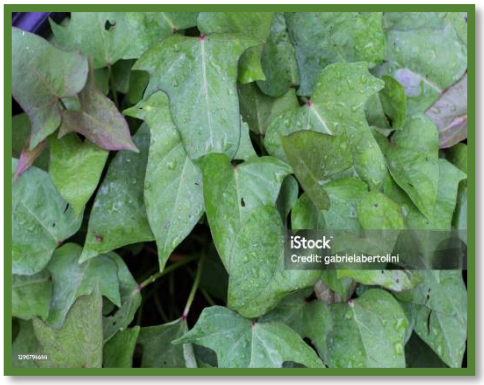
Promoting Health and Food Security with Indigenous Crops

A joint virtual Workshop between

The ARC Industrial Transformation Training Centre for Uniquely Australian Foods (ARC ITTC UAF), Queensland Alliance for Agriculture and Food Innovation (QAAFI), The University of Queensland, Brisbane, Australia

and

The SARChI Research Programme in Phytochemical Food Network to Improve the Nutritional Quality for Consumers, Tshwane University of Technology, Pretoria, South Africa



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Network to Improve the Nutritional Quality for Consumers

Tshwane University of Technology, South Africa

Workshop Invitation

Joint virtual workshop between the CNAFS, QAAFI, The University of Queensland, Australia and Tshwane University of Technology, South Africa

On

Promoting Health and Food Security with Indigenous Crops

Dates: 5th & 6th March, 2024
Time: 4.30 PM – 6.00 PM, Brisbane, Australia
8.30 AM - 10.00 AM Pretoria, Tshwane, South Africa

Guest Speaker: Prof Ing. Ladislav Kokoška

Department of Crop Sciences and Agroforestry of the Faculty of Tropical AgriSciences, Czech University of Life Sciences Prague, The Czech Republic

Title of the presentation: Underutilized crops as novel foods for health and nutrition improvement: A Samoa case study

About this workshop

According to a United Nations report, 75% of global food production comes from just 12 crops, with rice, maize and wheat providing around 60% of the protein and calories consumed by people. This is alarming, as the genetic diversity of plants has decreased by 75% since the start of the 20th century. Investing in indigenous crops could be a solution to both food insecurity and biodiversity loss. Indigenous crops offer numerous benefits such as improved nutrition and health, boosting local economies, strong adaptability to climate change, conservation of biodiversity in agriculture, and preservation of cultural heritage. Indigenous foods help to increase dietary diversity. This workshop aims to share the evidence-based research on the nutritional, bioactive and functional properties of Indigenous crops, impact of processing methods on phytonutritional compounds and antinutrients in Indigenous crop and product development and value addition. This workshop aims to improve research collaborations between the two institutions and encourages participation of postgraduates and early career researchers.

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Programme

Workshop on

Promoting Health and Food Security with Indigenous Crops

Dates: 5th & 6th March, 2024

Time: 4:30 PM – 6:00 PM, Brisbane, Australia

8:30 AM - 10 AM Pretoria, South Africa

Day 1: 5th March 2024		
Session Chair: Dr. Oladipupo Adiamo, UQ		
Opening of the workshop	**Professor Yasmina Sultanbawa, UQ**	10 min
Guest speaker Presentation	**Presenter: Prof Ing. Ladislav Kokoška**, Czech University of Life Sciences Prague. ***Title of Presentation***: Underutilized crops as novel foods for health and nutrition improvement: A Samoa case study.	15 min
Student Presentation 1	**Presenter: Samson O. Fawale, UQ** ***Title of presentation***: Nutritional, antinutritional and antioxidant properties of Australian bush tucker yams (*Dioscorea* spp.).	10 min
Student Presentation 2	**Presenter: Nobahle P. Cele, TUT** ***Title of Presentation*****:** Protein content and antioxidant activities of germinated and lactic acid bacteria fermented indigenous legumes.	10 min
Student Presentation 3	**Presenter: Jiale Zhang, UQ** ***Title of Presentation*****:** Physicochemical, nutritional, and bioactive properties of Australian native *Persoonia* spp.	10 min
Q & A		10 min
Day 2: 6th March 2024		
Session Chair: Dr. Saleha Akter, UQ		

