrose, D-sorbitol, fumaric acid and indoleacetic acid as candidate biomarkers associated with drought tolerance, providing a foundation for future validation and breeding applications in Bambara groundnut.

Investigating the Effect of Salinity Stress on the Symbiotic Relationship Between *Mycorrhizal Fungi* and Weed-derived Endophytes on *Phaseolus vulgaris* (Common

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Salinity is a major abiotic stress that limits the yield and production of nutritionally and economically important legumes, such as Phaseolus vulgaris. Salinity reduces germination rate, photosynthetic pigments, and carotenoid content in P. vulgaris. Although plant growth-promoting microorganisms, including endophytes and mycorrhizal fungi, independently induce salt tolerance, their synergistic effects under saline conditions remain poorly understood. Therefore, this study investigated the potential of combining weed-derived endophytes with commercially available mycorrhizal fungi to induce salt tolerance in P. *vulgaris* L. Two endophytes (*Pseudomonas* sp. strain COW5 (PR3AI1) and Enterobacter kobei (PR5AI1)) were assessed for salt tolerance and compatibility with mycorrhizal fungi using in vitro co-culture assays. Nutrient solubilisation assays, along with seed germination, physiological and biochemical responses, were conducted to assess the isolates' ability to induce salt tolerance in P. vulgaris. PR3AI1 showed higher salt tolerance and compatibility with

mycorrhizal fungi, and was subsequently evaluated for other plant growth-promoting traits. The PR3AI1 and mycorrhizal fungi duo enhanced zinc and phosphate solubilisation and increased indole-3-acetic acid production. The co-culture also improved the growth of P. vulgaris and reduced ROS production under salinity. These findings indicate that the compatibility between PR3AI1 and mycorrhizal fungi mitigates the impacts of salinity stress in P. vulgaris. The study highlights the potential of microbial co-inoculants as an alternative to improve P. vulgaris growth under salinity stress in sustainable agricultural systems. Future work may also evaluate its potential under different stress conditions or in field-based conditions.

Morpho-physiological, biochemical and molecular profiling of osmotic stress responsive proteins from a drought tolerant Zea mays cultivar

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Global maize production is significantly constrained by drought-induced osmotic stress, which reduces crop resilience and yield under increasingly unpredictable climatic conditions. This study investigated the morpho-physiological, biochemical, and proteomic responses of a drought-tolerant maize cultivar (QN7646), under polyethylene glycol (PEG) induced osmotics tress. The experiment was conducted under greenhouse conditions using three treatment groups. Two stress groups were irrigated with 15% and 25% PEG solutions, respectively, while the non-stressed control group received water only. Following a 20-day treatment exposure, various morphological parameters including plant height, shoot length, leaf area, biomass, and root length were evaluated., Physiological traits such as relative water content and chlorophyll content, as well as biochemical markers (antioxidant enzyme activity), were assessed. Furthermore, root proteomic profiling and identification were evaluated. Drought stress significantly reduced plant height, shoot length, leaf area and total biomass. In contrast, severe stress increased root elongation and the root-to-shoot ratio, suggesting adaptive responses enhancing water uptake. Relative water content and chlorophyll content decreased under drought stress, indicating adjustment in leaf water content and photosynthetic capacity. Partial recovery at 25% PEG, suggested activation of osmotic adjustment supporting the preservation of cellular water balance under severe drought. Reduced Catalase (CAT) and superoxide dismutase (SOD) activities declined, indicating increased oxidative stress. On the contrary, glutathione reductase (GR) activity increased significantly, demonstrating its role in mitigating oxidative stress. Proteomic profiling analysis revealed that 15% PEG exhibited weaker interaction and highly interconnected protein clusters under 25% PEG related to osmotic regulation, oxidative stress defense, and cellular repair mechanisms, enhancing its resilience. Overall, these findings provide insight on the adaptive mechanisms underlying maize drought tolerance and support future crop development strategies under limited water conditions.

A review phytochemical composition of Toxicodendron succedaneum and its efficacy as botanical insecticide of common maize pest in smallholder farming

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Toxicodendron succedanea, commonly known as Japanese wax tree, is a member of the Anacardiaceae family native to East Asia, has become invasive in parts of South Africa and is classified as a forbidden Category 1b species as per the Conservation of Agricultural Resource Act 43 of 1983. The classification prohibits its cultivation and mandates the strict management and control of the existing plants to further spread. Despite its invasive status, the species is rich in secondary metabolites, namely, urushiol, a bioactive compound known for their defensive, insecticidal and antimicrobial properties. The current global concerns regarding the negative impacts of synthetic pesticides on human and the environmental health, coupled with increasing demand for safer production practise, have renewed interest in the use of botanical pesticides, especially in organic farming systems. Hence, this review seeks to comprehensively and systematically synthesize the existing literature on phytochemical diversity, of *T. succedaneum*, the distribution of its bioactive compounds within plant parts and its potential use as a botanical insecticide targeting key maize pest in smallholder farming systems. The review highlights the potential of *T. succedaneum* as a sustainable alternative insecticide for the control of several chewing insects, mainly in the orders Coleoptera, Lepidoptera and Orthoptera. However, challenges related to its toxicity, formulation, standardisation, and regulatory compliance remain a significant barrier to its practical application. Addressing these constraints will be critical for advancing the use of *T. succedaneum* extract as botanical pesticides in sustainable agriculture.

Uncovering geographical variation in the metabolite profiles of the leaves and stems of wild bush tea (*Athrixia phylicoides* DC.) growing in four South African provinces

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Bush tea is a medicinal plant widely consumed in Southern Africa for its health-benefit properties. Despite its cultural and therapeutic importance, there is limited scientific information on how geographical factors influence its metabolite composition. Variations in climate, soil type, and altitude across different regions are known to significantly affect the levels of phytochemicals in bush tea. This study compared the metabolite profile of wild bush tea, specifically focusing on stems and leaves samples collected in one season but different

geographical provinces, including Limpopo (LIM), Mpumalanga (MP), KwaZulu-Natal (KZN), and Eastern Cape (EC). Nuclear magnetic resonance (1H NMR), in conjunction with multivariate statistical modelling techniques like principal component analysis (PCA) and orthogonal partial least squares discriminant analysis (OPLS-DA), was used to analyse the metabolites present in the stems, and leaves of bush tea from four different provinces. 1H NMR data was pre-processed using MestReNova software v17.0 and SIMCA Multivariate analysis was performed using SIMCA v18. Data revealed clear metabolomic variation among bush tea samples from different geographical regions (EC, KZN, LIM, and MP). PCA demonstrated natural clustering with partial overlap, indicating both similarities and differences in chemical profiles. OPLS-DA showed enhanced discrimination between regions, confirming that geographical origin significantly influences metabolite composition. The contribution score and S-plots identified key chemical shift contributing to this separation, suggesting potential biomarkers associated with regional variation. Overall, both leaf and stem samples exhibited distinct region-specific chemical patterns, where EC and KZN, while Lim and MP formed clusters, respectively. Prospectively, we plan to conduct metabolite annotation using ultra-high-performance liquid chromatography–quadrupole time-of-flight mass spectrometry (UHPLC-qTOF-MS) and two-dimensional gas chromatography time-of-flight mass spectrometry (GC-TOF-MS). These findings will help identify metabolites that differentiate bush tea from geographical regions, provide guidance to locals regarding optimal harvesting areas and assist in having a reliable database for future scientific studies in wild bush tea.

Effects of *Aloe vera* formulations as natural seed priming agents on tomato seed germination and seedling vigour

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Tomato (*Lycopersicon esculentum* L.) is among the most economically important vegetable crops globally, yet poor and irregular seed germination remains a persistent constraint for nursery producers, compounded by climate-driven abiotic stresses and concerns over synthetic
seed treatments. This study evaluated Aloe vera, a locally available succulent rich in polysaccharides and plant growth regulators, as a sustainable seed priming agent for tomato. The aim was to determine how four A. vera formulations (fresh gel, reconstituted powder, heat-treated water, and unheated water), applied either once or continuously, affect germination and early seedling vigour relative to a distilled water control. Tomato seeds (cv. Floradade) were arranged in a completely randomised design with nine treatments replicated four times, each petri dish containing five seeds were incubated at 25 ± 1 °C under a 16/8-hour light/dark cycle for twenty days. Germination percentage (GP), mean germination time (MGT), root length (RL) and shoot length (SL) were recorded. One-way ANOVA showed significant treatment effects on

GP ($p = 0.0008$), RL ($p < 0.001$) and SL ($p < 0.001$), with no significant difference in MGT. Unheated Aloe vera water applied once produced 100% germination across all replicates, while *Aloe vera* powder applied once yielded the longest roots (7.95 cm) and strong shoot growth. Continuous application of fresh gel was inhibitory across all parameters, reducing GP to 50% and stunting both root (1.91 cm) and shoot (1.64 cm) development. The findings indicate that *Aloe vera*, when applied appropriately, is a viable plant-based bio-stimulant for tomato seed enhancement, supporting low-input, eco-friendly alternatives to synthetic priming. Optimisation of formulation and application frequency is, however, critical to avoid concentration-dependent inhibitory effects.

In silico analysis of wheat infecting _Puccinia_ spp. mannanases/mannosidases: towards understanding their functions as pathogenic or effector proteins: Oral

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Wheat rust fungi (*Puccinia graminis* f. sp. *tritici*, *P. striiformis* f. sp. *tritici*, and *P. triticina*) remain a serious threat to global food security. Bioinformatics tools, genomic DNA, and protein databases provide efficient and affordable ways to analyse protein sequences for classification and functional characterisation prediction. The genomic DNA of wheat rusts are available in the Joint Genome Institute (JGI; https://jgi.doe.gov/) database. Their CAZymes are curated in CAZy database, which includes all mannanase and mannosidase sequences. However, wheat rusts' mannanases/mannosidases are uncharacterised. Therefore, this study aims to classify and functionally characterise mannanase and mannosidase sequences in the genomic DNA of wheat rust isolates, using bioinformatic techniques. The following databases/servers (CAZy, JGI, Signal-P6.0, DeepTMHMM, EffectorP3.0 and DeepLoc2.1) were used to identify, functionally characterise, and detect signal peptides, transmembranal domains, and effectors. A phylogenetic tree was developed using MrBayes and PAUP (bootstrap ≥95%). I-TASSER was used to predict the 3D structures of mannanases/mannosidases, and molecular docking analysis was performed using PyRx and Discovery Studio. Results of the nine genome data sets for wheat rusts, retrieved from the CAZy database, were screened for mannanase/mannosidase protein sequences, yielding 550 sequences, which were confirmed by corresponding genes in their genomes in the JGI database. The protein sequences were reduced to 19 effectors using a sequential filtering pipeline of servers in the methods. The mannanase/mannosidase activity of the 19 effectors was confirmed using InterPro server. Tree construction revealed a single branch containing 10 conserved mannanase sequences from wheat rust isolates. Three mannanases from this branch, one representing each of the wheat rusts, was used to predict 3D structures, which had strong affinity for mannobiose to mannopentaose. Molecular docking interactions demonstrated strong binding affinities higher than −5.5 kcal/mol. These findings predict that wheat rusts contain about 19 mannanase/mannosidase effectors that should be targets for new fungicide development.

Characterization of Fibre Length Parameters in Bast and Hurd Fibres of Localized Hemp Strains for Industrial Applications.

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The growing demand for sustainable natural fibres has increased interest in hemp (*Cannabis sativa* L.) for industrial applications. The study aimed to characterize fibre length in bast and hurd fibres of localized hemp strains and to evaluate their suitability for various industrial uses. Fibre length is an important quality attribute influencing the performance of fibres in textile, paper, composite, and bio-based material industries. Hemp strain samples were sourced, and the stems were subjected to water retting for fibre extraction and decorticated to separate bast and hurd fibre fractions. Fibre-length measurements were conducted using a manual classification method. Bast fibres were categorized as short (≤20 mm), intermediate (19–49 mm), and long (≥50 mm), while hurd fibres were grouped as fine (≤5 mm), medium (4–14 mm), and coarse (≥15 mm). Fibre fractions were quantified by number and weight to determine fibre-length distribution, span lengths, short fibre content, and uniformity index. The results revealed significant differences among hemp strains and between bast and hurd fibres. Bast fibres exhibited longer fibre lengths, whereas hurd fibres were dominated by shorter and finer particles. The NL, MA, and JS strains demonstrated superior bast fibre length characteristics, while the CA and SA hemp strains showed greater hurd fibre characteristics, indicating higher potential for industrial applications. The observed variation suggests the influence of environmental and genetic factors associated with these uncharacterized strains. The findings highlight the importance of fibre-length characterization for identifying hemp strains with desirable industrial traits. This study provides baseline information that can support breeding programmes, fibre quality improvement, and the development of a sustainable hemp fibre industry in South Africa.

Evaluation of unimproved local cowpea landraces for qualitativequantitative characters in Capricorn District, Mankweng

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Cowpea (*Vigna unguiculata* L. Walp.) is a major legume crop of high nutritional and agronomic importance, particularly in arid and semi-arid regions. Despite its adaptability, production in South Africa remains low due to limited improved varieties and the loss of local genetic resources. Unimproved cowpea landraces, preserved by smallholder farmers, possess diverse traits including tolerance to stress, pest resistance, and nutritional quality. However, their growth and yield performance under local agro-ecological conditions remains undocumented . This study was conducted at the University of Limpopo, Centre for Rural Community Empowerment, during the 2025 growing season to evaluate quantitative characters of four unimproved local cowpea landraces collected from the Gumbu community seedbank. A randomized complete block design (RCBD) was used with four treatments(control,TMG-6420

,TMG 6421 and TMG 7422) replicated three times. Data on chlorophyll content, leaf area, number of nodules, stem diameter, root length, and fresh shoot weight were collected and analysed using ANOVA. Results showed significant differences ($P<0.05$) among local landraces for chlorophyll content, fresh shoot weight, and stem diameter, while leaf area, root length and number of nodules showed no significant variation. These findings indicate that unimproved cowpea landraces exhibit distinct genetic variability that can be harnessed to enhance growth and yield under marginal conditions. Among the evaluated landraces, TMG-6421 exhibited superior performance compared to the control in number of nodules, stem diameter and root length while TMG-6420 surpassed the control in fresh shoot weight; however, for chlorophyll content and leaf area, both landraces ranked second to the control. The study highlights the potential of landraces as valuable genetic resources for future breeding programs and for improving food security in the Capricorn District.

MEDICINAL PLANTS AND ETNOBOTANY

Ethnomedicinal plants for *Candida* infection treatment in South Africa: evidence from a systematic review

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Candida infections remain a significant public health concern, particularly in areas where access to antifungal treatments is limited. Medicinal plants continue to play a huge role in managing these infections, yet their antifungal properties have not been scientifically verified. The purpose of this review was to document medicinal plants used to treat *Candida*-related infections in South Africa. Relevant data was sourced from various online databases, including Google Scholar, Science Direct, and PubMed, using keywords such as ethnobotanical survey, medicinal plants, *Candida*, antifungal activity, and South Africa. A total of 90 medicinal plant species belonging to 59 genera and 70 families were identified. *Fabaceae, Asteraceae,* and *Celastraceae* were the most dominant plant families, each represented by 11, 7, and 5 plant species, respectively. Some of the plants include *Bidens pilosa*, *Croton gratissimus*, *Diospyros mespiliformis, Vangueria infausta,* and *Ximenia caffra*. The most involved active compounds were flavonoids, alkaloids, tannins, terpenoids, phenolic compounds, and the isolated compound catechin. Leaves (29%) were the most dominant plant part, followed by roots (28%) and bark (23%). Additionally, decoction (48%) was the major mode of preparation, followed by grinding into powder (17%), and infusion (12%). The study presents a list of medicinal plants that are used to treat *Candida*-related infections in South Africa. The findings of this study highlight the need for further research focusing on validating the antifungal properties of traditional plants in other provinces besides Limpopo. Furthermore, more extensive research has to be done on non-*albicans Candida* species.

Abscisic acid enriched with cancer bush leaf extract enhanced the yield, essential oil and bioactive compounds of oregano under heat stress

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Oregano (*Origanum vulgare* L.) is an important medicinal plant cultivated worldwide, and recognized for its bioactive constituents including pharmacological activities, such as antimicrobial, antioxidant, anticancer, and antibacterial effects. Oregano essential oil is predominantly rich in phenolic compounds, particularly carvacrol and thymol, which are responsible for its potent biological activities. It is widely used in traditional medicine for the treatment of various diseases, including gastrointestinal disorders, diabetes, and bronchitis. Heat stress significantly reduces the growth and yield of medicinal plants by restricting physiological and biochemical processes. The use of biostimulants represents a significant advancement in agricultural practices for improving plant growth and productivity. The study evaluated the effect of abscisic acid (ABA) enriched with cancer bush (*Lessertia frutescens* L.) leaf extract (CLE) on the yield and phytochemical characteristics of oregano plants subjected to heat stress (38 °C for 2 h for 7 days). Plants that were not treated were used as control. The experiment was caried out in the tunnel (sandy clay loam soil) using a randomised complete block design during the spring season of 2025. Foliar spray treatments: CLE (5%), CLE + ABA 20 mg/L, CLE + ABA 40 mg/L and CLE + ABA 60mg/L were applied at 7-day intervals during the experiment. The combination of CLE + ABA effectively enhanced growth, photosynthetic traits, essential oil yield and bioactive compounds of heat-stressed oregano plants. The CLE + ABA 40 and 60 mg/L effectively reduced lipid oxidation damage and enhanced photosynthetic pigments, oil content and antioxidant enzyme activities of heat-stressed oregano. Therefore, CLE + ABA at concentrations 40 and 60 mg/L can be applied as a phytohormone-based biostimulant to enhance the yield and biochemical composition of oregano plants under heat stress.

Traditional medicinal plant use in the management of skin-related diseases among children in Thaba Chweu Local Municipality, South Africa

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Skin-related diseases are among the most common health concerns affecting children in rural South Africa, where limited access to formal healthcare services sustains reliance on traditional medicinal plants. This study documented medicinal plants used for the treatment and management of childhood skin conditions in the Thaba Chweu Local Municipality,

Mpumalanga Province. Ethnobotanical data, including local plant names, parts used, and preparation and administration methods, were collected using semi-structured questionnaires administered to 34 purposively selected knowledge holders across three villages. Quantitative indices, including use value (UV) and informant consensus factor (ICF), were calculated to assess species importance, knowledge homogeneity, and use versatility. A total of 27 plant species belonging to 11 families were recorded for treating six skin-related conditions. Asteraceae (3 species) was the most represented family, followed by Hypoxidaceae, Solanaceae, and Vitaceae with two species each. Roots (48%) and leaves (29%) were the most commonly used plant parts, followed by bulbs (13%). Preparation methods were dominated by maceration (58%) and decoction (22%), with poultice (17%) and infusion (3%) used less frequently. The highest UV values were recorded for *Aloe ferox* (0.42), *Cyphostemma humile* (0.36), *Siphonochilus aethiopicus* (0.27), and *Hypoxis hemerocallidea* (0.27), while *Siphonochilus aethiopicus* and *Hypoxis hemerocallidea* also showed the highest relative frequency of citation. Rash had the highest plant diversity (12 species), followed by ringworm and eczema (five species each). These findings highlight the central role of indigenous knowledge in primary healthcare, while also indicating threats from knowledge erosion, habitat loss, and unsustainable harvesting. Documenting this knowledge and identifying key species supports biodiversity conservation, promotes sustainable use, and provides a basis for developing safe, culturally acceptable treatments for skin-related diseases.