Student Presentation 4	**Presenter: Gengning Chen, UQ** ***Title of Presentation*:** Phenolic compounds of Burdekin plum during fruit leather processing and storage.	10 min
Student Presentation 5	**Presenter: Lebo Ruth Maila, TUT** ***Title of Presentation*:** The influence of cooking methods and leaf maturity on Total phenolic content and Total carotenoids bioavailability and bioaccessibility in okra (*Abelmoschus esculentus)* leaves.	10 min
Student Presentation 6	**Presenter: Chenxuan Xie, UQ** ***Title of Presentation*:** Nutritional composition and antioxidant properties of muntries cultivars and impact of their extracts on *in vitro* cell viability.	10 min
Student Presentation 7	**Presenter: Lavhelani Tshilongo, TUT** ***Title of Presentation***: Profiling and quantification of individual anthocyanins from purple-fleshed sweet potato (*Ipomoea batatas*) leaves harvested during the vegetative stage, tuber initiation stage and tuber maturation stage and their antioxidant activities.	10 min
Q & A		10 min
Closing of the workshop	**Professor Dharini Sivakumar, UQ & TUT**	10 min

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ABSTRACTS

The influence of cooking methods and leaf maturity on total phenolic content and total carotenoids bioavailability and bioaccessibility in okra (*Abelmoschus esculentus)* leaves.

Lebo Ruth Maila, Dharini Sivakumar and Faith Seke

Department of Crop Science, Tshwane University of Technology, Pretoria West 0001, South Africa.

Presenting Author: Lebo Ruth Maila

Population growth globally has led to an increase in nutritional deficiencies and diseases due to lack of essential nutrients in the human diet, especially in underdeveloped countries. Consuming fruits and vegetables can delay aging and reduce inflammation and oxidative stress linked to chronic diseases like cardiovascular and cancer. Okra (*Abelmoschus esculentus)* is crucial in human diets and provides essential nutrients and phytochemicals often lacking in diets of developing countries. Cooking alters the chemical composition of okra, affecting the concentration and bioavailability of bioactive compounds. The aim of this study was to evaluate different cooking methods (boiling, steaming, and stir-frying) on the carotenoids and total phenolic content of okra leaves. Young and mature okra leaves harvested after 60 days of planting were utilized in this study. In comparison to young and mature leaves, young leaves contained 5167.36mg/100 g and mature leaves 1567.368 mg/100g of total phenol contents. Raw mature leaves exhibited the highest carotenoids content (13574.0741 mg/100 g) compared to raw young leaves (12774.69 mg/100 g). The study found that all tested cooking methods resulted in an increase in total phenolic content in both young and mature leaves. This study found that steaming and boiling increased the total carotenoids in young leaves, with the latter containing 17762.3mg/100 g and 16981.48mg/100 g, respectively. The stir-frying of both young leaves resulted in a significant reduction in carotenoids. The study suggests that young leaves may be more suitable for consumption, steaming is considered the most effective cooking method due to its ability to maintain TPC and TC.

Nutritional, antinutritional and antioxidant properties of Australian bush tucker yams (*dioscorea* spp.)

Samson O. Fawale[1], Michael E. Netzel[1], Olufemi A. Akinsanmi[2] and Yasmina Sultanbawa[1]

[1]Centre of Nutrition and Food Sciences, Queensland Alliance for Agriculture and Food Innovation, The University of Queensland

[2]Centre for Horticultural Sciences, Queensland Alliance for Agriculture and Food Innovation, The University of Queensland

Presenting Author: Samson O. Fawale

The Australian bush tucker yam (*Dioscorea* species) have played an important role as a staple food in Aboriginal diets, subsistence, and historical settlement patterns. Despite their importance, their nutritional properties are unknown. This information is crucial to expand their usage as a whole food or a functional ingredient, as well as its domestication and most importantly its reintroduction back into the Australian culinary system. The aim of this study was therefore to determine the nutritional, anti-nutritional, and antioxidant properties of different plant parts (leaf, tuber, and peel) of two wild-harvested yam species, *Dioscorea alata* and *Dioscorea bulbifera*. The proximate compositions of the two species revealed a wide range for moisture (46.9 - 88.2%), ash (4.2 - 12.2%), fat (0.5 - 5.1%), total dietary fibre (14.5 - 60.5%), and crude protein (7.7 - 13.4%). Furthermore, *Dioscorea alata* was characterised by relatively high levels of phytate, total phenolics, and flavonoids as well as radical-scavenging capacity (2,2-diphenyl-1-picrylhydrazyl (DPPH) assay). Overall, the yam species showed promising nutritional properties, implying that the Australian bush tucker yams may have the potential to be considered as a nutritious food with potential health benefits or used as an ingredient in the development of functional food products. However, the relatively high phytate level and its dietary relevance should be investigated further.