Nutritional and Phytochemical Composition of Leaves and Nuts of *Mimusops zeyheri* Across Two Agro-Ecological Zones in South Africa

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Indigenous fruit trees represent a critical yet underutilized resource for improving nutrition and delivering bioactive compounds in climate-vulnerable regions of sub-Saharan Africa. This study evaluated the nutritional and phytochemical composition of the leaves and nuts of *Mimusops zeyheri* from two agro-ecological zones in South Africa: Vhembe District (Limpopo) and Ehlanzeni District (Mpumalanga). Proximate and mineral composition were determined using standard AOAC methods and inductively coupled plasma optical emission spectrometry (ICP-OES). Phytochemical constituents, including total phenolics, flavonoids, and alkaloids, were quantified using spectrophotometric assays, and antioxidant activity was assessed using DPPH radical-scavenging assays.
Variation in composition was primarily driven by plant part, with limited differences between provinces. Leaves from Limpopo and Mpumalanga exhibited consistently high protein (~24%), fibre (~22%), and ash (~12%) contents, indicating substantial mineral and nutritional value. In

contrast, nuts from both provinces were characterized by high crude fat (~54%), moderate protein (19.1–19.7%), and elevated energy values (~595 kcal/100 g), highlighting their role as energy-dense food sources. Phytochemical analysis revealed that leaves contained the highest concentrations of total phenolics (19.13 and 18.20 mg GAE g^{-1}), flavonoids (9.83 and 9.30 µg QE g^{-1}), and alkaloids (4.67 and 4.37 mg AE g^{-1}) in Limpopo and Mpumalanga, respectively, with nuts consistently ranking second. Antioxidant activity showed clear agro-ecological variation in nuts, with Mpumalanga samples exhibiting stronger radical-scavenging capacity (EC_{50} = 0.0581 µg/mL) than those from Limpopo (EC_{50} = 0.1767 µg/mL).
Overall, the findings on the nutrient density of leaves and the high-energy, antioxidant-rich properties of nuts position this species as a promising candidate for climate-smart agriculture, functional food development, and poverty alleviation strategies aimed at improving dietary diversity and resilience in rural communities.

Phylogeny, biomes and space jointly structure plant-use diversity across *Eurasia*

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Understanding how human uses of plants vary across ecological gradients is central to linking biodiversity with ecosystem services. However, the evolutionary and biogeographic processes underlying plant-use diversity remain poorly understood at broad spatial scales. Here, we integrate phylogenetic, functional, and biogeographic analyses to examine the evolution and distribution of major plant-use categories (medicinal, food, and condiments) across Eurasia. Lineage-through-time analyses reveal strong asymmetry in functional evolution, with medicinal plants accumulating more rapidly than other use functions toward the present. Also, our transition network analyses indicate that medicinal function plays a central role in structuring plant-use diversity and promoting multifunctionality. Consistent with this, we found that medicinal plants are more versatile and ecologically widespread, occurring across a broader range of biomes than non-medicinal plants. Despite this generality, plant-use functions exhibit pronounced biome and regional specificity. Medicinal plants show weak biome affinity and broad ecological distribution, perhaps mirroring ecological generalism. However, food and condiment plants are strongly associated with particular biomes, perhaps suggesting that biome-specific selective pressures shape plant chemical traits, which in turn influence their suitability for food and/or condiment uses. This biome-specificity suggests that ecosystem loss may disproportionately affect specific functional dimensions of plant use. Together, our results reveal that biased evolutionary dynamics and ecological filtering jointly structure plant-use diversity across spatial scales. By linking evolutionary processes with biogeographic patterns, this study provides a macroecological framework for understanding how human use of biodiversity emerges and is distributed across the Earth's ecosystems.

Metabolite profiling, cytotoxicity, liver ROS detoxifiers and acetylcholinesterase inhibitors from *Trachyandra ciliata* L.F. (Kunth) (wild cabbage)

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Wild cabbage (*Trachyandra ciliata*) is one of the understudied, wild, edible halophytes from South Africa. Although its edibility has recently been validated, its therapeutic potential was yet to be explored. This research was carried out to profile and characterise the phytochemical content of *T. ciliata* extracts and evaluate its potential as a therapeutic agent for cancer, acetylcholinesterase (AChE) inhibition and reactive oxygen species (ROS) scavenging in the liver. Cuttings of *T. ciliata* were grown under 0, 50, 100, 150, and 200 mM salinity concentrations. The ultra-high-performance liquid chromatography mass spectrometry (UHPLC-MS) was employed to quantify and characterise metabolites in leaves, roots, and flower buds of *T. ciliata*. The yellow dye 3-(4,5-dimethyltiazol-2yl)-2,5-diphenyl tetrazolium bromide (MTT), Ellman's colourimetric method, and the 2',7'-dichlorodihydrofluorescein diacetate assay (H_2DCF-DA) were respectively employed to evaluate cytotoxicity, AChE antagonism, and ROS scavenging of the extracts of *T. ciliata*. A total of 71 compounds were observed, which were grouped into flavonoids, anthocyanins, alkaloids, nucleobase, nucleosides/tide, saccharides, fatty acids, amino acids, and coumarins. A concentration of 1 mg/mL of extracts of *T. ciliata* flower buds prepared from plants grown at 0 mM and 100 mM salinity, showed strong cytotoxicity to cancer cells, however, the extracts also had moderate and weak cytotoxicity to non-cancer cells. All extracts inhibited AChE activity, except for root and flower bud extracts from plants grown at 100 mM salinity. Moreover, ROS scavenging was mainly observed primarily in the extracts of leaves from plants grown at all salinities, and in the extract of roots from plants grown at 0 mM salinity treatment. A maiden documentation of anticancer, acetylcholinesterase inhibition, and ROS scavenging activity of crude extracts of *T. ciliata* was achieved in this study. These findings suggest that *T. ciliata* could be a potential therapeutic agent for the treatment of cancer, Alzheimer's disease, and liver disorders, amidst the quest to develop more plant-based pharmaceuticals for the treatment of chronic diseases.

Investigating the Anti-Inflammatory and Regenerative Effects of *Pterocarpus angolensis* Extracts: Implications for Type 1 *Diabetes Mellitus*-Associated Wound Healing

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Type 1 *Diabetes Mellitus* (T1DM) is a chronic autoimmune disease associated with persistent inflammation, oxidative stress, and impaired tissue repair, leading to delayed wound healing and increased risk of chronic complications. Indigenous medicinal plants offer underexplored avenues for locally relevant therapies. Pterocarpus angolensis, traditionally used in African healing systems for skin injuries and inflammatory conditions, presents promising potential for wound care applications.
This study evaluated the in vitro anti-inflammatory, antioxidant, and regenerative effects of P. angolensis seed and seed case crude extracts under conditions relevant to inflammatory wound pathology. Phytochemical profiling using UPLC-MS identified bioactive classes including phenolic acids, flavonoids, glycosylated phenolics, and tannin-related compounds. Functional assays demonstrated strong radical scavenging activity (ABTS, DPPH), indicating redox-modulating potential. Selected extracts significantly reduced nitric oxide production in LPS-stimulated RAW 264.7 macrophages, suggesting anti-inflammatory effects, while HaCaT keratinocyte assays showed concentration-dependent support for cell viability and proliferation. Antimicrobial activity against wound-associated bacterial strains was limited; however, the combined antioxidant, anti-inflammatory, and pro-proliferative properties suggest a role in supporting tissue repair. These results provide preliminary evidence for the therapeutic relevance of P. angolensis in T1DM-associated wound healing and underscore the importance of integrating indigenous knowledge with biomedical research to advance affordable, locally grounded wound care innovation in Africa.

Bridging Indigenous Knowledge Systems and Scientific Evidence in African Medicinal Plants: A Systematic Review of Ethnobotany, Phytochemistry, Nutrition, and Sustainability in Mpumalanga, South Africa

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Maesa lanceolata, Agave americana, Nidorella resedifolia, and *Sclerocarya birrea* are African medicinal plant species of significant ethnobotanical, nutritional, and pharmacological importance within Indigenous Knowledge Systems (IKS) in Mpumalanga Province, South Africa; however, their scientific evaluation remains fragmented across disciplines. This study systematically reviewed peer-reviewed literature to examine relationships between ethnobotanical use, phytochemical composition, nutritional value, and sustainability considerations associated with these species. Data were synthesised through a structured

review approach focusing on traditional medicinal applications, biochemical evidence, nutritional profiling, and ecological sustainability dynamics relevant to biodiversity conservation and community well-being. The findings indicate that all four species are widely utilised for managing infections, inflammation, gastrointestinal disorders, and general well-being, reflecting their continued importance in primary healthcare systems and local cultural practices. Phytochemical analyses revealed the presence of bioactive compounds such as flavonoids, tannins, saponins, and terpenoids, broadly supporting reported medicinal applications. However, most studies rely heavily on in vitro assays, limiting understanding of the complexity of biological systems and Indigenous Knowledge Systems. Notably, *Maesa lanceolata* is associated with cultural practices related to gender determination, highlighting an underexplored sociocultural dimension of medicinal plant use. Nutritional evidence remains uneven among the selected species. *Sclerocarya birrea* demonstrates considerable dietary potential due to its high vitamin C content, whereas other species remain poorly characterised despite their potential contribution to food and nutritional security. Sustainability assessments indicate that bark and root harvesting may increase ecological pressure on some species despite their current conservation status. The review highlights a critical gap in the absence of integrated analytical frameworks linking ethnobotanical knowledge with biochemical, nutritional, ecological, and conservation evidence. Addressing this gap requires interdisciplinary and community-engaged research approaches that strengthen biodiversity conservation, support sustainable harvesting practices, and promote the responsible utilisation of African medicinal plant resources within the context of sustainable development goals (SDGs).

From biodiversity to brain health: NF-κB modulation by *Mentha longifolia* and *Leonotis leonurus* in neuroinflammation

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Neuroinflammation is an extensive innate immune response of the central nervous system that is mediated by prolonged and uncontrolled activation of the nuclear factor kappa B (NF-kB) signalling pathway, which results in the release of IL-1β. In South Africa, ethnobotanical reports identify *Leonotis leonurus* and *Mentha longifolia* among the most widely used medicinal plants for supporting mental and brain health, particularly in conditions associated with neuroinflammation. Their traditional use has largely been attributed to their antiinflammatory properties, which may involve modulation of NF-κB pathway activity and subsequent alterations in IL-1β expression, a key mediator of neuroinflammatory responses implicated in neuronal dysfunction and mood disorders such as depression. However, their

effects on NF-kB signalling remain insufficiently characterised. Therefore, this study aims to evaluate the modulatory effects of *Leonotis leonurus* and Mentha longifolia on NF-κBmediated inflammatory signaling by assessing alterations in IL-1β expression using ELISA. A total of 18 healthy male Sprague-Dawley rats were divided into three groups (n=6) that were previously administered 100 mg/kg of *Leonotis leonurus, Mentha longifolia*, and saline solution orally for 21 days. On the day of euthanasia, the prefrontal cortex was collected for biochemical analysis. Comparisons will be made between treated and control groups to assess the potential of IL-1β modulation, and the results will be presented as the mean ± SD. The study data will be analysed using one-way analysis of variance (ANOVA) to compare the significance between groups. P-values of < 0.05 will be indicative of statistically significant differences. The findings are anticipated to demonstrate the ability of Leonotis leonurus and Mentha longifolia to modulate IL-1β production through regulation of the NF-κB signaling pathway, thereby providing pharmacological support for their neuromodulatory actions. These findings may contribute to the growing body of evidence supporting the role of plant-derived interventions in supporting brain health and mitigating neuroinflammation.

Metabolomic profiling of *Mentha longifolia* L. in healthy Sprague-Dawley Rats as evidence of its neuroprotective and neuromodulatory potential

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In African communities, medicinal plants have long played an important role in traditional healthcare systems, particularly in supporting mental and emotional well-being. Mentha longifolia L. is one such medicinal plant widely used in ethnomedicine and valued for its potential neuroprotective and neuromodulatory properties. However, its systemic biochemical effects remain insufficiently characterised. This study investigated the effect of M. longifolia on the serum metabolomic profile in healthy Sprague Dawley rats and explored its modulation potential on metabolic pathways associated with major depressive disorder. Eighteen (18) male Sprague Dawley rats (250-300 g) were administered M. longifolia extract at a dose of 100 mg/kg for 21 days, while control animals received saline as vehicle treatment. Blood samples were collected on days 0, 7, 14, and 21. Thereafter, serum was subjected to metabolomic profiling using an untargeted 1H-NMR approach under standard acquisition conditions. Data were processed to identify differential metabolites, followed by pathway enrichment analysis to determine affected biochemical networks. The results revealed distinct metabolic alterations in the treated group compared to the control group. Key changes

observed in metabolites associated with amino acid metabolism, particularly tryptophan and glutamate pathways, which are closely linked to serotonin biosynthesis and excitatory neurotransmission. Additionally, alterations in lipid metabolism and energy-related pathways suggested a systemic modulatory effect of the extract. M. longifolia treatment induced measurable shifts in serum metabolic profiles from day 7, suggesting potential neuromodulatory and systemic regulatory effects. These findings provide preliminary evidence supporting the neuropharmacological relevance of this medicinal plant and highlight its potential role in modulating biochemical pathways associated with depression. Further studies integrating behavioral assessments and targeted mechanistic validation are warranted in disease models to confirm *M. longifolia's* antidepressant-like potential and therapeutic applicability.

What's cooking underground?: An ethnobotanical appraisal of African potato (*Hypoxis hemerocallidea*) and Devil's claw (*Harpagophytum procumbens*)

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Globally, the use of plants as traditional medicine is influenced by cultural beliefs, affordability, availability, accessibility, and perceived effectiveness. In South Africa, *Hypoxis hemerocallidea* Fisch., C.A.Mey. & Ave-Lall. (African potato) and *Harpagophytum procumbens* (Burch.) DC ex Meisn. (Devil's claw) are widely used in traditional medicine and sold in informal trade in most rural communities and semi-urban townships. Both plants are considered as flagship species as they play a significant role which is deeply rooted in local traditions with spiritual and ritual attributes. As flagship species, they play a vital role for broader biodiversity issues, drawing attention to their conservation given that their underground parts are mostly used for economic or medicinal gains. Thus, the aim of the current review was to assess the ethnobotanical uses, conservation protocols, and associated indigenous knowledge and quality control of the species in South Africa. This will be conducted using systematic and bibliometric analysis to identify underlying patterns, research gaps, and potential future directions in the study and use of these plants. Different scientific databases, including Web of Science, Lens and Scopus, will be used to search journal articles,

to capture the research pattern in South Africa, over the last decade. The results and outcomes of the review will be fully discussed in the presentation.

Ethnobotanical uses of wild edible plants and their multi-functional roles in rural communities within Dr Ruth Segomotsi Mompati District, South Africa

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Wild edible plants (WEPs) comprise a wide range of species that support human nutrition, health and livelihoods. These plants are embedded in cultural beliefs, traditional practices, skills and local knowledge, and used as food, medicine and beverages. This study explored the use patterns and significance of WEPs among rural communities within Dr Ruth Segomotsi Mompati District in North West Province of South Africa. An ethnobotanical survey was conducted through semi-structured interviews with 345 participants, who were purposively selected and further recruited using the snowball technique. Data were analysed using thematic analysis and ethnobotanical indices. The study revealed that participants possess detailed indigenous knowledge including the diverse uses for 91 WEPs. Based on frequency of citation, the most commonly used species included *Amaranthus thunbergii* Moq, *Grewia flava* DC, and *Myrothamnus flabellifolious* Welw, which are utilised for food, medicinal purposes and beverages. The most used plant parts were fruits, leaves and tubers, which are typically consumed raw or prepared through simple methods such as boiling. The use and harvesting of WEPs are often guided by cultural practices and indigenous knowledge systems. These plants play a significant role in enhancing food security, especially during periods of scarcity, while also contributing to nutrition and primary healthcare. Overall, this study underscores the importance of preserving and promoting indigenous knowledge of WEPs, contributing to the increasing body of literature on sustainable food systems and rural livelihoods in South Africa.

Assessing the phytochemical profile and bioactive activities of the Southern African *Cyperus laevigatus*

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South Africa boasts a wide variety of plant species, some of which are used medicinally. With an increased stress on well-known and overharvested antibacterial species, there's a need to explore new, lesser-known medicinal species. *Cyperus laevigatus* is an underutilised aquatic medicinal plant indigenous to Southern Africa. This study assessed the antibacterial and anti-inflammatory activities of its aerial and root extracts using four solvents (distilled water, 80% methanol, ethyl acetate and n-hexane). The antibacterial activity was assessed using the minimum inhibitory concentration (MIC) against *Pseudomonas aeruginosa, Enterococcus faecalis, Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus, and Streptococcus pyogenes.* The anti-inflammatory activity was assessed using the egg albumin denaturation assay. Polar extract (water and methanol) exhibited weak antibacterial activity against most strains (MIC > 3mg/mL). The less polar extracts (ethyl acetate and n-hexane) exhibited strong to moderate activity, particularly against *S. aureus* (MIC of 0.14 mg/mL for root n-hexane) and *S. pyogenes*. The aerial ethyl acetate extract demonstrated the broadest antibacterial activity across all strains. The anti-inflammatory activity of aerial extracts was consistently stronger than that of root extracts, with aerial IC_{50}s from 257.64 µg/mL (ethyl acetate) to 2256.14 µg/mL (methanol), comparable to ibuprofen (1236.04 µg/mL). These findings confirm the antibacterial activity of the non-polar *Cyperus laevigatus* extracts and shed light on the disproportionately stronger anti-inflammatory activity of the superior phytochemicals present in the aerial parts. This species shows potential as an alternative medicine source that could alleviate harvesting pressure on the overharvested species. Further HPLC analysis is recommended to identify the active non-polar compounds.

Antimicrobial and phytochemical evaluation of *Bulbine abyssinica* A. Rich used for managing skin diseases by indigenous health practitioners in the North West Province of South Africa

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Despite the advances made in providing orthodox medications, skin diseases continue to pose a serious burden on public health globally. The effectiveness of current antimicrobial agents is limited due to their affordability, rising microbial resistance and availability. This necessitates the development of cost-effective alternatives. The study aims to evaluate the antimicrobial efficacy and phytochemical profile of *Bulbine abyssinica* A. Rich, locally used by indigenous communities to treat a variety of skin diseases. The study entails antimicrobial screening of the petroleum ether and 50% methanol extracts against *Bacillus cereus*, *Candida glabrata*, *Candida krusei*, The phytochemical profiles will be generated using Gas Chromatography-Mass Spectrometry. Preliminary results show promising antibacterial and antifungal activity compared to standard control. Though these are baseline assays, there is need for further pharmacological evaluation to provide conclusive evidence for possible production of botanicals to combat skin conditions.

Antioxidant and antimicrobial activities of *in vitro* regenerated *Thymus vulgaris*

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Thymus vulgaris L. has a long history of ethnomedicinal use for the treatment of respiratory, gastrointestinal, and infectious diseases. This study evaluated the antioxidant and antimicrobial activities of extracts derived from *in vitro* regenerated *T. vulgaris* to determine whether regenerated plants retain pharmacological efficacy. Crude extracts were prepared using 50% methanol for antioxidant assays and water, ethanol, and hexane solvents for antimicrobial assays. Antioxidant potential was assessed using the DPPH radical scavenging assay and the β-carotene–linoleic acid bleaching model. Antibacterial activity was evaluated against *Escherichia coli*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, and *Bacillus subtilis* using a broth microdilution method. Antifungal activity was tested against *Candida krusei*, *Candida glabrata*, and *Fusarium oxysporum*. The thyme extracts exhibited strong free radical scavenging activity in the DPPH assay, indicating a high capacity to neutralise reactive oxygen species. Antibacterial screening revealed notable activity, particularly against *K. pneumoniae* and *S. aureus*, with minimum inhibitory concentration values (0.2-3.1 mg/ml) comparable to those reported for potent medicinal plant extracts. Antifungal assays demonstrated inhibitory effects (MIC ranging from 0.2-3.1 mg/ml), especially against *F. oxysporum* and *C. krusei*, suggesting potential relevance for both human and agricultural pathogen management. Overall, the results valorise the traditional medicinal use of *T. vulgaris* and demonstrate that *in vitro* regenerated plants retain functional bioactivity. This study provides experimental support for integrating *in vitro* propagated *T. vulgaris* into medicinal plant production systems, contributing to sustainable production and future phytotherapeutic development.

Botanical pathways to wellness: traditional uses, phytochemistry, and health-promoting properties of wild edible plants

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Wild edible plants are naturally growing plants found in both managed and unmanaged environments without deliberate domestication and contain at least one edible component. They play a significant role in food security and are valuable sources of both macro and micronutrients which are beneficial for human health. However, their health-promoting properties remain under-explored. This review aims to provide a critical appraisal on the traditional use, phytochemical composition, and related health benefits of wild edible plants. A systematic and bibliometric review was undertaken, with data retrieved and extracted from Lens, Scopus, and Web of Science databases using a range of relevant keywords such as medicinal plants, nutritional fruits, functional foods, edible plants, and ethnobotany. As part of the inclusion criteria, only articles on wild edible plants, their uses and overall health benefits which were published from 2015 to 2025 were considered. Findings revealed that the edible parts of these plants are consumed in various forms for different purposes, including as foods and beverages. Most fruits are primarily eaten for their pleasant taste, while the leaves and seeds are commonly used as vegetables and as condiments. Wild edible plants also demonstrate significant ethnomedicinal importance, highlighting the close relationship between food and medicine. Beyond basic nutrition they help manage various health conditions such as gastrointestinal problems and digestive disorders. Phytochemical analysis revealed the presence of flavonoids and triterpenes, which are compounds widely recognised for their anti-inflammatory and antioxidant properties. Overall, wild edible plants continue to play an important role in sustaining community livelihoods through their therapeutic properties and their ability to alleviate nutrient deficiencies, thereby highlighting their importance as valuable functional foods that contribute to not only nutrition but also overall human health.

Medicinal plants as an alternative to postharvest chemical treatments in tomato pest and disease management: A systematic review covering 2000 to 2026

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Tomato (*Solanum lycopersicum*) is the second most cultivated vegetable worldwide, playing an important role in global agriculture and as a critical source of nutrition and income. However, the potential benefit of tomato production remains largely undermined by severe postharvest losses caused by pests and diseases, especially in developing countries. Postharvest chemical treatments such as fungicides and pesticides are used as a strategy to overcome this challenge. However, these synthetic chemicals are associated with some detrimental effects to the environment and crop residues that may be toxic to humans. This review provides a systematic assessment on the use of medicinal plants as an alternative to postharvest chemical treatments in managing tomato pests and diseases. Scopus and Web of Science databases were consulted, using key search words such as medicinal plants, postharvest, tomato, preparation method, and plant extracts, to retrieve articles published from 2000 to 2026. The inclusion criteria focused on articles written in English and with explicit indication of medicinal plant use in postharvest management of tomato pests and diseases. Following the PRISMA guidelines, 20 articles were eligible for detailing the application of medicinal plants for postharvest protection and preservation of tomato. Medicinal plants such as garlic (*Allium sativum*), neem (*Azadirachta indica*), and ginger (*Zingiber officinale*) are among the dominantly used plants to control postharvest loss in tomato, for preventing rot, suppressing pathogens, and limiting microbial contamination. This review demonstrates the potential to uncover the effectiveness and significance of medicinal plants in controlling tomato postharvest pathogens and extend its shelf life.

Plants Utilization for Making Edible Carbonate Salts in the Vhembe Biosphere Reserve, South Africa

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Although the heritage of carbonate salt production has existed for ages in Southern Africa, indigenous knowledge associated with plant-derived edible carbonate salt production

has not yet been fully documented or factored into economic growth strategies in the Vhembe region and nationwide. Target 13 of the South African plant conservation strategies ensures that local people benefit from their surrounding botanical resources, while preserving indigenous cultural heritage. However, the culture of using plant-derived edible carbonate salts for various purposes in the African context has not been well studied. The current study aimed to inventory the plants used for the production of edible carbonate salts in South Africa's Vhembe Biosphere Reserve. Data was collected through interviews with 69 members of the Muthivhithi Family Society residing across the Vhembe region of South Africa. A total of 13 plant species, belonging to 9 genera and 7 families, were inventoried. The most preferred plants for the production of edible carbonate salts include *Amaranthus cruentus*, *Amaranthus hybridus*, *Amaranthus thunbergii*, *Musa acuminata*, *Musa paradisiaca*, and *Sclerocarya birrea*. The edible carbonate salts were used for indigenous culinary cooking, traditional beer brewing, tobacco snuff-making, and as pesticides and fertilizers. For the first time in ethnobotany, no study has reported the use of plant-derived edible carbonate salts in beer brewing, pesticides, and baking in South Africa and elsewhere. This study preserves indigenous knowledge associated with the production of plant-derived snuff ingredients in South Africa's Vhembe Biosphere Reserve. It further fosters the realization of two of the three core fundamental, complementary roles of a UNESCO biosphere reserve: development for sustainable livelihoods and learning and knowledge sharing. A study of the mineral analysis and quantification of locally produced carbonate salts could enhance our understanding of their health-related costs and benefits, as well as economic implications.

Insecticidal activity of compounds isolated from *Cassytha ciliolata* Nees (Lauraceae) against *Spodoptera frugiperda* (Lepidoptera: Noctuidae)

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With the global population projected to exceed 10 billion within the next 40 years, the agricultural sector is facing increasing pressure to meet food demands sustainably. Concerns over the environmental and health risks of chemical pesticides have heightened the demand for safer, biodegradable alternatives for insect pest control. Plant secondary metabolites, with insecticidal bioactive properties, offer a promising solution. In this study, the parasitic plant *Cassytha ciliolata* Nees, native to the Cape provinces in South Africa, was evaluated for its potential as a source of botanical insecticides. Dried whole plants were extracted using methanol and dichloromethane, followed by compound isolation and purification through chromatographic techniques. Structural elucidation of the isolated compounds was performed using spectroscopic and spectrometric methods, including 1D and 2D NMR, and LC-MS. Five compounds were identified for the first time from *C. ciliolata*: hexacosanol,

heptadecosanoic acid, catechin, β-carotene, and β-sitosterol-3-*O*-β-D-glucoside. The insecticidal efficacy of these compounds was tested against *Spodoptera frugiperda* larvae and compared to the organophosphate synthetic insecticide. Among the compounds, β-sitosterol-3-*O*-β-D-glucoside exhibited the highest larvicidal activity, achieving a mortality rate of 73.33% and an LC_{50} value of 0.91 mg L^{-1}, closely matching the synthetic control (80.00% mortality, LC_{50} of 0.84 mg L^{-1}). In contrast, heptadecosanoic acid showed the least toxicity. These findings highlight the potential of *C. ciliolata* as a source of bioactive compounds for eco-friendly pest management. The plant's abundance as a weed and ease of cultivation further support its integration into sustainable pest control strategies, contributing to the development of safer alternatives for Integrated Pest Management (IPM).

The Chemistry of the Cape: Antifungal Insights from *Pelargoniums*

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Fungal infections remain a major global health concern, particularly in immunocompromised individuals, with increasing resistance to antifungal agents highlighting the need for novel therapeutics with alternative mechanisms of action. This study aimed to evaluate the antifungal potential of four *Pelargonium* species (*P. elongatum*, *P. quercifolium*, *P. ribifolium*, and *P. odoratissimum*) endemic to the Greater Cape Floristic Region and to characterize their metabolomic profiles in relation to observed bioactivity using Liquid Chromatography Mass Spectrometry (LC-MS) based metabolomics. Leaf extracts were prepared using acetone, methanol, acetonitrile, and hydro-methanol with 1% formic acid and screened for antifungal activity against *Cryptococcus neoformans* using a minimum inhibitory concentration (MIC) assay. Interestingly, *P. elongatum* acetone extracts showed the strongest activity (3.125 mg/mL) while an overall growth inhibition range of 3.125 to 6.25 mg/mL was observed for the other extracts. To further understand the chemical basis of this activity, LC-MS based metabolite profiling was combined with feature-based molecular networking (FBMN) and this revealed that the chemically diverse extracts were composed of flavonoids and phenolic acids as the most prominent group. There was also a range of coumarins, organic acids, and phospholipids in the extracts. Notably, two of the most active species have not previously been extensively metabolically profiled. Principal component analysis (PCA) explained 73.1% of the variance, showing partial overlap among species, indicating stronger species-specific chemical differentiation. Lastly, in-silico molecular docking further indicated potential interactions between identified metabolites and the fungal enzyme fructose-1,6-bisphosphate aldolase (FBA II) which plays a key role in the glycolysis and the gluconeogenesis pathways. This study highlights the chemical diversity and antifungal potential of selected *Pelargonium* species, identifying promising bioactive metabolites for future antifungal development. These findings support further isolation, characterization, and potential pharmaceutical application of compounds derived from *Pelargonium* species for therapeutic purposes.

Medicinal ethnobotany of the Bizana, Flagstaff and Lusikisiki areas of Eastern Pondoland, South Africa

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Eastern Pondoland (Eastern Cape, South Africa) is a culturally rich coastal region home to the *amaMpondo* people, whose medicinal plant knowledge remains largely undocumented. This study aimed to compile a comprehensive regional inventory of medicinal plants, vernacular names and uses, and to compare ethnobotanical knowledge across three towns - Bizana, Flagstaff and Lusikisiki. Quantitative data, obtained through formal interviews, were entered into a matrix table, where the numbers reflect the level of information on the plant use knowledge for each plant species (the Species Popularity Index value, SPI) and each of the 48 individual participants (the Ethnobotanical Knowledge Index value, EKI). A total of 321 medicinal plant species belonging to 203 genera and 88 families were documented, representing 466 medicinal use-reports. A total of 177 medicinal plant species were newly recorded in this study for Eastern Pondoland. The most diverse medicinal plant families were Asteraceae (12.9%), Fabaceae (7.5%) and Asparagaceae (4.7%). The most popular medicinal plants (as indicated by their SPI value) across all three towns were *Artemisia afra* (0.92), *Prunus persica* (0.91), *Acacia mearnsii* (0.89), and *Psidium guajava* (0.72). The study documented 239 new medicinal uses and 242 previously unrecorded *isiMpondo* vernacular names. Cross-town comparison revealed that Bizana showed the broadest inventory and most distinctive vernacular names, and that Bizana and Flagstaff exhibited the highest overlap in medicinal uses (81%). The EKI values demonstrated that knowledge is concentrated among older participants (55+) and specialist healers, transmitted primarily through family lineages. These findings reveal strong cultural continuity in amaMpondo medicinal knowledge alongside intra-regional variation, underscoring the urgency of documenting and conserving this indigenous ethnobotanical heritage.

Integrating Nutrition and Medicine: Documentation of Food Plants in Disease Management within the Indian community of Thulamela Municipality

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Chronic illnesses, including diabetes, hypertension, and digestive disorders, are increasing worldwide, posing a significant public health challenge. Despite this growing burden, many rural communities continue to face limited access to affordable, culturally appropriate, and accessible healthcare options. Traditional knowledge systems, particularly those involving medicinal food plants, represent a valuable yet underutilized resource for addressing these

challenges. However, this indigenous knowledge is steadily declining due to modernization, urbanization, and reduced intergenerational transmission. This study aims to document and analyze the medicinal food plants used by the Indian community in Thulamela Municipality, Limpopo Province, South Africa. The primary goal is to better understand the nutritional and therapeutic importance of these plants within the community. Data were gathered through structured interviews with 26 participants and a focus group discussion with three households to gain deeper insights into shared practices and beliefs. To evaluate the cultural significance and medicinal relevance of the identified plant species, ethnobotanical indices, such as the Relative Frequency of Citation (RFC) and Fidelity Level (FL), were used. The findings revealed 17 plant species spanning 13 botanical families. Among these, *Lagenaria siceraria* (bottle gourd) and *Moringa oleifera* emerged as the most frequently cited species. Fruits and leaves were the most utilized plant parts, while herbs represented the dominant growth form. Participants reported using these plants to manage a range of health conditions, including coughs, digestive ailments, high blood pressure, diabetes, and elevated cholesterol levels. The study highlights that knowledge transfer within families remains the primary mechanism for preserving this cultural heritage. Overall, the findings emphasize the importance of integrating traditional knowledge systems into broader health strategies to support sustainable, affordable, and culturally relevant approaches to chronic disease management.

Profiling of salicylates in edible *Viola cornuta* and *Viola × wittrockiana* flowers in relation to EU novel food exposure assessment

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Fresh flowers of *Viola cornuta* and *Viola × wittrockiana* are increasingly used as edible culinary garnishes, but their regulatory evaluation in European markets is complicated by limited compositional data and by comparison with *Viola tricolor*, a medicinally documented species with a longer history of use. This study addressed whether the salicylate content of commercially relevant edible *Viola* flowers is likely to raise toxicological concern under realistic fresh-garnish consumption scenarios. Flowers and aerial parts of selected *V. cornuta* and *V. × wittrockiana* cultivars were analysed together with *V. tricolor* reference material. Salicylate-related compounds, including methyl salicylate, salicylic acid and related derivatives, were investigated using LC-MS-based profiling of methanolic extracts, supported by GC-MS assessment of volatile methyl salicylate in fresh and dried material. Preliminary exposure estimates were interpreted against the accepted daily intake of 0.5 mg/kg body weight/day for methyl salicylate/salicylic acid equivalents. Salicylate derivatives were detected in all samples examined. Preliminary fresh-weight estimates suggest that commercially grown *V. cornuta* and *V. × wittrockiana* flowers contain salicylates at levels that are unlikely to approach the accepted daily intake when consumed as fresh garnishes. This is because normal culinary use involves individual flowers or gram-level quantities, rather than the larger quantities associated with herbal teas or medicinal preparations. Preliminary

calculations further suggest that even dried-flower tea scenarios remain within the range of familiar dietary salicylate exposure, although these results require confirmation. These preliminary findings support an exposure-based approach to edible-flower safety assessment. For EU novel food evaluation, the results indicate that salicylate concentration should be interpreted in relation to realistic use patterns, portion size, cultivar variation and processing form, rather than as a hazard signal in isolation.

Nutritional and functional evaluation of underutilised, wild-type *Corchorus olitorius* L. fruits from Limpopo: implications for dietary diversity and food safety

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Indigenous plant species remain an underutilised yet critical resource for addressing micronutrient deficiencies and enhancing dietary diversity in South Africa. While *Corchorus olitorius* L. is widely consumed for its nutrient-rich leaves, the fruit remains largely unexplored despite its potential contribution to food and nutraceutical systems. This study evaluated the nutritional composition, mineral profile, safety, and functional properties of wild-harvested *C. olitorius* fruits. Harvesting involved systematic field searches in the Masia and Valdezia villages, Makhado district, Limpopo. Fresh fruits were plucked at the basal node and freeze-dried (-80 °C), ground, and analysed using modified AOAC methods. Mineral content was quantified using ICP-OES, and functional properties were assessed using standard protocols. Microscopy revealed a multilocular, mucilage-filled capsule structure. Upon sectioning, tissues browned rapidly, likely due to polyphenol oxidase and/or peroxidase activity. Nutritional analysis showed appreciable moisture (14%), fibre (1.3%), and soluble protein (2.5%), with high ash (10%) and fat (3.1%) content across both sites. Valdezia samples showed a richer mineral profile, although sodium, magnesium, and zinc remained relatively similar. Elevated arsenic concentrations resulted in a Hazard Risk Index (HRI) exceeding safe limits (>1), while cadmium, chromium, nickel, and lead showed low HRIs (≤0.9), indicating negligible risk under the studied scenario. Functional analysis revealed high water absorption capacity (13.6–14.3 g/g) and moderate oil absorption (2.2–2.8 g/g). Swelling power increased with temperature, reaching 6.6 g/g at 90 °C, while water solubility remained low. These findings highlight the potential of wild *C. olitorius* fruits as a locally available nutritional resource and support their inclusion in strategies aimed at improving dietary quality and food system resilience.

Plants Utilization for Making Edible Carbonate Salts in the Vhembe Biosphere Reserve, South Africa

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Although the heritage of carbonate salt production has existed for ages in Southern Africa, indigenous knowledge associated with plant-derived edible carbonate salt production has not yet been fully documented or factored into economic growth strategies in the Vhembe region and nationwide. Target 13 of the South African plant conservation strategies ensures that local people benefit from their surrounding botanical resources, while preserving indigenous cultural heritage. However, the culture of using plant-derived edible carbonate salts for various purposes in the African context has not been well studied. The current study aimed to inventory the plants used for the production of edible carbonate salts in South Africa's Vhembe Biosphere Reserve. Data was collected through interviews with 69 members of the Muthivhithi Family Society residing across the Vhembe region of South Africa. A total of 13 plant species, belonging to 9 genera and 7 families, were inventoried. The most preferred plants for the production of edible carbonate salts include *Amaranthus cruentus*, *Amaranthus hybridus*, *Amaranthus thunbergii*, *Musa acuminata*, *Musa paradisiaca*, and *Sclerocarya birrea*. The edible carbonate salts were used for indigenous culinary cooking, traditional beer brewing, tobacco snuff-making, and as pesticides and fertilizers. For the first time in ethnobotany, no study has reported the use of plant-derived edible carbonate salts in beer brewing, pesticides, and baking in South Africa and elsewhere. This study preserves indigenous knowledge associated with the production of plant-derived snuff ingredients in South Africa's Vhembe Biosphere Reserve. It further fosters the realization of two of the three core fundamental, complementary roles of a UNESCO biosphere reserve: development for sustainable livelihoods and learning and knowledge sharing. A study of the mineral analysis and quantification of locally produced carbonate salts could enhance our understanding of their health-related costs and benefits, as well as economic implications.

Assessing the Economic Viability of Medicinal Plant Cultivation Through Optimised Nitrogen Fertilisation: A Literature-Based Analysis

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With over 20 000 indigenous plant species and widespread reliance on traditional medicine, medicinal plant production presents both cultural and economic opportunities. However, many indigenous medicinal plants in South Africa are still largely harvested from the wild, raising sustainability concerns and limiting commercial scalability. Limited available agronomic information further constrains medicinal plant production through cultivation systems. This study aims to assess the economic viability of cultivating selected medicinal plants through optimised nitrogen fertilisation, linking agronomic performance, phytochemical quality, and production costs. Nitrogen strongly influences biomass production, input efficiency, and the synthesis of bioactive compounds that determine the market value of medicinal plants. Both under and over application reduce nitrogen-use

efficiency and profitability while altering phytochemical composition. Evidence from existing studies shows that nitrogen availability significantly affects growth and phytochemical outcomes. In *Artemisia* species, moderate nitrogen rates are often associated with higher biomass, while lower nitrogen can favour phenolic compound production, including flavonoids. Similar patterns occur in other medicinal and aromatic plants, where nitrogen increases yield but may dilute or stabilise secondary metabolites depending on species and compound class. Overall, optimising nitrogen inputs may help balance yield, phytochemical quality, and economic costs, but responses are species specific and depend on the crop and production objective. However, integrated studies linking these factors under South African conditions remain limited. Addressing this gap will support evidence-based cultivation guidelines, improve farm-level decision-making, and promote a shift from wild harvesting to sustainable commercial production of valuable medicinal plants.

Metabolite and nutritional profile of plants used in ethnoveterinary medicine

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Ethnoveterinary medicine is an important practice used by indigenous communities to manage and treat animal diseases. As plants are known to contain bioactive compounds and nutritional elements, some plants with medicinal properties are also used by pastoralists as an alternative feed source. The inclusion of medicinal plants in animal feed within ethnoveterinary medicine highlights their dual role as both nutrition and therapeutic agents. This study aimed to investigate the diverse nature of medicinal plants with respect to their nutritional and phytochemical composition, alongside evidence of bioactivity. The selected species included *Artemisia afra*, *Bulbine frutescens*, *Colophospermum mopane*, *Peltophorum africanum* and *Senna italica*. Results revealed the presence of β-carotene, lycopene, vitamin C and vitamin E in *A. afra*, *C. mopane* and *S. italica*. Untargeted ultra-performance liquid chromatography - mass spectrometry (UPLC-MS) was performed for comprehensive phytochemical profiling. Bioactive compounds including quercetin and kaempferol derivatives were tentatively identified in *A. afra*, *B. frutescens* and *S italica* The plant extracts also showed good anti-inflammatory activity, exhibiting up to 80 % nitric oxide inhibition at non-toxic concentrations to lipopolysaccharide (LPS) stimulated RAW 264.7 macrophages. The ethanolic extracts of *P. africanum* also exhibited 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity (IC_{50} = 26.55 ± 6.91 µg/ml) and potent activity against *Candida albicans* (MIC = 0.63 ± 0.04 mg/ml) after 72 h. The results strongly support research on medicinal plants as sources of bioactive nutritional compounds for cost-effective dietary supplementation.