Phenolic compounds of Burdekin plum during fruit leather processing and storage

Gengning Chen[1], Michael E. Netzel[1], Daniel Cozzolino[1], Sandra Milena Olarte Mantilla[1], Dharini Sivakumar[1,2] and Yasmina Sultanbawa[1]

[1]ARC Industrial Transformation Training Centre for Uniquely Australian Foods, Queensland Alliance for Agriculture and Food Innovation, The University of Queensland

[2]Phytochemical Food Network, Department of Crop Sciences, Tshwane University of Technology, Pretoria, South Africa

Presenting Author: Gengning Chen

Burdekin plums (BP) are fruits of *Pleiogynium timoriense* (DC.) Leenh, a tree native to Australia. In this study, BP fruit leathers were developed by blending BP puree with apple puree (0 to 80%) to make five formulations of BP fruit leathers (100BP, 80BP, 60BP, 40BP, and 20BP). Bioactive phenolic compounds and microbial stability of fruit leathers were studied during a six-month storage at ambient conditions (temperature 16 – 25 °C, humidity 60 – 77 %). Principal Component Analysis (PCA) showed a decrease in anthocyanins and catechins after the puree was processed into leather and also after six months of storage, whereas ellagic acid and quercetin increased. The content of gallic acid, digalloyl glucose and trigalloyl glucose remained stable. Total phenolic content (TPC) and ferric reducing antioxidant power (FRAP) were unaffected by processing and storage with only a slight reduction in 80BP and 100BP. Furthermore, fruit leathers were microbiologically safe and shelf-stable during the six months storage. The results clearly demonstrated the potential of BP to be processed into a shelf stable fruit leather rich in bioactive phenolics.

Physicochemical, nutritional, and bioactive properties of Australian native *Persoonia* spp.

Jiale Zhang[1], Dharini Sivakumar[1, 2], Michael E. Netzel[1], Andrew Pengelly[3], Yasmina Sultanbawa[1]

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Presenting Author: Jiale Zhang

Wild plants have become more popular and used in functional products in both developing and developed countries, where an increase in acceptance of plant-based products has emerged. Thus, it is important to understand the health-enhancing profile of Australian native species. *Persoonia* species, endemic to Australia, have been previously studied, but with limited health-related information. Therefore, the present study was to investigate the nutritional, physicochemical including phytochemical and bioactive properties of different fruit tissues of *P. linearis* (PL), *P. stradbrokensis* (PS), and *P. falcata* (PF). The intention of this study is to contribute knowledge to the Aboriginal people by connecting western science with traditional knowledge and exploring the market access of potential functional food ingredients. In the initial study done on the three species of *Persoonia* the results showed, variability of morphology between *P. stradbrokensis* and *P. linearis* fruits. In proximate and mineral analysis, PS and PL fruits showed high values of Manganese at approximately 13 mg/100g DW compared to recommended dietary allowance (5.5 mg/day), indicating *Persoonia* fruits will be a good source of Manganese. The peel of PS and PL presented the significantly higher antioxidant and antimicrobial activities ($p < 0.05$) compared to their pulp and seed. Moreover, a positive correlation between total phenolic content (TPC) and free radical assays was observed. *Persoonia* species show promising properties to be value added as functional food ingredients or nutraceuticals. Further analysis will develop on the nutritional, proximate and mineral components of *P. falcata* fruits and other bioactive properties of three selected *Persoonia* species fruits to provide comprehensive results to support health-related product development.

Profiling and quantification of individual anthocyanins from purple-fleshed sweet potato (*Ipomoea batatas*) leaves harvested during the vegetative stage, tuber initiation stage and tuber maturation stage and their antioxidant activities.

Lavhelani Tshilongo[1], Sunette Laurie[2], Tino Shoko[1] and Dharini Sivakumar[1]
[1]Department of Crop Science, Tshwane University of Technology, Pretoria West 0001, South Africa
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Presenting Author: Lavhelani Tshilongo