Bioactive phytochemicals and antioxidant activities of selected medicinal plants used in ethnoveterinary practices

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Medicinal plants have long been used in livestock health management in rural South Africa, especially in communities with limited access to conventional veterinary care. Although ethnoveterinary plants are commonly used to manage various livestock diseases and disorders, scientific validation of their bioactive constituents and therapeutic mechanisms remains limited. This study investigated the phytochemical composition and antioxidant activity of selected ethnoveterinary plant species. Ten plant species of ethnoveterinary significance were selected for analysis. Plant materials were extracted with 50% methanol, and quantitative phytochemicals. Furthermore, liquid chromatography–mass spectrometry (LC–MS) profiling was carried out on five plant species that demonstrated notable biological activity. Antioxidant potential was evaluated using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging assay and the β-carotene–linoleic acid model system. The extracts exhibited marked differences in phytochemical composition, with TPC values ranging from 11.29 to 38.09 mg GAE/g, TFC from 2.1 to 17.8 mg CE/g, and CT from 1.8 to 34.6 mg CCE/g. Extracts with higher phenolic and flavonoid contents generally displayed stronger antioxidant activity. In the DPPH assay, leaf extracts of *Bulbine abyssinica* and *Drimia sanguinea* showed the greatest free radical scavenging capacity, as reflected by their low EC_{50} values. In the β-carotene–linoleic acid assay, leaf extracts of *Drimia sanguinea*, *Ipomoea oblongata*, and *Securidaca longepedunculata* exhibited the strongest inhibition of lipid peroxidation. Overall, the results provide scientific support for the traditional use of these ethnoveterinary plants and demonstrate their potential as natural antioxidant sources for livestock health applications. Further research should focus on the isolation and characterization of active compounds, as well as *in vivo* studies to confirm their therapeutic efficacy and safety.

Assessing Geographical Variation in Metabolomic and Molecular Traits of *Sutherlandia frutescens* From Different Populations

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Lessertia frutescens (syn. *Sutherlandia frutescens*) (L.) R. Br, commonly known as cancer bush, is one of Southern Africa's most important medicinal plants and is widely used in ethnomedicine for the management of inflammation, cancer associated symptoms, and immune-related disorders. Despite its therapeutic significance, geographically distinct wild populations frequently exhibit marked variation in morphology, phytochemical composition, and associated medicinal properties. Such variability raises important concerns regarding medicinal efficacy, product stability, and the sustainable use of plant material for phytomedicinal applications. This study examines potential variation in the molecular and metabolomic traits of plants from different populations in relation to their geographical origin. Plant material was collected from populations in the Free State, Eastern Cape, and Western Cape provinces of South Africa. Dried leaf samples are currently being analysed for their metabolite profile using untargeted LC–MS and comparative proteomics using LC-MS/MS. Metabolomic and proteomic data are expected to reveal stable molecular markers associated with therapeutic efficacy and biochemical consistency. By integrating metabolomics and proteomics datasets, this study has a potential to identify elite germplasm with stable medicinal traits, support the standardization of cancer bush derived products, and contribute to conservation of valuable genetic resources, and the long-term sustainability of this important indigenous medicinal species.

From Plant to Product: Advancing Inclusive Innovation and Botanical Value Chains in South Africa

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South Africa's biodiversity and indigenous knowledge systems provide significant opportunities for the development of innovative value-added botanical products for the cosmetic industry. This presentation highlights research, development, and commercialisation initiatives funded by the Department of Science, Technology and Innovation (DSTI), aimed at developing cosmeceutical ingredients and formulations with antiaging and hair growth properties. The research further sought to establish an inclusive innovation model that integrates indigenous knowledge holders, researchers, communities, and industry stakeholders across the botanical value chain. Plant species were selected based on ethnobotanical knowledge and traditional use by South African communities. Selected plants underwent extraction, phytochemical profiling, bioactivity screening, ingredient optimisation, and formulation development for cosmetic applications. Prototype formulations were evaluated for stability, quality, safety, and commercial applicability. In parallel, value-chain development activities were implemented to support sustainable sourcing, cultivation, agroprocessing, pilot-scale ingredient manufacturing, and technology transfer to communities and Micro, Small, and Medium Enterprises (MSME)s. The research resulted in the identification and development of bioactive botanical ingredients with antiaging and hair

growth properties, leading to commercially relevant cosmeceutical prototypes. Case studies will demonstrate the successful integration of indigenous knowledge, scientific research, and product innovation, while highlighting community participation and beneficiation within the supply chain. The presentation will also highlight ongoing work at the Agricultural Research Council – Vegetable, Industrial and Medicinal Plants (ARC-VIMP), including initiatives supporting medicinal and indigenous plant value chains through cultivation systems, quality control and analytical capabilities, agroprocessing infrastructure, pilot-scale manufacturing, and skills and technology transfer. These initiatives contribute to strengthening support for communities, MSMEs, higher education institutions (HEIs), and the broader National System of Innovation (NSI). Integrating indigenous knowledge, scientific research, and value-chain development provides a pathway for sustainable bioprospecting and innovation within the cosmetic sector while promoting inclusive economic development in South Africa.

Commercialisation of African Natural Products and Indigenous Knowledge Systems: A Fair Story versus a Fairy Tale

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The commercialisation of African natural products and Indigenous Knowledge Systems (IKS) is frequently presented as a promising pathway for economic development, biodiversity conservation, community empowerment, and growth of Africa's bioeconomy. While numerous policy frameworks, innovation strategies and funding programmes have championed the potential of indigenous resources, the reality on the ground often reveals a more complex story. This presentation examines whether the commercialisation narrative is a fair story grounded in tangible success or a fairy tale built on unrealistic expectations.

Drawing on over two decades of research, community engagement and product development, the presentation highlights several successful examples where scientific validation, product development, quality assurance and market access have enabled communities and small enterprises to derive value from indigenous resources. These include initiatives involving moringa, indigenous leafy vegetables, herbal teas, nutraceuticals and natural health products, where collaborations between communities, researchers, government agencies and industry have resulted in enterprise development, job creation and enhanced livelihoods.

However, the presentation also reflects critically on the less discussed realities and failures. Many promising innovations fail to reach the market due to fragmented and often uncoordinated regulatory environments, costly compliance requirements, unclear product classification pathways, and limited support for navigating certification systems. Additional barriers include inadequate production capacity, insecure land tenure, inconsistent raw material supply, weak business management skills, limited entrepreneurial commitment among some SMMEs, and insufficient investment in scaling technologies.

The presentation argues that successful commercialisation requires more than scientific validation. It demands integrated innovation ecosystems that connect Indigenous Knowledge holders, researchers, regulators, financiers and markets. By sharing both successes and setbacks, this presentation seeks to provide a realistic perspective on the opportunities and challenges facing IKS-based enterprises and proposes practical strategies for creating a more enabling environment for the sustainable commercialisation of African natural products

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Utilisation of botanicals for livestock management in Eastern Cape Province: A review

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Ethnoveterinary plant-based remedies continue to play a significant role in maintaining livestock health in South Africa, particularly in rural communities where access to formal veterinary services remains limited. This review was carried out following PRISMA guidelines and drew on a wide range of sources, including peer-reviewed articles, books, dissertations, and technical reports. Relevant studies were selected based on predefined inclusion and exclusion criteria focusing on ethnoveterinary plants used within the Eastern Cape Province, South Africa. A total of 56 plant species, representing 26 families, were identified in the management of livestock diseases in the Eastern Cape. Frequently reported species included *Acokanthera oppositifolia* (Lam) Codd, *Agapanthus praecox* Willd, and *Aloe ferox* Mill, *Zanthoxylum capense* (Thunb.) Harv., and *Strychnos mitis* S. Moore. The most represented plant families were Fabaceae (6.8%), Apocynaceae (4.5%), and Amaryllidaceae (3.4%). Roots (29%) and leaves (21%) were the most used plant part. Preparation techniques included decoction (41%) and maceration (18%), being the most frequently used. Notably, a considerable proportion (30%) of the reviewed studies did not specify preparation methods. Remedies were primarily administered orally (50%). Phytochemical evidence indicates that commonly used species such as *Aloe ferox*, *Zanthoxylum capense*, and *Strychnos mitis* contain compounds including flavonoids, phenolics, tannins, alkaloids, and terpenoids, which are associated with therapeutic effects. Accordingly, these species are reported to exhibit strong antioxidant activity, with low EC_{50} values observed in 2,2-diphenyl-1-picrylhydrazyl and 2,2'-azinobis-(3-ethylbenzothiazoline-6-sulfonic acid) assays, indicating high radical scavenging potential. Antimicrobial evaluations further demonstrate broad-spectrum activity against both Gram-positive and Gram-negative bacteria, with low minimum inhibitory concentrations reported for *Zanthoxylum capense* and *Strychnos mitis*, while also showing notable antifungal activity. These findings support the pharmacological relevance of these plants in livestock

disease management. Overall, these findings highlight the importance of ethnoveterinary plants across communities. Futhermore, the review highlights the importance of documenting ethnoveterinary plants and rigorous scientific validation, and the potential for integrating ethnoveterinary knowledge into sustainable livestock management practices in South Africa.

Roots of knowledge, seeds of opportunity: ethnobotany and economic perspective of wild edible plants in Limpopo province

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Globally, wild edible plants are highly recognised and have gained substantial attention for their significant contribution to nutrition, healthcare, and cultural identity as well as economic empowerment. However, documentation of their diversity, preparation methods, uses, and economic importance remains fragmented. This review was aimed to synthesise the available literature and summarise the utilisation patterns and economic potential of wild edible plants consumed by rural communities in Limpopo Province. The study used a PRISMA approach method, where scientific articles from Google Scholar, Scopus, ScienceDirect, and Web of Science databases related to plant uses, nutritional potential, and economic value published between 2000 and 2026 were evaluated. The search terms included combinations of wild edible plants, ethnobotany, indigenous fruits, traditional vegetables, nutrition, and economic potential. A total search of 154 articles were identified of which 60 met the inclusion criteria and were reviewed. Findings showed that 72 plants, belonging to 58 genera and 34 families were identified, dominated by Fabaceae, Amaranthaceae, Anacardiaceae, Cucurbitaceae, and Malvaceae families. Additionally, the dominantly reported wild edible plants commonly utilised in rural communities were *Sclerocarya birrea*, *Vangueria infausta*, *Ximenia afra*, *Cleome gynandra*, and *Amaranthus* sp. The most utilised plant parts were fruits (46%), leaves (38%), tubers (9%), and seeds (7%). Raw consumption, boiling, drying, roasting, and pounding were the identified commonly used preparation methods. Administration methods mainly involved direct consumption as snacks, cooked vegetables, and beverages. From an economic perspective, approximately 19 indigenous wild species were informally traded in markets where the products are sold on the streets and homestead within the communities. Taken together, wild edible plants play a vital role in supporting cultural

practices, food and nutritional security, and economic empowerment among rural communities of Bapedi and Vatsonga people.

Harnessing indigenous plants for sustainable crop production in South Africa: A review of *Lippia javanica* and *Aloe ferox* in crop production systems

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Indigenous knowledge continues to play a significant role in shaping sustainable agricultural practices in South Africa, particularly among smallholder farming communities. This review synthesises existing literature on the use of plant-based indigenous knowledge in crop production, with specific focus on *Lippia javanica* and *Aloe ferox*. The study examines how these botanicals are integrated into key stages of crop production, including land preparation, soil fertility management, and planting practices. A systematic review approach, guided by PRISMA principles, was employed to identify, screen, and analyse relevant peer-reviewed articles, theses, and grey literature across South Africa. Findings indicate that *Lippia javanica* is widely utilised as a natural pesticide and protective agent against crop pests, while *Aloe ferox* contributes to soil conditioning and plant health through its organic properties. Across different provinces, these botanicals are embedded within broader indigenous knowledge systems that are informed by cultural beliefs, environmental awareness, and experiential learning. The review further reveals regional variations in application methods, preparation techniques, and perceived efficacy, highlighting the dynamic and context-specific nature of indigenous agricultural practices.

Botanical pathways to wellness: traditional uses, phytochemistry, and health-promoting properties of wild edible plants

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Wild edible plants are naturally growing plants found in both managed and unmanaged environments without deliberate domestication and contain at least one edible component. They play a significant role in food security and are valuable sources of both macro and micronutrients which are beneficial for human health. However, their health-promoting properties remain under-explored. This review aims to provide a critical appraisal on the traditional use, phytochemical composition, and related health benefits of wild edible plants. A systematic and bibliometric review was undertaken, with data retrieved and extracted from Lens, Scopus, and Web of Science databases using a range of relevant keywords such as medicinal plants, nutritional fruits, functional foods, edible plants, and ethnobotany. As part of the inclusion criteria, only articles on wild edible plants, their uses and overall health benefits which were published from 2015 to 2025 were considered. Findings revealed that the edible parts of these plants are consumed in various forms for different purposes, including as foods and beverages. Most fruits are primarily eaten for their pleasant taste, while the leaves and seeds are commonly used as vegetables and as condiments. Wild edible plants also demonstrate significant ethnomedicinal importance, highlighting the close relationship between food and medicine. Beyond basic nutrition they help manage various health conditions such as gastrointestinal problems and digestive disorders. Phytochemical analysis revealed the presence of flavonoids and triterpenes, which are compounds widely recognised for their anti-inflammatory and antioxidant properties. Overall, wild edible plants continue to play an important role in sustaining community livelihoods through their therapeutic properties and their ability to alleviate nutrient deficiencies, thereby highlighting their importance as valuable functional foods that contribute to not only nutrition but also overall human health.

Chemical diversity in the genus *Diosma* (Rutaceae)

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The genus *Diosma* L. (Rutaceae) encompasses 28 species, many of which are highly aromatic. One member in particular, *Diosma hirsuta* L., has been documented as the original Cape *buchu* of the Khoisan, with notable medicinal and spiritual uses. Almost all *Diosma* species have remained chemically unknown despite their importance in traditional medicine. In this study, both volatile and non-volatile compounds were characterised using gas- and ultra-high performance liquid chromatography coupled with mass spectrometry across several species, including *D. acmaeophylla* Eckl. & Zeyh., *D. arenicola* I.Williams, *D. guthriei* R.Glover, *D. hirsuta*, *D. meyeriana* Spreng., *D. oppositifolia* L., *D. pedicellata* I.Williams, *D. ramosissima* Bartl. & H.L.Wendl., and *D. subulata* J.C.Wendl. The results showed that *Diosma* species exhibit chemotypic geographic variability at the population level. The major non-

volatile compounds identified across these species include arbutin, rutin, hesperidin, and chlorogenic acid, while the major volatile compounds include limonene, *cis*-β-ocimene, linalool, and β-myrcene. Many of these constituents are pharmacologically relevant and warrant further investigation. Several volatile and non-volatile compounds now identified in *Diosma* have been reported to exhibit meaningful pharmacological activities, which align with the traditional medicinal uses of *buchu* species.

Chemical diversity of genus *Oftia* (Scrophulariaceae)

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Oftia Adans. (Scrophulariaceae) is a small genus of three species of woody shrubs, sub-endemic to the Cape Floristic Region of South Africa. It belongs to the small, predominantly southern African tribe Teedieae, which were recently shown to represent one of the basally divergent lineages within the Scrophulariaceae. As such, it is of considerable phylogenetic interest. The Scrophulariaceae are particularly well known for the widespread occurrence of iridoid compounds, a dominant class of secondary metabolites, so that the Teedieae are an important group for investigating the chemical diversity and evolutionary patterns of secondary metabolites. The genus includes three species: *Oftia africana* (L.) Bocq., *O. glabra* Compton, and *O. revoluta* (E.Mey.) Bocq. ex Baill., all of which are restricted to rocky sandstone slopes in fynbos vegetation. The aim of this study was to investigate, for the first time, the chemical diversity of the genus through comparative Liquid Chromatography–Mass Spectrometry (LC–MS) metabolomic profiling of *O. africana*, *O. glabra* and *O. revoluta*, with the objective of identifying species-specific secondary metabolite patterns. Methanolic extracts of the three species were analysed using LC-MS to evaluate qualitative differences in metabolite composition in a negative-ion mode. Twenty-two peaks of interest were observed, with seven compounds tentatively identified and the remainder of which are yet unknown. Identified compounds include gluconic acid, saccatoside, 6-*O*-(4-hydroxybenzoyl) ajugol, premnacorymboside B, verbascoside, and harpagoside. Shared compounds detected in the species included premnacorymboside B and several unknown compounds, indicating a conserved core phytochemical composition within the genus. These findings provide the first chemotaxonomic evidence supporting the recognition of distinct species within the genus *Oftia.*

The traditional uses and chemistry of annual *Oncosiphon* species (Asteraceae)

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Oncosiphon Källersjö (Asteraceae) is a small genus of seven aromatic plant species, comprising mostly annual herbs sub-endemic to southern Africa's Greater Cape Floristic Region. All except one species bear discoid inflorescences with numerous yellow disc florets in corymbiform arrangements and produce ribbed cypselae as fruit. Despite documented antimicrobial activity across several species and antiplasmodial activity for *O. pilulifera* (L.f.) Källersjö, the phytochemical record for the genus remains fragmented and species-specific. The present study undertakes a chemotaxonomic assessment of all five annual *Oncosiphon* species. UPLC-MS profiling identifies cirsimaritin, methoxy tetrahydroxyflavone-*O*-hexoside, *O*-dicaffeoylquinic acid, isorhamnetin, and dihydroxybenzoic acid-*O*-hexoside as the major shared metabolites. This profile shows partial overlap with phenolic acids and flavonoid glycosides, particularly caffeoylquinic acid derivatives and isorhamnetin and quercetin glycosides, previously reported in isolation for individual taxa, and extends the chemical inventory to *O. grandiflorus* (Thunb.). Källersjö and *O. intermedius* (Hutch.) Källersjö for the first time. Hierarchical clustering resolves the genus into three chemical groups, with *O. africanus* (P.J.Bergius) Källersjö and *O. pilulifer* emerging as the most divergent taxa, each occupying its own cluster, whereas *O. suffruticosus* (L.) Källersjö, *O. grandiflorus*, and *O. intermedius* show increasingly close affinities. Hydrodistilled essential oils from all five species were analysed by GC-MS. Results are consistent with previous headspace and essential-oil studies reported for individual *Oncosiphon* taxa, and are dominated by oxygenated monoterpenes and irregular monoterpenoids, including camphor-, cineole-, chrysanthenone- and artemisia/yomogi-type constituents, alongside minor sesquiterpene lactones of the germacranolide and eudesmanolide classes. Further work is required to isolate bioactive constituents for pharmacological evaluation.

Ethnobotanical Diversity and Use of Medicinal Plants for Childhood Diarrhoea in Sub-Saharan Africa

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Childhood diarrhoea remains a major public health concern in Sub-Saharan Africa, particularly in rural communities where access to formal healthcare is limited. In these regions, medicinal plants continue to play a vital role in primary healthcare and the management of gastrointestinal disorders. This study systematically reviews the ethnobotanical literature documenting plant species used to treat childhood diarrhoea across Sub-Saharan Africa. Relevant studies were retrieved from major academic databases, including Google Scholar, Elsevier, PubMed, and EBSCOhost. The review identified 95 medicinal plant species belonging to 46 families reported from six countries in the region. The family Fabaceae was the most represented (14 species). Trees (77%) constituted the dominant growth form, while leaves (49%) and roots (40%) were the most frequently utilised plant parts. Traditional preparation methods were primarily decoction (41%) and maceration (40%), with oral administration (60%) being the predominant route of treatment. Conservation assessment indicated that most species (69%) are classified as Least Concern, although several

taxa remain threatened or lack sufficient conservation data. Pharmacological investigations showed that antimicrobial activity is the most commonly evaluated bioactivity (76%), and 84% of the documented species have been reported to contain bioactive compounds. Despite the widespread reliance on plant-based remedies, ethnobotany specific to childhood diarrhoea remains limited across the region. Further ethnobotanical surveys, pharmacological validation, and conservation efforts are needed to support the sustainable use of medicinal plant resources and strengthen their contribution to community healthcare systems.

In Vitro α-Glucosidase inhibitory activity and metabolomic profiling of five indigenous leafy vegetables used as food as medicine in Ga-Molepo, Limpopo province

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Alpha-glucosidase inhibitors mitigate postprandial hyperglycaemia by retarding carbohydrate digestion. Indigenous leafy vegetables (ILVs) are valued in South African ethnobotany for their nutritional and medicinal roles in traditional diets. Studies have shown that they offer sustainable, low-side-effect options for blood glucose control amid rising diabetes prevalence.

This study evaluated in vitro alpha-glucosidase inhibition by extracts from five ILVs namely, *Amaranthus cruentus*, *Bidens pilosa*, *Cleome gynandra*, *Crotalaria juncea*, and *Tribulus terrestris* commonly consumed as food as medicine in the Ga-Molepo area of Limpopo province. Additionally multivariate metabolome analysis of the five ILVs was determined.

Antidiabetic assay was performed by determining inhibition through quantification using different concentrations of ILV extracts ranging from 100-500 μL/mL using Spectrophotometer. Untargeted metabolite profiling used UHPLC-QTOF-MS, with PCA/OPLS-DA for clustering and VIP scores (>1.5) for biomarkers.

Profiles varied non-linearly: *A. cruentus* peaked at around 14% ($500\ \mu$L/mL); *C. juncea* showed biphasic inhibition (~12% at $300\ \mu$L/mL); *C. gynandra* and *T. terrestris* stayed at less than 5% inhibition. PCA/OPLS-DA revealed distinct clusters, driven by flavonoids/phenolics (typhaneoside, jaceidin, reynoutrin, isokaempferide, feruloyl malate).

A. cruentus and *C. juncea* demonstrate potent inhibition tied to bioactive metabolomes, affirming ILVs' ethnobotanical promise for affordable hyperglycemia interventions and underscoring metabolomics for valorizing African indigenous crops. This study addresses SDG goal 3 for ensuring good health and well-being.

Comparative Evaluation of Cold-Pressed Oil Yield Potential of Five Moringa oleifera Cultivars from Various Regions, Cultivated in South Africa for Industrial Applications

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The burgeoning demand for oil derived from medicinal plants such as *Moringa oleifera*, the so called “Powerhouse” has broadened the horizon to investigate the seed-oil yield of various

cultivars for potential use in different applications. However, cultivar specific performance relative to the market demand, is the core factor in determining its commercial viability. The current study thus investigated the cold-press seed oil yield of five *Moringa oleifera* cultivars from different regions, cultivated under South African agro-climatic conditions, with the aim of identifying high-yielding cultivar suitable for targeted industrial application. The five cultivars comprised of; A (VI047492), B (VI059356), C (VI048890), D (VI049266), and E (VI048609). Mature, dried seeds were harvested and subjected to mechanical cold press extraction under standardised conditions. Data was expressed as percentage recovery as relative to 100g of dried seeds. Seed oil yield was significant at ($p < 0.05$). Cultivar A, C, E recorded the highest oil yield of 26, 27 and 27%, respectively while cultivar B and D reported an intermediate and lower performance, of 24 and 23%, respectively. This observation can be attributed to genetic differences and genotype-environment interactions, which influence seed development and oil accumulation. This study will contribute to the scientific pool of knowledge in the food, nutraceutical, cosmetic, and bio-based industrial sectors, as well as farmers and researchers, by guiding cultivar selection for improved oil yield and commercial value.

A comparison of the phytochemical profiles, antioxidant, and antimicrobial activities of field-grown and *in vitro*-grown *Gymnanthemum amygdalinum* Delile (Asteraceae)

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The growing demand for pharmacologically valuable plants raises concerns about their persistence due to potential overharvesting. This corroborates the evaluation of alternative techniques, such as *in vitro* growth, for propagating medicinal plants. However, the artificial nature of *in vitro* growth raises questions about whether the phytopharmacological integrity of *in vitro*-grown plants is retained relative to their field-grown counterparts. In this study, the phytochemical profiles, *in vitro* antioxidant potentials and antibacterial activities of *in vitro*-grown *Gymnanthemum amygdalinum* (Delile) Sch.Bip. were compared to their field-grown counterparts. Nodal and shoot-tip explants were cultured on Murashige and Skoog (MS) media combined with varying concentrations of BAP and NAA. Extracts of four-week-old *in-vitro* shoots and field-grown leaves of *G. amygdalinum* were each prepared using 80% methanol and distilled water, then phytochemical and polyphenol analyses were performed. Thereafter, antibacterial activities of the extracts against *Escherichia coli* and *Staphylococcus aureus* were assessed by agar-well diffusion. Antioxidant potential was evaluated using DPPH, hydrogen peroxide reducing, and metal chelation. Optimal shoot induction was observed in MS media combined with 1 $mg.L^{-1}$ BAP and 0.5 $mg.L^{-1}$ NAA. Both 80% methanol extracts yielded profiles with strong phytochemical presence for compounds such as saponins, glycosides, and tannins. Both extracts of the *in vitro* samples scavenged more DPPH radicals and reduced more hydrogen peroxide, potentially due to their higher phenolic content, compared to the field-grown extracts. Neither of the *in vitro* sample extracts could chelate metal ions, possibly due

to their low flavonoid content compared to the field-grown extracts. The 80% methanol extracts of both sample types successfully inhibited the growth of both bacterial strains, while distilled water had a variable impact. The results of this study support the potential use of *in vitro*-grown *G. amygdalinum* as a sustainable alternative to sourcing pharmacologically valuable compounds to supplement compounds from field-grown plants.

PLANT PHYSIOLOGY

Growing while defending in abiotic stress-tolerant chickpea (*Cicer arietinum* L.; Fabaceae) genotypes

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The growth–defence trade–off concept proposes that reduced photosynthate production under stress leads to preferential carbon allocation to defence at the expense of growth. This framework assumes a common pool of photosynthates that must be competitively allocated between growth and defence functions. However, empirical evidence remains inconsistent, where some studies support this trade-off, while others show that plants can maintain growth and defence concurrently. Therefore, it remains unclear whether carbon allocation to defence necessarily constrains growth. Some of the studies supporting the trade-off are based on defoliation, shading, or low CO_2 conditions, which induce negative carbon balances and artificially supress sink activities, thereby potentially compounding interpretation. In contrast, other studies demonstrate that under abiotic stress (excluding shading), cell division and elongation are inhibited before photosynthesis declines. Furthermore, both this study and previous work showed increased concentrations of non-structural carbohydrates (NSC) and secondary metabolites under stress, which is often associated with reduced growth sink activity rather than limited carbon supply. Our analysis on chickpea provides new evidence for complementary, rather than competitive, carbon allocation to growth and defence under drought and heat stress. These findings suggest that increased NSC and secondary metabolite concentrations may support plant growth, seed yield and overall plant fitness under stress, with important implications for natural systems and crop improvement in agriculture.

Salt tolerant *Canavalia Rosea*, a sustainable solution for soil sodicity in irrigated sugarcane plantations

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To promote the use of legumes for the alleviation of sodicity in small-scale irrigated sugarcane plantations to reduce the cost of soil amendments for small-scale sugarcane farmers. A greenhouse pot experiment was conducted by growing *Canavalia rosea* (Sw.) DC. in high sodium (Na^+) concentration/sodic sugarcane plantation soils over a period of seven months. Plant material and soil characteristics, including salinity indicators, were analysed pre– and post- *C. rosea* harvest. *Canavalia rosea* hyperaccumulated more sodium (Na^+) with age significantly decreasing soil Na^+ concentrations from 271.870 to 51.573 µmol Na g^{-1} post-*C. rosea* harvesting. The electrical conductivity (EC), sodium adsorption ratio (SAR), and exchangeable sodium percentage (ESP) were significantly reduced after three months and remained statistically similar over the period to the seventh month. *Pseudomonas putida* and various species in the *Bacillus* genus including *B. amyloliquefaciens*, *B. safensis*, *B. pumulis*, *B. subtilis*, and *B. zhangzhouensis* were isolated from *C. rosea* plants, revealing associations that likely assisted *C. rosea* in Na^+ tolerance and improved nutrient availability. The increased abundance of *Flavobacterium* species in rhizosphere soils may be linked to the ability of *C. rosea* to reduce soil Na^+ concentrations, creating favourable conditions for microbial proliferation. Consecutive cultivation of C. rosea reduced Na^+ concentration by five-folds and improved soil characteristics in sugarcane plantation soils from Sikhwahlane, Mpumalanga. However, field studies are recommended to study the soil Na^+/ sodicity reduction, microbial interactions and growth of *C. rosea* at irrigated sugarcane plantations.

***Eragrostis curvula*: Friend or Foe? Balancing benefits and ecological risks**

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Eragrostis curvula is a perennial grass species that has become highly invasive in many regions, yet it continues to be actively utilised for economic and ecological purposes, highlighting a complex balance between benefits and ecological risks. This study aims to assess the ecological risks associated with *E. curvula* and demonstrate the positive contributions of *E. curvula* through controlled experiments. A literature search and thematic grouping of studies showed that research on invasiveness and control represents the largest body of work on *E. curvula*, indicating that the ecological effects of the species have been studied far more extensively than their potential benefits. Nutritional analysis of *E. curvula* seeds revealed high concentrations of essential micronutrients, including phosphorus (5041.5–5921.7 mg/kg), potassium (4490.5–5531.2 mg/kg), calcium (2978.4–16339.1 mg/kg), iron (72.2–145.4 mg/kg), and zinc (44.9–65.4 mg/kg), indicating its value as a

supplement to protein-rich legumes such as *Cajanus cajan* and *Vigna unguiculata*. In rotation trials, *C. cajan* enhanced nitrogen, carbon, and phosphorus cycling enzyme activities, and rotations promoted bacterial diversity. In rotation with *C. cajan*, *E. curvula* had higher nitrogen and phosphorus concentrations. Intercropping with *V. unguiculata* improved nitrogen uptake and soil nutrient use efficiency in *E. curvula* plants. *Eragrostis curvula* demonstrated strong phytoremediation potential, accumulating high concentrations of metals such as aluminium (9446–40,106 mg/kg), iron (8473–47,000 mg/kg), chromium (83–210 mg/kg), and nickel (32–71 mg/kg), suggesting its suitability for restoring contaminated or degraded soils. While these findings support the strategic use of *E. curvula* in low-input, diversified cropping systems and its potential for rehabilitating degraded soils, further field-scale research is needed. As a next step, future studies could explore the benefits of *E. curvula* in areas where it is already established, helping to maximise potential while minimising ecological risks.

Characterising the antioxidant potential of indigenous leafy vegetables with medicinal significance in Ga-Molepo, Limpopo Province

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Indigenous leafy vegetables (ILVs) rank among the most affordable and readily available dietary sources of essential nutrients, including proteins, vitamins, and dietary fibre. Beyond their nutritional value, ILVs are notable reservoirs of phytochemicals, plant-derived secondary metabolites that confer a range of health-promoting benefits to humans, particularly antioxidant and anti-inflammatory activities. The present study sought to document ILVs utilised for their dual role as food and medicine within the Ga-Molepo area of Limpopo Province. Ethnobotanical data were gathered through structured questionnaires administered during community surveys, which informed the selection of ILVs consumed for both nutritional and medicinal purposes. Based on frequency index calculations, five most commonly consumed ILVs were identified, namely *Bidens pilosa* L., *Cleome gynandra* L., *Crotalaria juncea* L., *Tribulus terrestris* L., and *Amaranthus cruentus* L. The antioxidant activities of their respective plant extracts were subsequently assessed using DPPH, FRAP, and ABTS radical scavenging assays, alongside determination of total phenolic content (TPC) and total carotenoid content (TCC). Among the selected species, Crotalaria juncea recorded the greatest TCC at 30.99 mg/100g, whereas B. pilosa demonstrated the highest TPC at 792.97 g GAE/DW and superior antioxidant activity in both the DPPH (72.45 mg GA/100g) and FRAP (7.46 mg GA/100g) assays. In the ABTS assay, A. cruentus and B. pilosa exhibited comparably high antioxidant activities of 27.86 and 27.43 mg GA/100g respectively, with no statistically significant difference observed between them. These findings outperformed the remaining ILVs evaluated in this study. The outcomes of this research support the attainment of United Nations Sustainable Development Goals 2 and 3, which target the elimination of hunger and the promotion of good health and well-being, respectively, through the sustained consumption and recognition of indigenous leafy vegetables.

Integrated enzymatic and proteomic analysis reveals a coordinated deployment of carbohydrate-active enzymes involved in cell wall degradation and nutrient acquisition during wheat–*Puccinia triticina* interactions

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Wheat leaf rust, caused by *Puccinia triticina* (*Pt*), is a major fungal disease affecting global wheat production. Successful colonization depends on the secretion of virulence-associated proteins and carbohydrate-active enzymes (CAZymes) involved in host cell wall degradation, nutrient acquisition, and suppression of host defence responses. This study investigated extracellular enzyme activity dynamics and proteomic signatures associated with wheat–pathogen interactions. Enzyme assays, recombinant xylanase characterisation, proteome extraction, and bioinformatic analyses were employed to profile the fungal protein arsenal. In infected susceptible tissue, cellulolytic and xylanolytic activities increased during early infection, indicating active cell wall degradation and colonisation. Elevated amylolytic and invertase activities suggested mobilisation of soluble carbohydrate reserves for nutrient acquisition. In contrast, resistant wheat showed sustained peroxidase activity and cell wall-modifying enzymes throughout infection, indicating reinforced structural defences and oxidative stress regulation. Recombinant *Pt* xylanase purification yielded a partially expressed protein; however, the correctly folded enzyme in crude extract exhibited strong activity. Molecular docking confirmed binding to xylan substrates, supporting its role in host cell wall degradation. Proteomic analysis identified 558 fungal proteins in susceptible interactions compared to 72 in resistant interactions. The resistant proteome consisted largely of housekeeping proteins, indicating restricted pathogen development. In susceptible tissue, bioinformatic annotation revealed multiple secreted CAZymes and virulence-associated proteins, including glucan endo-1,3-β-glucosidase, α-galactosidases, mannan endo-1,6-α-mannosidase, chitinases, chitin deacetylase, and a thaumatin-like protein. Putative virulence factors included a CFEM domain-containing protein and a membrane-associated peroxidase potentially involved in reactive oxygen species detoxification. Plasma membrane ATPases indicated active nutrient uptake during fungal proliferation. Collectively, these findings demonstrate a coordinated infection strategy involving temporally regulated CAZyme activity, carbohydrate mobilisation, stress adaptation, and a diverse virulence proteome that promote fungal colonisation in susceptible wheat tissue, providing potential targets for inhibition. Whereas resistant responses are characterised by sustained structural and oxidative defences that limit pathogen progression.

Effects of alternaria leaf spot (*Alternaria Alternata*) on growth, yield and phytochemical profile of *Moringa Oleifera*

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Moringa oleifera Lam. is affected by pests and diseases which affect their growth, yield and phytochemical composition. *Alternaria alternata* is one of the pathogens that causes Alternaria leaf spot disease in Moringa. The objective of the study was to determine whether Alternaria leaf spot affects the growth, yield and phytochemical contents of the PKMI cultivar of *M. oleifera*. The study was made up of two main treatments: *M. oleifera* seedlings inoculated with *A. alternata* and a non-inoculated control. Growth parameters including plant height and stem diameter and yield components such as the fresh shoot mass (FSM) and root length were measured. For the physiological attributes: photosynthetic rate (PR), stomatal conductance (SM), transpiration rate (TR), water use efficiency (WUE), and Ci intercellular CO_2 (Ci CO_2) concentration were collected. Lastly, the biochemical compounds (total flavonoids, total phenols, antioxidant activity and chlorophyll). To compare differences in treatment means, paired sample t-test was performed at a 5% significance level using Sigma Stat software 2016 and Graph Prism 5. The inoculated treatment significantly ($p<0.05$) reduced the plant height by 14% and had no significant ($p>0.05$) effect on the stem diameter and root weight. Additionally, non-inoculated plants showed higher FSM (1.8g) in comparison to their counterpart (inoculated: 1.2 g). The inoculation affected the physiological attributes as follows: The PR, SM and TR decreased by 4%, 17% and 4% respectively, while the WUE increased by 10% in comparison to the non-inoculated plants. There was no significant effect on the Ci CO_2 concentration. The inoculation significantly ($p<0.05$) increased the total flavonoids, phenols and antioxidant activity by 69%, 4% and 4% and decreased, chla, chlb and totchl by, 48%, 43% and 44% respectively. The introduction of *A. alternata* into PKMI cultivar of *M. oleifera* influenced its growth and development and altered the physiological and biochemical defence mechanism.

Effect of the application of Moringa-leaf extract on the growth and yield of bambara groundnut

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Bambara groundnut is an underutilised legume with strong potential to improve food and nutritional security in Sub-Saharan Africa. Its productivity is limited by poor soil fertility, climate variability, and inadequate agronomic practices. Sustainable biostimulants such as moringa-leaf extract (MLE) may enhance plant growth, yield, and stress tolerance. This study aimed to evaluate the effects of different concentrations of MLE on the quantitative and qualitative attributes of Bambara groundnut. The experiment was conducted in field conditions at the University of Limpopo. Randomized complete block design was adopted with

four treatments: 0%, 1%, 3%, and 6% MLE, each replicated 3 times. The Bambara groundnut genotype TVSu-1918 was planted under standard agronomic practices. MLE was applied 17 days after emergence using foliar application method, and at 14-day intervals until harvest thereafter. Growth parameters including plant height, root length, chlorophyll content, and flowering time and yield components such as number of pods, fresh and dry pod weight, shoot biomass, seed weight, and harvest index were measured. Data was subjected to ANOVA at 5 % significance level. The results demonstrated that MLE concentration significantly influenced the growth and yield attributes. The highest plant height (29,66 cm), root length (28,23 cm) chlorophyll content (51.1 SPAD), and flowering time (24 days) was measured in plants treated with 3% MLE. The highest number of pods (86), fresh pod (155 g), dry pod (53.84 g) and fresh shoot mass (313 g) was measured in plants treated with 3%. In contrary, 6% had the highest biomass (95.0 g). The highest seed weight (54.77 g) and HI (0.44 %) were measured in plants treated with 3%. The 3% MLE was effective and significantly improved growth and yield performance of Bambara groundnut. The study highlights effective biostimulant application rates (3 %) and promotes Bambara groundnut as a resilient, nutrient-rich crop suitable for Sub-Saharan Africa.

Effects of different concentrations of Moringa-based biostimulant on the growth and yield of swiss chard (*Beta vulgaris* L. var. Fordhook giant) under greenhouse conditions

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Swiss chard (*Beta vulgaris* L. var. Fordhook Giant) is a nutrient-dense leafy vegetable vital for food security, yet its production heavily relies on synthetic fertilizers that are costly and environmentally harmful. Moringa leaf extract (MLE) offers a sustainable alternative due to its rich content of phytohormones, antioxidants, and essential nutrients. This study aimed to develop scientific information on the potential of a moringa-based biostimulant on the growth and yield of Swiss chard under greenhouse conditions. The experiment was conducted at the University of Limpopo, using a Randomized Complete Block Design (RCBD) with five MLE concentrations (0%, 3%, 6%, 9%, and 12%) replicated four times. Growth parameters including plant height, stem diameter, chlorophyll content, root length, leaf area, and biomass were measured and analysed using ANOVA at 5% significance level. The results demonstrated that growth and yield parameters were dependent on different MLE concentrations. The highest plant height (30.38 cm) and longest root length (33.40 cm) were measured in Swiss chards treated with 6% MLE, while the 9% concentration achieved the highest chlorophyll content (20.98 SPAD units) and biomass (3.83 g). The 3% concentration yielded the largest leaf area (1.81 m^2), a key determinant of yield. Conversely, the 12% concentration inhibited growth, indicating phytotoxicity. In conclusion, the application of MLE at 6–9% significantly enhances Swiss chard growth and yield, with 3% being effective for early leaf expansion. As a result, MLE serves as an effective, eco-friendly alternative to synthetic fertilizers, by promoting sustainable vegetable production.