Amidst escalating climate stress and population growth, there is increasing recognition of the potential of drought-resistant and nutritious sweet potato leaves (SPLs) as a sustainable food source. These leaves are valued for their contribution to household resilience and food security. Specifically, the purple SPLs genotype stands out as a notable source of anthocyanins, associated with various health benefits. Although SPLs rich in anthocyanins are suitable leafy vegetables, the accumulation of anthocyanins as influenced by harvesting stages remains unclear. This study determined the effect of different harvesting stages (vegetative stage 8 weeks after planting (VS-8WAP), tuber initiation stage (TIS-12WAP) and tuber maturation stage 16WAP (TMS-16WAP)), on the anthocyanin composition and antioxidant activity (AA) of five purple SPL genotypes (Purple-Purple, 08-21p, 2019-11-2, 16-283p and 2019-1-1). The results showed that SPLs contained anthocyanins such as cyanidin, peonidin, delphinidin, malvidin and petunidin. Cyanidin chloride and delphinidin-3-glucoside were the predominant compounds contributing towards the total anthocyanin content (TAC), highest in genotype '2019-11-2' x TIS-12WAP (98.89 µg/g) and '2019-1-1' x TIS-12WAP (111.14 µg/g) respectively. Genotype '2019-11-2' x TIS-12WAP maintained a potent AA with FRAP (53.92 TEAC mM/g) as well as ABTS (0.22 IC_{50} mg/mL) and DPPH (0.58 IC_{50} mg/mL) with no significant difference to VS-8WAP. The trend observed was the purple-fleshed genotypes exhibited high TAC and potent AA during TIS-12WAP with the exclusion of 2019-11-2. These anthocyanins correlated positively with FRAP and showed a negative correlation with ABTS and DPPH. There is a potential to utilise these genotypes as a leafy vegetable and anthocyanin source.

Nutritional composition and antioxidant properties of muntries cultivars and impact of their extracts on *in vitro* cell viability

Chenxuan Xie[1], Oladipupo Adiamo[1], Saleha Akter[1], Yasmina Sultanbawa[1], Dharini Sivakumar[1,2]

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Presenting Author: Chenxuan Xie

Muntries (*Kunzea pomifera*) are one of the Indigenous plants in Australia, growing on the southern coast of Victoria and South Australia. Muntries fruits are green or red, and look like blueberries, but taste like spicy apples. The dried fruits are consumed by the Indigenous Australians as part of their diet. This study aimed to provide information on the quality and safety of fruits from three muntries cultivars (Rivoli Bay, Neville Bonney and Teen's favourite) by investigating their nutritional composition, antioxidant properties, antinutritional factors and cytotoxicity for potential use as functional ingredients in food formulation. The results of this research showed that muntries have high dietary fibre (24.1 to 26.9%), potassium (11,800 to 14,400 mg/kg), and iron (42.7 to 51.7 mg/kg) but possess low amounts of antinutrients. The antioxidant analysis showed that muntries fruits have high total phenolic contents (22.8±2.04 to 34.7± 0.92 mg GAE/g dried sample). The dried fruits also exhibited high antioxidant properties including DPPH (IC_{50} values: 52.71 to 81.24 µg/mL), FRAP (0.38±0.03 to 0.57±0.04 mmole Fe2+ eq/g dried sample), and ABTS (574.1 to 1224.8 µ mole TE/g dried sample). Among these three muntries cultivars, Neville Bonney and Teen's favourite cultivars had higher antioxidant properties. In conclusion, the three muntries fruit varieties have the potential to be used as functional ingredients in food formulation.

Protein content and antioxidant activities of germinated and lactic acid bacteria fermented indigenous legumes

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Presenting author: Nobahle P. Cele

Indigenous bambara groundnuts (BGN) and morama bean (MB) legumes are high in protein, fat, fibre, ash, and minerals. It possesses antioxidant properties as a potential source of phytonutrients including polyphenols, carbohydrates, and dietary fiber. BGN seeds are divided into various genotypes including cream with brown eye, cream with black eye, red, and cream with no eye, black, purple, and speckled. Due to hard-to-cook phenomenon and underutilisation, access to protein nutrient for healthy lifestyle is limited on poor people in Sub Saharan Africa (SSA). The focus of research is on market-oriented legumes like beans, which subject BGN and MB to post-harvest losses. Another challenge legume contains anti-nutritive compounds which cause postharvest nutrition loss and contribute to food insecurity. BGN and MB are linked to alleviate protein energy malnutrition, hidden hunger and could be an affordable strategy to provide non-dairy, gluten free functional food to lactose intolerant individuals in rural communities. Germination and fermentation processes are significant to utilise such underutilised fruits and may reduce postharvest losses while providing nutritional enrichment, improving shelf life and food quality, and addressing the seasonality of food supply while promoting healthy well-being to rural people. In addition, it would help rural communities to establish community owned enterprise. Rural community would benefit economically, socially, and culturally by producing a nutrient dense and climate smart product for Sub-Sahara consumers to promote food security.

Acknowledgment

The University of Queensland (UQ) acknowledges the Traditional Owners and their custodianship of the lands on which UQ operates. We pay our respects to their Ancestors and their descendants, who continue cultural and spiritual connections to Country. We recognise their valuable contributions to Australian and global society.