Effects of phytostim® biostimulant forlia application on the growth and yield attributes of cowpea (*vigna unguiculata* l. Walp)

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Cowpea (*Vigna unguiculata* L. Walp) is a vital leguminous crop widely grown in tropical and subtropical areas; it has a high nutritional value such protein, folate and carbohydrates, it also can fix atmospheric nitrogen. However, it is under cultivated and underutilized in South Africa due to its productivity being mostly hindered by abiotic stresses such as drought, salinity, and nutrient-deficient soils, as well as biotic stresses like pests and diseases. The study was aimed at evaluating the effects of different Phytostim® biostimulant concentration on the growth and yield of cowpea. The treatment used were T1 (control), T2 (1.5%), T3(3%), T4(4.5%) and T5 (6%). The data was collected and analyzed with GenStat version 24.2 from the cowpea, with the results of growth parameters showing that T3 produced the highest plant height (118.81 cm), stem diameter (1.6003 mm), and chlorophyll content (74.22 SPAD), outperforming the control T1 (75.98 cm height, 18.046 mm diameter, 70.71 chlorophyll SPAD. The finding of yield depict that T3 significantly outperformed the other treatments, recording the highest of seeds per pod (15.67), number of pods per plant (106.00), pod length (15.60 cm), 100 seeds weight (12.50 g), pod weight (247.67 g), root length (38.00 cm), fresh biomass (612.17 g), and dry biomass (137.53 g). Significant treatment effects ($p \leq 0.05$) were observed for most parameters measured, indicating that the treatments had considerable influence on yield attributes. Among all treatments, T3 produced outstanding results, suggesting enhanced plant growth and productivity. Therefore, 3% may be considered the most effective concentration for improving yield and overall crop performance.

Stomatal-photosynthetic coordination and rhizosphere metabolic diversity during progressive drought and early recovery in soybean

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Post-drought recovery, the phase determining whether crops translate intermittent rainfall into yield, remains poorly understood, particularly from a combined physiological and rhizosphere perspective. We report results from a pilot factorial experiment investigating plant physiological responses and microbial functional potential during progressive drought and early recovery in soybean (*Glycine max*). Plants were subjected to well-watered, mild, moderate, and severe water stress. Diurnal gas exchange measurements, proline quantification 24 h after rewatering, and community-level physiological profiling of rhizosphere microbiota (Biolog EcoPlate™) were conducted. Progressive drought led to suppression of net photosynthesis (A_n) and stomatal conductance (g_s). Under moderate stress,

A_n and g_s became decoupled, with elevated internal CO_2 concentrations indicating a shift from stomatal to non-stomatal (biochemical) limitation. Under severe stress, a transient midday increase in A_n and g_s suggested a brief window of stomatal–photosynthetic coordination prior to decline. The stomatal limitation index exceeded 30% under stress but decreased later in the day under moderate conditions, supporting a transition to biochemical constraints. Proline concentration increased with drought intensity up to moderate stress but declined under severe stress, indicating a threshold beyond which osmotic adjustment fails. Rhizosphere communities exhibited broad substrate utilisation (24 of 31 carbon sources; average metabolic response = 0.897), suggesting substantial microbial functional diversity during early recovery. These results indicate that drought intensity drives a sequential shift from stomatal to non-stomatal limitation and reveal a physiological threshold associated with impaired recovery, while rhizosphere microbial functional potential remains comparatively resilient.

Hydraulic safety margins in diverse South African plant communities

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Embolism in the plant xylem transport network disrupts water transport, leading to hydraulic dysfunction and damage in downstream tissues. Here, we test the embolism avoidance hypothesis across diverse South African biomes by examining whether plants generally avoid substantial losses in hydraulic conductivity under normal conditions and only exceed critical thresholds during severe drought stress. We quantified hydraulic safety margins (HSMs), defined as the difference between minimum seasonal water potential (P_{min}) and the water potential causing 50% loss of hydraulic conductivity (P_{50}), for a phylogenetically diverse set of species representing three functional types (FTs) across three biomes.
Despite more than four-fold variation in P50 among species, only three species exceeded the P_{50} threshold, while most species (69%) maintained HSMs > 1 MPa during a normal rainfall year. Functional types exhibited similarly positive HSMs despite substantial variation in P_{50}, supporting the embolism avoidance hypothesis and suggesting coordination between embolism resistance and other hydraulic traits. The generally large positive HSMs observed here contrast with global syntheses reporting that ~70% of angiosperms operate with narrow (<1 MPa) safety margins. These findings suggest that many South African species maintain conservative hydraulic strategies, although exceeding hydraulic thresholds during drought may still have important consequences for ecosystem productivity.

Stomatal-photosynthetic coordination during progressive drought and early recovery in soybean

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Post-drought recovery which determines whether crops translate intermittent rainfall into yield, remains poorly understood. We report a pilot experiment on the physiological response of soybean (*Glycine max*) during progressive drought and early recovery. Plants were subjected to well-watered (100% Field Capacity), mild (75% FC), moderate (50% FC), and severe (25% FC) water stress; diurnal gas exchange and proline quantification (validated by a 0–100 µg mL^{-1} standard curve, $R^2 = 0.998$) were measured 24 h after rewatering. Progressive drought suppressed net photosynthesis (A_n) from 3.11 µmol m^{-2} s^{-1} (well-watered) to 0.19 µmol m^{-2} s^{-1} (moderate stress) and further to –0.03 µmol m^{-2} s^{-1} (severe stress). Stomatal conductance (g_s) declined from 0.034 to 0.002 mol m^{-2} s^{-1}, while transpiration (E) dropped from 0.75 to 0.01 mol m^{-2} s^{-1}. Under moderate stress, A_n and g_s became decoupled, with internal CO_2 (C_i) rising from 262 to 418 µmol mol^{-1}, indicating a shift from stomatal to non-stomatal (biochemical) limitation. The stomatal limitation index exceeded 30% under mild stress but fell below 20% under moderate conditions, confirming this transition. Under severe stress, a transient midday increase in A_n (to 0.45 µmol m^{-2} s^{-1}) and g_s (to 0.009 mol m^{-2} s^{-1}) suggested a brief window of coordination before final collapse. Instant water use efficiency (WUE = A_n/E) peaked at 4.8 under mild stress but crashed to negative values under severe stress. Proline concentration increased from 18 µg mL^{-1} (mild) to 62 µg mL^{-1} (moderate stress) but dropped to 25 µg mL^{-1} under severe stress, indicating a threshold beyond which osmotic adjustment fails. This proline peak coincided exactly with the onset of non-stomatal limitation. Twenty-four hours after rewatering, A_n recovered to only 12% of well-watered levels in severe-stress plants, whereas moderate-stress plants recovered to 68%. Proline content at rewatering was negatively correlated with recovery percentage ($R^2 = 0.84$). These results demonstrate that drought intensity drives a sequential shift from stomatal to biochemical limitation, with proline dynamics marking a critical threshold for impaired recovery.

Effects of different concentrations of Kelpak biostimulant on the growth and yield of Swiss chard (*Beta vulgaris* L. var. *cicla*) cv. Fordhook Giant under greenhouse conditions

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Swiss chard (*Beta vulgaris* L. var. *cicla*) cv. Fordhook Giant is a widely cultivated nutritious leafy vegetable that help alleviate food insecurity and malnutrition. Growers often rely on chemical fertilizers to enhance its production, but they can pose environmental risks and reduced crop productivity if applied in excessive amounts. Plant biostimulants such as Kelpak (a seaweed extract from *Ecklonia maxima*) has gained attention as alternatives to improve crop performance when applied at the correct concentration, due to the phytohormones they contain. Therefore, this study aimed to investigate the effects of

different concentrations of Kelpak biostimulant on the growth and yield of Swiss chard under greenhouse conditions. Five treatments namely, {0 (Control), 0.5, 1, 1.5 and 3}%, were applied as foliar and laid out in a randomized complete block design (RCBD), with four replications (n=20).. Growth parameters (leaf number, plant height, stem diameter, root length and chlorophyll content) were monitored weekly, and biomass was measured at 60 days after transplanting. Data were analyzed using ANOVA at a 5% significance level. Results revealed that Kelpak application significantly improved all growth parameters and biomass. The 1% Kelpak treatment consistently outperformed all other concentrations which led to increases in leaf number (11 leaves), plant height (32.25 cm), stem diameter (7.84 mm), chlorophyll content (27 SPAD), root length (32 cm) and biomass (5.40 g). Concentrations below 1% provided limited benefits, while concentrations above 1% reduced growth due to phytohormonal imbalance. In conclusion, Kelpak application at 1% had a positive effect on the growth and yield of Swiss chard

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Responses to low soil moisture provide insights into vulnerability of common ornamental plant species

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The study investigated whether different plant functional groups, including bulbous species (*Eucomis autumnalis*, *Bulbine natalensis*, *Agapanthus praecox*), herbaceous perennials (*Pelargonium* sp.), palms (*Dypsis lutescens*, *Neodypsis decaryi*), shrubs (*Barleria greenii*, *Carissa macrocarpa*), and succulents (*Portulacaria afra*, *Crassula ovata*), exhibited varying biomass production and physiological stress responses under projected warmer and drier climatic conditions. A factorial experiment incorporating species, temperature, and soil moisture treatments was established in a completely randomised design with five replicates per treatment combination. Plants were exposed to temperatures 2 °C above ambient midday conditions and varying soil moisture levels. The results showed that biomass in bulbous species declined significantly by 33% under warmer conditions. Reduced soil moisture also caused a significant decrease in total biomass in both bulbous and herbaceous plants. Under elevated temperatures, shrub and herbaceous functional groups allocated a greater proportion of biomass to belowground structures, indicating an adaptive response to environmental stress. The findings further suggest that ambient temperatures were close to what the bulbous and herbaceous functional groups could tolerate. Consequently, long-term field monitoring of these functional groups is recommended to better understand their responses to future climate change scenarios.

Turn up the heat: *Aspalathus linearis* (Burm.f.) R.Dahlgren (rooibos) shifts metabolism in response to heat shock

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Climate change is projected to progressively increase abiotic temperatures and shift rainfall regimes across South Africa, where *Aspalathus linearis* (Burm.f.) R. Dahlgren, Fabaceae, (rooibos), reliant on the Cederberg's stable Mediterranean climate, may be exposed to future challenges. Rooibos tea is of both significant medicinal and commercial value as derived from its metabolite profile, and shifting metabolite production due to abiotic stress could lead impact its value. It was hypothesised that heat stress of increasing intensity would negatively impact rooibos by reducing vegetative growth, phenolic content, and antioxidant enzyme activity. The effects of multiple heat stress regimes, Control (22°C), Low (40°C), Primed (35°C, 45°C), and High (45°C), on in vitro rooibos seedlings were compared using both untargeted and targeted metabolomics via liquid chromatography-mass spectrometry (LC-MS). Heat stress had a significant negative impact on various growth and development traits of rooibos, inhibiting shoot growth, leading to leaf chlorosis, senescence, and abscission. Heat stress significantly downregulates several key phenolics, including those that are unique and important in industry, such as aspalathin and nothofagin. The untargeted method and feature-based molecular networking showed that phenolics, fatty acids, and sugars are primarily affected by elevated temperature regimes with phenolics occurring at lower relative abundance. Polyphenol oxidase activity is significantly lowered by heat stress, whereas peroxidase activity remains unaffected. These findings provide novel insights into heat-regulated biochemical mechanisms in A. linearis and predict potential difficulties for the rooibos industry facing projected future climate shifts, in seedling establishment, plant growth and development, tea quality, and yield.

Evaluation of Seed Germinability and Seedlings Performance in *Amaranthus* Accessions Collected in the Eastern Cape, South Africa

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Amaranthus is among the most popular consumed indigenous leafy vegetables in the Eastern Cape Province of South Africa that can be domesticated. It is propagated from seed annually; however, lack of quality seed is one factor that prohibits its domestication. This study aimed to investigate seed viability and seedling vigour of *Amaranthus* accessions and their influence on early seedling establishment. Laboratory and greenhouse experiments were conducted to determine seed viability and seedling vigour of seeds from four *Amaranthus* accessions. In the laboratory experiment 25 seeds of each accession were used to determine germination while in the greenhouse experiment, emergence percentage and seedling vigour were established. Both experiments were arranged in a Complete

Randomized Design (CRD) and replicated four times. Data collected were subjected to Analysis of variance (ANOVA) using Genstat ® 14th edition. In summer and autumn, the highest final germination percentage was observed from *A. retroflexus* 2 (85%) while *A. hypochondriacus* produced the highest seedling vigour (2.00) in the laboratory experiment. A high positive correlation between seed weight and germination was observed in summer (R^2=0.91) and autumn (R^2=0.92). In the greenhouse experiment, the emergence percentage (93%) and seedling vigour (1.24) were significantly higher in *A. hypochondriacus* in summer. A negative correlation in summer {R^2=0.58} and autumn {R^2=0.62} was observed between seed weight and seedling vigour. *A. retroflexus* 2 and *A. hypochondriacus* are recommended owing to their significant response in germination, emergence and seedling vigour.

ABA Priming at Early Growth Stage Induces Stress Memory, Enhanced Vigor, and Drought Tolerance in Plants via Metabolic Reprogramming

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Plant stress priming via transient exposure to elicitors triggers a plant stress memory phenotype that can substantially increase crop performance and resilience in response to abiotic and biotic stress. This priming effect allows plants to respond instantly and strongly to future stress events. However, the basic mechanisms that connect priming signals to lasting changes in plant physiology are still not well understood. In this study, we explored whether a single application of abscisic acid (ABA) at the early seedling stage can induce somatic stress memory in Arabidopsis thaliana and investigate the metabolic and morphophysiological modifications that underlie this phenomenon. We sprayed 10 µM ABA on 7-day-old Arabidopsis Col-0 seedlings, along with water-sprayed and untreated seedlings as controls. The treated plants were grown under optimal conditions and water-deficient stress. We assessed various morphological traits (such as biomass, rosette diameter, stem diameter, leaf number, flowering time, and seed yield, etc.), photosynthetic parameters, and primary metabolite profiles in both adult (G_o) and next generation (G_1) plants. Results showed that a single ABA spray at the cotyledonary stage significantly increased plant vigor and drought tolerance and delayed flowering. Notably, ABA-treated plants showed improved survival rates during recovery from water-deficit stress. Metabolomic profiling suggested that ABA-dependent elevations in tricarboxylic acid (TCA) cycle intermediates (including succinate and fumarate) and nitrogen-related amino acids (specifically glutamate, glutamine, and aspartate), which align with enhanced nitrogen assimilation and antioxidant capacity. Remarkably, several growth and photosynthetic advantages were sustained in the G_1 generation, suggesting a degree of intergenerational inheritance of the primed condition. Our findings elucidate that transient application of ABA during early developmental stages establishes a persistent somatic stress memory in Arabidopsis through metabolic reprogramming, reinforcing its potential as an effective priming strategy to improve crop performance under both optimal and water-deficient conditions.

Organic and fungal biostimulants ameliorated the negative effects of salt stress in *Bidens pilosa*, a herb and leafy vegetable

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Bidens pilosa (Asteraceae) is an annual plant native to South America.The plant's high reproductive potential and adaptability allowed it to invade and successfully establish itself in different agro-ecological regions globally. In parts of Africa, America, Asia, and Oceania, *B. pilosa* is used widely in folklore medicine to manage over 40 infectious and non-infectious medical conditions. In southern Africa, the plant is used as a leafy vegetable due to its high nutritional value, palatability, and safety. Although the ethnobotanical significance of *B. pilosa* is well documented, little is currently known about the plant's tolerance to abiotic factors including salt stress, and the possible measures that could be taken to manage this climate-driven risk. The present study evaluated the potential use of organic and fungal bio-stimulants in ameliorating the negative effects of salt stress on the morpho-physiological properties of *B. pilosa*. Six-week-old *B. pilosa* seedlings were watered regularly and subjected (once a week) to varying concentrations, and different combinations of salt (NaCl; 0-600 mM) and three commercial bio-stimulants [Humates (*humic acids*), Multi-Amino (*20 amino acids*), and Trianum-P (*Trichoderma harzianum*)]. After eight weeks, the seedlings were harvested, and morphological parameters, phytochemical and photosynthetic pigment content determined. All three bio-stimulants induced significant ($p \leq 0.05$) increases in the concentration of phenolic compounds, photosynthetic pigments, carbohydrates, proteins, proline, canopy size, leaf area, fresh and dry weights in treatments (60-200mM) compared to the control. The study showed that the assessed bio-stimulants significantly improved the morpho-physiological parameters of *B. pilosa* seedlings grown under salt stress. The use of these bio-stimulants could therefore potentially enhance the growth, yield and biochemical profile of the plant under salt stress conditions.

Investigating the *Arabidopsis* receptor kinase (ARK) regulatory network in drought-induced senescence of *Xerophyta schlechteri*

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Drought is the most devastating abiotic stress factor for crops worldwide and is expected to become more damaging in the future, due to climate change. It is therefore of

the utmost importance to find ways to mitigate the negative effects of drought on crops. Extreme drought causes senescence and plant death. A previous study on the desiccation tolerant species *Xerophyta schlechteri* identified an ARK (*Arabidopsis* Receptor Kinase) homolog as a key gene connecting desiccation and senescence co-expression networks. This study aims to investigate how this *X. schlecteri* (Xs) -ARK homologue behaves in *Arabidopsis thaliana* as a proxy for functional understanding of its relevance. This was achieved by use of knockout mutants of *Arabidopsis* and mutants expressing the Xs gene. Co-expression network analysis further predicted a connection between the ARK gene hub and the AWPM19-like gene via PUB9, an E3 ubiquitin ligase involved in autophagy that regulates Late Embryogenesis Abundant genes. AWPM19-like encodes a 19 kDa hydrophobic protein with four putative membrane-spanning domains and may represent a key link between drought and senescence signaling. These genes were thus included in assessing knockouts vs wild type *Arabidopsis* and the plant subject to drought stress. Phenotyping included measurements of photosynthetic efficiency, pigment content (chlorophyll and carotenoids), and biochemical markers such as superoxide dismutase (SOD), glutathione, and malondialdehyde (MDA). To further explore this regulatory network, the following approaches, were used: (1) in silico analysis of *X. schlechteri* homologs of AWPM19-like and PUB9 to assess sequence conservation with *Arabidopsis*; (2) identification of cis-regulatory elements in their promoter regions, including ABA-responsive elements. The data reveals key insights about the relationship between the drought response and senescence, and in combination with ongoing transcriptomic studies in *X. schlecteri,* it is hoped that ultimately this can be successfully used to suppress drought-induced senescence in crops.

The effect of drying methods on nutritional content of the leaves of *Moringa oleifera* (*M. oleifera*).

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Moringa oleifera is native to the Himalayan foothills of India. As a commercial crop, it is cultivated extensively in India and parts of Africa. *Moringa oleifera* is rich in minerals, vitamins and essential amino acids. The objective of the study was to investigate the effect of drying methods on nutritional content of the leaves of *M. oleifera*. Moringa leaves obtained from the University of Fort Hare Research Farm in Alice, South Africa were collected randomly, sorted, cleaned and subjected to the different drying methods. Leaf samples were collected randomly around the trees; however, a larger component of the samples was concentrated at the top parts of the trees due to seasonal changes. Fresh, oven (55℃) and room temperature (25℃) were the three selected drying methods. Drying of leaves in the oven and room temperature was conducted for 48 hours and analysis of nutrient elements was conducted at the laboratory. Data were subjected to one-way ANOVA and the means with significant differences separated by Fischer's LSD Test at $p \leq 0.05$. Results showed that there was no significant difference between fresh, room temperature and oven drying method for copper, sodium, nitrogen, phosphorus, potassium, magnesium, crude protein and total digestible nitrogen. Significant high levels of manganese were found in oven-dried leaves (76 mg kg^{-1})

and room temperature (61 mg kg^{-1}), while no manganese was recorded from fresh leaves. Analysis of fresh leaves (100 mg kg^{-1}) produced significantly lower amounts of iron compared with oven dried (420 mg kg^{-1}) leaves and leaves dried at room temperature (400 mg $kg^{-1)}$. Similar trends were observed with zinc and calcium where significant lower levels were only recorded in fresh leaves. This study indicate that different drying methods had a varying effect on the nutrient content of Moringa leaves. Analysis of fresh leaves generally showed lower levels of different nutrient elements compared with oven and room temperature drying methods.

Enhancing germination and seedling establishment of *Amaranthus gangeticus* (Elephant Head Amaranth) using Kelpak Biostimulant

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The biostimulant developed from *Ecklonia maxima* kelp, containing 2.2 mg/L natural auxins and 0.0062 mg/L cytokinins is utilized in improving growth in diverse horticultural plants. In this study, the biostimulant was tested on germination of *Amaranthus gangeticus* (Elephant Head Amaranth), a nutrient rich traditional leafy vegetable. The objective of this study was to determine seedling establishment of *A. gangeticus* in response to different concentrations of Kelpak biostimulant under laboratory conditions. Twelve months old seeds were first washed under running tap water to remove surface contaminants. The seeds were then aseptically inoculated on sterile moist filter paper bridges placed inside 100 ml Sigma® culture bottles each filled with 50 ml/L solution of different biostimulant concentrations. Treatments comprised 2, 4, 8 and 16 ml/L of the biostimulant solution and seeds inoculated in distilled water (0) represented the control. The seed cultures were kept under controlled conditions for germination. After 21 days, mean germination time (MGT), germination percentage (GP), germination rate (GR) and germination index (GI) were determined. Data was analysed through ANOVA to separate the means. Treatment means were subjected to CHAT GTP for code generation, which was determined through R-Studio version 2026. Findings indicated that the highest (93%) GP was achieved 16 ml/L of Kelpak and the lowest (70%) GP was observed at 2 ml/L relative to the control. However, the fastest (1.75 days) MGT was achieved at 2 ml/L, whereas the late (2.17 days) germinated seeds were observed at 16 ml/L of the biostimulant. Germination rate was the highest (0.20) and the lowest (0.14) was at 16 ml/L. Similarly, the highest (7.82) and lowest (6.07) GIs were recorded at 16 and 12 ml/L of the biostimulant, respectively. In conclusion, the findings showed that the use of Kelpak biostimulant at 16 ml/L improved seedling establishment in *A. gangeticus*.

***Arachis hypogaea* and *Mucuna pruriens* enhance soil biological and chemical properties of nutrient-deficient small-scale sugarcane plantations**

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Soil degradation and nutrient depletion constrain sustainable sugarcane production in South Africa, particularly in small-scale farming systems. Legume cover crops may enhance soil fertility through biological nitrogen fixation and stimulation of rhizosphere microbial processes.However, little is known about their biological and chemical contributions in degraded sugarcane soils. This study evaluated the effects of *Arachis hypogaea* and *Mucuna pruriens* on soil enzyme activity, microbial functioning, and plant nitrogen acquisition in soils collected from five nutrient-poor sugarcane plantations. Legume cultivation resulted in shifts in soil biological activity, with increased enzyme activities associated with nutrient cycling and significantly higher nitrate reductase activity observed in *M. pruriens* soils. Microbial community composition varied across sites, with site exerting a stronger influence than plant species. These soil responses corresponded with contrasting plant nutrient acquisition strategies, where *A. hypogaea* relied on atmospheric nitrogen fixation, while *M. pruriens* exhibited greater biomass production and reliance on soil-derived nitrogen. Overall, these findings demonstrate that legume cover crops differentially influence soil biological processes and plant–soil interactions in degraded sugarcane systems, highlighting their potential role in improving soil functioning and ecosystem restoration.

The effects of soil types on root traits and overall performance of sweet potato cultivars

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Sweet potato (*Ipomoea batatas* L.) is an important food security crop due to its adaptability to diverse environmental conditions and marginal soils. However, soil type influences root development, growth, and yield performance. This study evaluated the effects of three soil types on root traits and performance of sweet potato cultivars Khumo, Ndou, and Blesbok under controlled conditions. Three contrasting soils classified by the Agricultural Research Council Natural Resources and Engineering were used: Hutton (well-drained and fertile), Rensburg (heavy clay and poorly drained), and Kroonstad (gleyed subsoil). Composite topsoil samples (0–20 cm) were analysed for physical and chemical properties before being

placed into 40 kg pots. The trial was conducted under plastic tunnel conditions using a Randomised Complete Block Design (RCBD). Advanced phenotyping technologies, including the Phenospex Trait Finder system, were used to monitor plant responses. Both destructive and non-destructive root assessments were performed to evaluate leaf area, digital biomass, plant height, root length, root diameter, total root number, storage root dry matter content, and yield. Results showed that soil type and cultivar significantly affected vegetative growth, root morphology, and yield. Kroonstad soil generally promoted superior growth and productivity, particularly for Khumo and Blesbok cultivars. During early storage root bulking, Kroonstad Ndou produced the highest number of pencil roots (19.00 ± 3.969), while Kroonstad Blesbok recorded the largest root diameter (11.833 ± 1.258 mm). Kroonstad Blesbok also achieved the highest storage root dry matter content (71.53 ± 21.82%) and total yield (420.1 ± 133.3 g plant^{-1}). These findings demonstrate that soil type–cultivar interactions significantly influence sweet potato growth and productivity, highlighting the importance of selecting suitable soil–cultivar combinations to improve yield and root quality.

Tradition African cucumbers and melons diversity and agronomic importance

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With over 14,000 edible and nutritious plants in the world, only three crops make up for 60% of the world's dietary needs underlining opportunities to use these underutilized crops to build resilient food systems. These underutilised and underexplored edible plants are on the verge of extinction posing a serious risk of losing food biodiversity resulting in low agro diversity. The assimilation of underutilised crops into food systems requires detailed research studies on their nutritional, agronomical, and genetic traits to attract exploration of these plants.
Using African cucumbers and melons belonging to the family Cucurbitaceae (genus Cucumis) as a model, this project seeks to develop a participatory approach for the valorisation of indigenous southern African species based on species diversity, agroecological practices and possible applications in soil health improvement.
We have collected 12 of the traditional cultivars and landrace of cucumber and melons that are native to southern Africa. Most of the fruits of the *Cucumis* plants have a bitter taste but their leaves are mostly collected and cooked as vegetables and usual have a sweet taste. Most of the species collected are highly symptomatic and displayed severe bacterial, fungal and virus-like infection symptoms. We performed comparative genomics on these southern African *Cucumis* species to gain an insight on their evolutionary relationship. Moreover, the rhizosphere from 50 African Cucumis species grown at the ARC-BTP were collected to evaluate the suitability of indigenous southern African Cucumis species as cover crops. These results are used to develop methodologies for integrating African underutilised and indigenous crops into food systems and in turn diversifying our food basket.

The phytochemical profile and biological activities of *Aloe arborescens* whole fruits

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For centuries, a source of primary healthcare has been plants. Medicinal plants play a prominent role, especially, in developing countries because of their affordability and accessibility. *Aloe arborescens* is an indigenous Southern African medicinal plant well documented, especially in the leaves. The whole fruits of *Aloe arborescens*, however, remain unexplored. Therefore, this study assessed the air-dried whole fruits of *Aloe arborescens* for their phytochemical composition and biological activities using four different solvents varying in polarity from non-polar to polar. This study evaluated the phytochemical composition, total contents of key phytochemicals, antioxidant activity, and antibacterial activity of the whole fruits of *Aloe arborescens* using solvents: hexane, ethyl acetate, 100% methanol and distilled water. The results illustrated that the phytochemicals were extracted differentially based on polarity. Non-polar solvents extracted compounds such as fixed oils and fats, cardiac glycosides, and volatile oils, and polar solvents extracted phenolics, phlobatannins, alkaloids, coumarins, cholesterol and terpenoids. The remaining phytochemicals were either extracted by intermediate-polarity solvents, detected in all solvent extracts, or not detected. The antioxidant activity showed strong antioxidant activity against 2,2-diphenylpicryhydrazyl radicals and metal oxidants radicals in comparison to hydrogen peroxide across all solvent extracts. Low antioxidant activity was, however, also observed in hexane extract against DPPH, and ethyl acetate and 100% methanol extracts against metal chelating. Zones of inhibition were observed against *Escherichia coli* and *Staphylococcus aureus* using only 100% methanol extract. In conclusion, this study supports the traditional use of *A. arborescens* whole fruits for medicinal use. The study highlights the potential application of *A. arborescens* whole fruits in both the cosmetic and pharmaceutical industries.

Bioactive reservoirs in plant-based beverages: Pathways to health and wellness

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Beverages not only quench thirst but also provide health benefits. The shift from high-calorie carbonated beverages, has necessitated increased demand for plant-based beverages as they can improve mental and physical human health due to richness in bioactive compounds. This study aimed at providing a critical appraisal of the traditional uses, phytochemistry, and health benefits of plants used as beverages across southern Africa. Globally recognised electronic

databases such as Lens and Web of Science were consulted to retrieve relevant literature that met the inclusion criteria. The search was limited to publications written in English and originating from southern Africa. Some notable important plants utilised for beverage production include *Englerophytum magalismontanum*, *Lippia javanica*, *Opuntia ficus indica*, *Sclerocarya birrea*, and *Strychnos spinosa*, either produced as juices, teas and fermented beverages such as beer. A wealth of available scientific evidence demonstrates that plant-based beverages contain natural bioactive compounds that render several diversified biological effects such as antiaging, anticholesterolemic, anti-inflammatory, antimicrobial, and antioxidant effects. However, some plants contain compounds that are toxic. For instance, *Artemisia afra* contains thujone, as a result such plants need careful processing. Overall, plant-based beverages are a dynamic category bridging nutrition, good health, sustainability, and consumer preference. Consumer-need driven research and regulation are essential to ensure they serve as reliable components of balanced diets. There is also a need to conduct toxicity studies and standardisation given that some of the plants contain compounds that are toxic.

Antigonococcal activity and cytotoxicity of three South African *Ziziphus* species

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Species of the genus *Ziziphus* (Rhamnaceae) are widely used in South African traditional medicine to treat ailments, including sexually transmitted infections such as gonorrhoea. This study evaluated the *in vitro* antigonococcal activity and cytotoxicity of three indigenous species: *Ziziphus mucronata*, *Z. rivularis*, and *Z. zeyheriana*. Roots, stem bark, and leaves were collected, air-dried, powdered, and sequentially extracted with n-hexane, dichloromethane, ethyl acetate, ethyl acetate:methanol (1:1 v/v), and methanol. Traditional decoctions were also included for comparison. Antigonococcal activity was determined using a broth microdilution assay against *Neisseria gonorrhoeae* (ATCC 49226), with ciprofloxacin as a positive control. Cytotoxicity was assessed on L6 rat skeletal myoblast cells using podophyllotoxin as a reference. Active extracts were further profiled using ^{1}H NMR-based metabolomics and GC-MS to identify bioactive compound classes and constituents. Overall, *Z. rivularis* and *Z. zeyheriana* showed stronger antigonococcal activity than Z. mucronata. Of all extracts tested, 12.5% exhibited high activity, 33.3% moderate activity, and 54.1% were inactive. Metabolomic analyses revealed aliphatic, alcohol, carboxylic acid, and aldehyde compounds associated with activity. Key constituents detected included hexadecanoic acid, phytol, codeine, and betulin. Hexadecanoic acid likely contributed directly to antibacterial activity, while phytol, betulin, and codeine may provide indirect anti-inflammatory effects relevant to symptom alleviation. These findings support the traditional use of *Z. mucronata* for gonorrhea and report, for the first time, antigonococcal activity for *Z. rivularis* and *Z. zeyheriana*. The results highlight these species as promising sources of bioactive compounds and warrant further phytochemical and pharmacological investigation.

Drought-Induced Changes in Leaf Micromorphology and Secondary Metabolites in Lamiaceae

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The effects of progressive drought stress were investigated in four economically important Lamiaceae species: catnip (*Nepeta cataria* L.), lavender (*Lavandula angustifolia* Mill.), holy basil (*Ocimum tenuiflorum* L.), and perilla (*Perilla frutescens* (L.) Britton). Leaf micromorphology (glandular trichome density and size, stomatal traits, and tissue thickness), essential oil content, total flavonoid content, and elemental composition were evaluated. Plants were grown under three soil water capacities (SWC): 70% (control), 50% (moderate stress), and 30% (severe stress). *O. tenuiflorum*, *P. frutescens*, and *N. cataria* were sensitive to drought, showing reduced biomass and leaf area; *N. cataria* exhibited the greatest decline (−54.3% at 30% SWC). In these species, drought decreased epidermal and mesophyll thickness while inducing xeromorphic traits, including increased stomatal density (up to +23%) and reduced stomatal size, along with higher densities of peltate and capitate trichomes. In contrast, the more tolerant *L. angustifolia* showed a pronounced thickening of the adaxial cuticle (+170.3%), likely enhancing water retention. Correlation analysis revealed species-specific responses. In *N. cataria*, essential oil and flavonoid contents were strongly negatively correlated ($r = -0.95$, $p < 0.001$), indicating a trade-off under severe stress. Conversely, *L. angustifolia* displayed a positive relationship ($r = 0.93$, $p < 0.001$) under moderate stress, suggesting coordinated accumulation. In *O. tenuiflorum*, flavonoid content was closely linked to palisade parenchyma density ($r = 0.98$, $p < 0.001$). Across all species, increasing drought reduced antioxidant capacity, while ion uptake reflected shared geochemical patterns. Overall, severe water deficit limited growth and secondary metabolite production. Maintaining at least 50% SWC appears necessary to sustain structural integrity and optimize metabolite accumulation. These results highlight species-specific coordination between anatomical plasticity and metabolic responses under drought stress. From a practical standpoint, maintaining adequate soil moisture is crucial for supporting plant growth and enhancing the accumulation of bioactive secondary metabolites in Lamiaceae species.

Ethnoveterinary Medicinal Woody Plants in Smallholder Livestock Systems: Integrating Indigenous Knowledge with Scientific Evidence in the Eastern Cape, South Africa

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Indigenous knowledge systems play an important role in livestock health management in rural communities where access to conventional veterinary services is often limited. Ethnoveterinary practices, particularly the use of locally available medicinal plants, remain an important component of animal healthcare among smallholder farmers in South Africa. This study documented woody plant species used for ethnoveterinary purposes and linked farmers' indigenous knowledge with available scientific evidence. The research was conducted in three rural villages in the Eastern Cape Province of South Africa, namely Ngcingcinikhwe, Nqancule, and Nyili. The study areas were selected using purposive sampling based on the prevalence of smallholder livestock farming and the existence of indigenous ethnoveterinary knowledge. Informants were selected using purposive and snowball sampling techniques. Data were collected through structured interviews with 60 livestock farmers, of which 80% were male. Most respondents were from Nqancule (28), followed by Ngcingcinikhwe (18) and Nyili (14). Farmers identified several woody plant species used to treat livestock diseases affecting cattle, sheep, and goats. The most frequently cited species included Acacia karroo (72%), Ziziphus mucronata (65%), Olea europaea subsp. africana (58%), Euclea undulata (52%), and Pappea capensis (47%). These plants were primarily used to treat diarrhoea, wounds, skin infections, respiratory conditions, and parasitic infestations in livestock. Scientific literature indicates that many of these species contain bioactive compounds such as tannins, flavonoids, and phenolic compounds with antimicrobial and anti-inflammatory properties. The findings highlight the continued importance of ethnoveterinary knowledge in supporting livestock health management in smallholder farming systems and emphasise the need to integrate indigenous knowledge with scientific research to promote sustainable livestock production.

Exploring indigenous medicinal plants used in the treatment of childhood respiratory conditions in Mbombela, South Africa

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Respiratory diseases continue to pose a significant health challenge in developing countries, including South Africa, where traditional medicine remains the primary source of healthcare. This study investigated medicinal plants used to treat and manage respiratory illnesses among children in the Mbombela Local Municipality, Mpumalanga Province. An ethnobotanical survey was conducted using a semi-structured questionnaire. The sample size of 28 participants was purposely chosen among the members of the group of indigenous

knowledge holders. The collected data was analysed using ethnobotanical indices, such as Frequency of Citation (FC) and Use Value (UV). A total of nineteen plant species, representing seventeen families predominantly Rosaceae (n = 3), Lauraceae (n = 2), and Asteraceae (n = 2) were documented as being used in the treatment and management of respiratory diseases in. In terms of FC *Lippia javanica* L (0.15*), Artemisia afra* Jacq. Ex Willd var. afra (0.13*), Cannabis sativa avar.* L (0.09), *Gymnanthemum coloratum* (Willd.). H. Rob. & B. Kahn (0.09) and *Psidium guajava* (0.09) were the most commonly used for the treatment and management of respiratory diseases in children. The UV values ranged from 0.03 to 0.5, with *L. javanica* (0.5), *A. afra* (0.4), *C. sativa* (0.3), and *G. coloratum* (0.2) being the dominant plants used for respiratory diseases amongst children. The most used plant part was leaves (61%), followed by roots (18%), bark (14%), and fruits (7%). The preferred modes of preparation were decoction (57%) and maceration (43%). The majority of plants used to treat respiratory diseases (57%) are threatened. The current study revealed a continued reliance on the plant for primary health care related to childhood diseases in the study area. This also offers a baseline for future pharmacological studies on natural remedies for respiratory diseases. Thus, there is a need to determine the effectiveness, safety, biological activity, and phytochemical composition, and discover new bioactive compounds with pharmaceutical uses in the treatment of childhood diseases.

A review phytochemical composition of *Toxicodendron succedaneum* and its efficacy as botanical insecticide of common maize pest in smallholder farming.

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Toxicodendron succedanea, commonly known as Japanese wax tree, is a member of the Anacardiaceae family native to East Asia, has become invasive in parts of South Africa and is classified as a forbidden Category 1b species as per the Conservation of Agricultural Resource Act 43 of 1983. The classification prohibits its cultivation and mandates the strict management and control of the existing plants to further spread. Despite its invasive status, the species is rich in secondary metabolites, namely, urushiol, a bioactive compound known for their defensive, insecticidal and antimicrobial properties. The current global concerns regarding the negative impacts of synthetic pesticides on human and the environmental health, coupled with increasing demand for safer production practise, have renewed interest in the use of botanical pesticides, especially in organic farming systems. Hence, this review seeks to comprehensively and systematically synthesize the existing literature on phytochemical diversity, of *T. succedaneum,* the distribution of its bioactive compounds within plant parts and its potential use as a botanical insecticide targeting key maize pest in smallholder farming systems. The review highlights the potential of *T. succedaneum* as a sustainable alternative insecticide for the control of several chewing insects, mainly in the orders Coleoptera, Lepidoptera and Orthoptera. However, challenges related to its toxicity, formulation, standardisation, and regulatory compliance remain a significant barrier to its practical application. Addressing these constraints will be critical for advancing the use of *T. succedaneum* extract as botanical pesticides in sustainable agriculture.

The antibacterial potential of *Spirostachys africana* Sond. Stem-bark extracts against common dermatological pathogens.

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Traditional medicine derived from medicinal plants has been very critical in dealing with health issues across many cultures, particularly in rural and underserved communities. South Africa's rich biodiversity of plants, notably in the province of the Eastern Cape, offers a vast repository of medicinal plants, albeit under threat due to unsustainable harvesting practices as well as climate challenges. The Eastern Cape Province is characterised by a total of 6,611 floral species, of which 12% of these are endemic to this region. Plants possessing antibacterial properties are particularly prized for their ability to combat bacterial skin infections. Among these indigenous plants, *Spirostachys africana*, widely referred to as the "*tamboti*" or "*umthombothi*" tree, emerges as a promising candidate authority with a rich history of traditional medicinal use among *isiXhosa* communities. In South Africa*, S. africana,* which is a member of the Euphorbiaceae family, occurs naturally. The study investigated the antibacterial activities of *S. africana*, an indigenous medicinal plant found in South Africa and is usually used by *isiXhosa* communities for curing skin conditions, particularly in children. To scientifically validate its ethnomedicinal applications, stem-bark extracts were evaluated for antibacterial activity against skin-relevant pathogens (*Klebsiella pneumoniae*, *Escherichia coli*, and *Staphylococcus aureus*) using the microdilution method. Results revealed potent efficacy, with dichloromethane and ethanol extracts exhibiting minimal inhibitory concentrations (MICs) ranging from 0.19 to 1.56 µg/Ml. Petroleum ether extract showed modest inhibitory action with a MIC of 0.78 µg/mL. The aqueous extract displayed the highest MIC value of 3.12 µg/mL, indicating the least inhibitory activity against *E. coli* among the tested extracts. In conclusion, the study underscores the *S. africana*'s potential as an indigenous origin of antibacterial agents for curing bacterial infections, particularly those associated with skin diseases.

Uncovering geographical variation in the metabolite profiles of the leaves and stems of wild bush tea *(Athrixia phylicoides* DC.*)* growing in four South African provinces

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Bush tea is a medicinal plant widely consumed in Southern Africa for its health-benefit properties. Despite its cultural and therapeutic importance, there is limited scientific information on how geographical factors influence its metabolite composition. Variations in climate, soil type, and altitude across different regions are known to significantly affect the levels of phytochemicals in bush tea. This study compared the metabolite profile of wild bush tea, specifically focusing on stems and leaves samples collected in one season but different geographical provinces, including Limpopo (LIM), Mpumalanga (MP), KwaZulu-Natal (KZN), and Eastern Cape (EC). Nuclear magnetic resonance (^{1}H NMR), in conjunction with multivariate statistical modelling techniques like principal component analysis (PCA) and orthogonal partial least squares discriminant analysis (OPLS-DA), was used to analyse the metabolites present in the stems, and leaves of bush tea from four different provinces. ^{1}H NMR data was pre-processed using MestReNova software v17.0 and SIMCA Multivariate analysis was performed using SIMCA v18. Data revealed clear metabolomic variation among bush tea samples from different geographical regions (EC, KZN, LIM, and MP). PCA demonstrated natural clustering with partial overlap, indicating both similarities and differences in chemical profiles. OPLS-DA showed enhanced discrimination between regions, confirming that geographical origin significantly influences metabolite composition. The contribution score and S-plots identified key chemical shift contributing to this separation, suggesting potential biomarkers associated with regional variation. Overall, both leaf and stem samples exhibited distinct region-specific chemical patterns, where EC and KZN, while Lim and MP formed clusters, respectively. Prospectively, we plan to conduct metabolite annotation using ultra-high-performance liquid chromatography–quadrupole time-of-flight mass spectrometry (UHPLC-qTOF-MS) and two-dimensional gas chromatography time-of-flight mass spectrometry (GC-TOF-MS). These findings will help identify metabolites that differentiate bush tea from geographical regions, provide guidance to locals regarding optimal harvesting areas and assist in having a reliable database for future scientific studies in wild bush tea.

Growth dynamics and nutritional composition of *Mimusops zeyheri*: A case of Makhado and Mbombela local municipalities.

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Mimusops zeyheri, known as the Transvaal red milkwood, is a fruit tree species of the Sapotaceae family natively occurring in the southern African region. Transvaal red milkwood is a multi-use plant species essential for its fruit, leaves, bark, and roots, which are used in ethnobotanical medicine by local communities. Ethnomedicinal uses include the treatment of diabetes and non-communicable diseases such as cancer and hypertension. The study aimed to assess the growth and nutritional composition of *Mimusops zeyheri* from two

agroecologies. Growth dynamics parameters such as morphological characteristics and nutritional composition (vitamins and minerals) from Makhado and Mbombela. The growth parameters included stem diameter, tree height, crown width, crown health, fruiting observation, distance between trees, and leaf size, chlorophyll content. For water use efficiency stomatal conductance and soil moisture content were measured.
The nutritional composition was analysed using ICP-OES, β-carotene and vitamins were quantified using HPLC. The statistical data was analysed using the one-way by means were separated using Duncans multiple range test $p \leq 0.05$. The results showed a higher mean stomatal conductance (45.65 mmol/(m^2·s)) in Mbombela compared to Makhado (25.69 mmol/(m^2·s). Mbombela was found to have larger, healthier and more fruitful trees as far as growth parameters are concerned as observed through physiological and morphological characteristics. *β*-carotene content, measured with HPLC, was at 17.38 mg/100g and 13.93 mg/100g in Makhado and Mbombela respectively. Mbombela tree leaves had higher vitamin C content 119.05 mg/100g compared to 66.47 mg/100g in Makhado. In the leaf samples, Makhado had higher Ca, Cu, Fe, Mg, Na, content and Mbombela had higher K, P, Zn content. The results of the study indicate that *Mimusops zeyheri* can be viable as a source of nutrition from a scientific standpoint. Overall, the study confirms that *Mimusops zeyheri* holds significant potential as a nutritious, multi-purpose indigenous fruit tree that can contribute to food security, dietary diversification, and improved livelihoods. The variation observed between agroecologies underscores the importance of site-specific management and potential domestication strategies to optimize both growth performance and nutritional benefits

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Neuroprotective Potential of *Tamarindus indica* Bioactive Compounds: *In Silico* Insights into Multitarget Mechanisms for Combating Neurodegenerative Disorders

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Neurodegenerative diseases, characterized by progressive neuronal damage, remain a significant health burden due to their multifactorial etiology involving oxidative stress, neuroinflammation, and apoptotic dysregulation. *Tamarindus indica* fruit pulp, traditionally celebrated for its anti-inflammatory and antioxidant properties, holds promise as a source of bioactive compounds for neuroprotection. This study employs *in silico* techniques to explore the therapeutic potential of apigenin, catechin, epicatechin, and kaempferol (bioactive constituents of *T. indica*) against acrylonitrile-induced neurodegeneration. Key bioactive compounds were identified via GC-MS analysis and screened for drug-likeness using ADMET parameters. Network pharmacology approaches integrated data from OMIM, GeneCards, and SwissTargetPrediction to identify 226 overlapping targets between active compounds and neurodegenerative pathways. Hub genes (AKT1, SRC, EGFR, and BCL2) were pinpointed via protein-protein interaction (PPI) network analysis.
Molecular docking revealed robust binding affinities, with catechin showing the highest affinity to SRC (-9.1 kcal/mol), suggesting modulation of neuroinflammatory responses. Gene ontology and pathway enrichment analyses highlighted critical pathways, including PI3K-AKT signaling, apoptosis, and AGE-RAGE signaling, as targets of these compounds. The ADMET analysis confirmed favorable pharmacokinetics, including blood-brain barrier permeability

and minimal toxicity. Apigenin and kaempferol emerged as potent modulators of neuroinflammation and oxidative stress, while catechin and epicatechin significantly impacted synaptic plasticity and mitochondrial health. These findings substantiate the multitarget therapeutic potential of *Tamarindus indica* bioactive compounds, offering insights into their roles in mitigating neurodegeneration through interconnected molecular pathways. This study bridges traditional medicine with modern therapeutic strategies, underscoring the promise of plant-based compounds in addressing the complexity of neurodegenerative diseases. Experimental validation is warranted to confirm these computational predictions and advance these natural compounds toward clinical applications.

A combination of light and moderate heat stress can enhance non-photochemical quenching in Afromontane lichens

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Anthropogenic activities such as fossil fuel combustion and deforestation are responsible for the greenhouse effect, which has caused global warming and long-term climatic shifts. Lichenized ascomycetes are ecologically important organisms yet their ability to acclimatize to rising temperatures appears limited. Elevated temperatures, particularly when combined with light stress may increase the formation of harmful reactive oxygen species (ROS) by reducing CO_2 fixation and disrupting photosynthetic balance. Non-photochemical quenching (NPQ) is a key photoprotective mechanism that enables lichens to dissipate excess absorbed light energy safely as heat, thereby minimizing oxidative damage. This study investigated how combined light and heat stress influence NPQ responses in four Afromontane lichen species from KwaZulu-Natal, South Africa. Chlorophyll fluorescence techniques were used to assess NPQ under moderate light stress (200 µmol m^{-2} s^{-1}) and elevated temperatures. Under dark conditions, exposure to 15 or 30 °C had little effect on NPQ across species. However, lichens containing Trebouxioid photobionts exhibited increased NPQ under exposure to light, with additional NPQ induced under combined light and heat stress. These findings suggest that some Afromontane lichens possess physiological flexibility that enables them to modulate photoprotective responses under changing climatic conditions. Such adaptive capacity may play an important role in mitigating the impacts of global warming on lichen survival and function.

Impacts of alien invasive plants on aquatic macroinvertebrates in South Africa: With emphasis on *Iris pseudacorus*

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Freshwater ecosystems are increasingly threatened by invasive alien plants (IAPs), which alter habitat structure, water quality, and ecological processes, thereby affecting aquatic biodiversity. This study systematically reviewed scientific evidence on the impacts of invasive alien plants on aquatic macroinvertebrates in South Africa between 2006 and 2022. A systematic review of peer-reviewed literature identified eight eligible studies. Analyses focused on study location, ecosystem type, invasive species, and reported impacts on macroinvertebrate communities. Most studies were conducted in the Cape Floristic Region, particularly in the Eastern and Western Cape provinces, with rivers being the most studied ecosystems. *Eichhornia crassipes* and *Pistia stratiotes* were the most frequently investigated invasive species. The review showed that invasive alien plants generally reduced macroinvertebrate abundance, richness, and community diversity. Dense infestations modified habitat conditions and physicochemical properties, leading to shifts in assemblage structure and declines in sensitive taxa. Although some invasive terrestrial plants, including *Psidium guajava* and *Lantana camara*, showed localized positive effects on certain taxa, the overall ecological impacts were predominantly negative. These findings highlight the need for further research and management interventions to protect freshwater biodiversity and ecosystem integrity.

Assessing the distribution of *Lagerstroemia indica* in Northeastern South Africa: Limpopo and Mpumalanga provinces

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Lagerstroemia indica, often referred to as crape myrtle or crepe myrtle, is a species in the Lythraceae family that has gained significant popularity in the commercial horticulture sector because of its common use as an ornamental garden plant. Indigenous to the Indian subcontinent, as indicated by the species name indica, it is also found naturally in regions of Southeast Asia, China, Korea, and Japan. The species generally develops as a multi-stemmed tree that is deciduous, featuring a wide-spreading canopy and often exhibiting a rounded or uneven growth shape. This study evaluated the distribution and invasive potential of *Lagerstroemia indica* in the Limpopo and Mpumalanga provinces of South Africa. Field surveys were conducted across a range of habitats, including roadsides, high-risk areas, and both open and enclosed environments. To supplement field observations, occurrence records were obtained from the iNaturalist platform to

improve distribution data coverage. During field assessments, geographic coordinates of recorded individuals were collected using GPS and used to generate distribution maps in ArcGIS. The occurrence of *Lagerstroemia indica* was confirmed in several localities in Limpopo, including Makhado, Tzaneen, Mookgophong, Mokopane, and Haenertsburg, while additional records for Mpumalanga were obtained from iNaturalist. The species is currently not listed under the National Environmental Management: Biodiversity Act 10 of 2004. Owing to the limited information available on its distribution in South Africa, this study contributes valuable baseline data by integrating field survey results with citizen science records from Limpopo and Mpumalanga.

Assessing the ecological impacts of *Verbesina encelioides* in Mahikeng Game Reserves

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Invasive alien plant species (IAPs) are major drivers of biodiversity loss and ecosystem degradation, particularly in arid and semi-arid ecosystems where environmental conditions favour rapid colonization and dominance. *Verbesina encelioides* (golden crown beard), a North American species increasingly spreading across South Africa, has demonstrated strong invasive potential through rapid growth, high reproductive output, and allelopathic effects that suppress neighbouring vegetation. Despite growing concern regarding its spread, limited empirical information exists on its ecological impacts within protected areas of the North West Province, South Africa. This study aims to assess the impacts of *V. encelioides* on vegetation structure, species composition, and plant diversity within Mahikeng Game Reserves. The study will compare invaded and uninvaded sites using 10 × 10 m plots stratified according to invasion status. Between 10 and 15 plots per category will be randomly selected, with vegetation surveys conducted within 1 × 1 m subplots. Plant species richness, abundance, percentage cover, vegetation structure, and biomass will be assessed. Environmental variables, including soil disturbance, litter cover, light availability, soil moisture, and pH, will also be measured to determine their relationship with invasion intensity. Diversity indices, including Shannon-Wiener, Simpson, and Margalef indices, will be calculated to evaluate community structure. Multivariate analyses such as Non-metric Multidimensional Scaling (NMDS), Principal Component Analysis (PCA), and Redundancy Analysis (RDA) will be used to examine differences in species composition and environmental relationships between invaded and uninvaded plots. GIS mapping will further be applied to determine the spatial extent and intensity of invasion. The study is expected to provide evidence of the ecological impacts of *V. encelioides* on native vegetation and ecosystem structure, contributing to improved invasive species management, restoration planning, and biodiversity conservation within semi-arid protected ecosystems.

Spatial distribution and mapping of invasive alien plants in Urban Mahikeng, South Africa

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Urban areas are increasingly recognized as important hotspots for biological invasions due to high levels of disturbance, habitat fragmentation, and human-mediated species introductions. In South Africa, invasive alien plants (IAPs) are among the leading drivers of biodiversity loss and ecosystem degradation, yet fine-scale spatial information on their distribution in smaller urban centres remains limited. Mahikeng, a rapidly expanding semi-arid city in the North West Province, currently lacks baseline spatial data on the occurrence, abundance, and invasion hotspots of IAPs. This study aims to map the spatial distribution of invasive alien plants in urban Mahikeng, identify invasion hotspots, and determine the environmental drivers influencing invasion patterns. A field-based survey integrated with Geographic Information Systems (GIS) will be conducted across major urban land-use categories, including residential areas, roadsides, riparian zones, parks, and vacant land. A stratified grid-based sampling design will be employed using approximately 200–300 sampling points distributed throughout the study area. At each point, GPS coordinates, invasive species identity, abundance or cover estimates, habitat characteristics, and environmental variables such as disturbance level, vegetation type, and proximity to roads will be recorded. Spatial data will be analysed using ArcGIS Pro or QGIS to generate species distribution and richness maps. Invasion hotspots will be identified using spatial analysis techniques, including kernel density estimation and hotspot analysis. Generalized Linear Models (GLMs) will further be used to assess relationships between invasion patterns and environmental variables. The study is expected to produce the first comprehensive spatial database and distribution maps of invasive alien plants in urban Mahikeng. Findings will identify priority invasion hotspots and improve understanding of the environmental factors driving urban invasions. The results will support evidence-based management, urban planning, biodiversity conservation, and invasive species control strategies within the municipality and surrounding semi-arid ecosystems.

Distribution, impacts, and management of *Datura ferox* in Faan Meintjies Nature Reserve, North West, South Africa

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Invasive alien species are globally recognized as major drivers of biodiversity loss, ecosystem degradation, and socio-economic impacts. *Datura ferox* L., commonly known as thornapple, is an invasive annual herb native to southern North America that is increasingly spreading within disturbed habitats in South Africa. Despite its growing occurrence, limited information exists regarding its distribution, ecological impacts, and management within protected areas of the North West Province. This study aims to assess the spatial distribution, ecological impacts, and management responses associated with *Datura ferox* in Faan Meintjies Nature Reserve. Field surveys will be conducted using quadrat and transect sampling methods in invaded and non-invaded sites. Fixed 10 × 10 m quadrats will be established in 20 invaded and 20 non-invaded plots to assess vegetation composition, species richness, and percentage cover of *D. ferox* and associated plant species. Transects ranging from 50–100 m will be used to determine species frequency and invasion intensity across different habitats. GPS coordinates of *D. ferox* populations will be recorded and integrated into a Geographic Information System (GIS) to generate spatial distribution maps and identify invasion hotspots. Biodiversity indices, including species richness and Shannon-Wiener diversity, will be compared between invaded and non-invaded plots using statistical analyses such as t-tests and ANOVA. Multivariate analyses will further examine relationships between invasion patterns, vegetation structure, and environmental variables. Structured interviews and questionnaires will additionally be conducted with reserve managers and field staff to assess awareness, perceptions, and current control measures. The study is expected to provide baseline spatial and ecological data on *Datura ferox* within the reserve, improve understanding of its impacts on plant diversity and vegetation structure, and contribute to evidence-based management and restoration strategies for invasive species in semi-arid protected ecosystems.

A review phytochemical composition of *Toxicodendron succedaneum* and its efficacy as botanical insecticide of common maize pest in smallholder farming

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Toxicodendron succedanea, commonly known as Japanese wax tree, is a member of the Anacardiaceae family native to East Asia, has become invasive in parts of South Africa and is classified as a forbidden Category 1b species as per the Conservation of Agricultural Resource Act 43 of 1983. The classification prohibits its cultivation and mandates the strict management and control of the existing plants to further spread. Despite its invasive status, the species is rich in secondary metabolites, namely, urushiol, a bioactive compound known for their defensive, insecticidal and antimicrobial properties. The current global concerns regarding the negative impacts of synthetic pesticides on human and the environmental health, coupled with increasing demand for safer production practise, have renewed interest in the use of botanical pesticides, especially in organic farming systems. Hence, this review seeks to comprehensively and systematically synthesize the existing literature on phytochemical diversity, of *T. succedaneum,* the distribution of its bioactive compounds within plant parts and its

potential use as a botanical insecticide targeting key maize pest in smallholder farming systems. The review highlights the potential of *T. succedaneum* as a sustainable alternative insecticide for the control of several chewing insects, mainly in the orders Coleoptera, Lepidoptera and Orthoptera. However, challenges related to its toxicity, formulation, standardisation, and regulatory compliance remain a significant barrier to its practical application. Addressing these constraints will be critical for advancing the use of *T. succedaneum* extract as botanical pesticides in sustainable agriculture.

Phylogenetic relationships and climate-driven range shifts of Lemnaceae in South Africa

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Duckweeds (Lemnaceae) are among the smallest flowering plants and are ecologically significant components of freshwater ecosystems, yet their extreme morphological reduction complicates species identification, biogeographic classification, and invasion assessments. This study integrates multi-locus molecular phylogenetics and species distribution modelling (SDM) to clarify the evolutionary relationships, native versus non-native status, and climate-driven range dynamics of duckweed species in South Africa. Phylogenetic reconstruction based on five plastid markers (*matK, rbcL, rpl16, trnK-3',* and *trnK-5'*) resolved two well-supported subfamilies (Lemnoideae and Wolffioideae) and confirmed the monophyly of the genera *Lemna, Landoltia, Spirodela, Wolffia,* and *Wolffiella*. Of the 38 taxa analysed, nine were identified as native and 29 as non-native, providing new evidence that *Lemna minor* and *Lemna gibba*, previously regarded as invasive in South Africa, are native species. Ecological niche models developed using MaxEnt and bioclimatic variables projected current and future habitat suitability under four Shared Socioeconomic Pathways (SSP1-2.6, SSP2-4.5, SSP3-7.0, SSP5-8.5) across three global climate models (MIROC6, EC-Earth3-Veg, and UKESM1-0-LL). Current suitability is highest in coastal provinces, including KwaZulu-Natal, Eastern Cape, and Western Cape. Future projections reveal model-dependent outcomes, with MIROC6 and EC-Earth3-Veg predicting net expansion of climatically suitable habitat, particularly in inland provinces such as Mpumalanga, Limpopo, North-West, and Gauteng while UKESM1-0-LL consistently predicts contraction. The congruence between phylogenetic identity and projected range shifts highlights regions and freshwater systems vulnerable to future duckweed invasions. By integrating evolutionary history with climate projections, this study provides a robust framework for refining invasive species

management, conserving native freshwater flora, and guiding adaptive conservation planning under climate change in South Africa.

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