AFRICA-*ai*- JAPAN Project (Phase 2):
African Union -*african innovation* - JKUAT AND PAUSTI Network Project

Towards Enhancement of JKUAT-PAUSTI Research and Innovation Capacity

Abstracts of Scientific Publications: 2022-2023

April 2023

Preface

The AFRICA-*ai*-JAPAN Project phase II, is a five-year extension of the Project Phase I, an initiative of JICA-JKUAT collaboration to enhance the University's capacity for supporting PAUSTI, started in 2014.

The Project operates through four sub taskforces which include: (1) Integrated Prototyping Innovation and Innovation Centre (iPIC) which has the key objective of employing modern technologies in developing African indigenous knowledge into products and services that enhance science, engineering and technology education. The iPIC thematic areas are environment and infrastructure solutions, sustainable transport vehicles and systems, agricultural and industrial machinery and processes; (2) the Innovation Centre for Bio-resources (iCB) which has the objective to apply modern technologies to enhance the utilization of endogenous bio-resources to reduce or eliminate food and nutrition insecurity by applying climate smart approaches. The iCB thematic areas are Crop Science and Production, Animal Health and Production, Postharvest handling and Value Addition, Bio-diversity and Conservation, and Smart Waste Management; (3) Innovation Centre for Molecular Biology and Biotechnology (iCMoB) with an objective to foster understanding the molecular basis of biological activity in organisms to enhance the development of innovative solutions to meet human needs. Its thematic areas are Drug and Disease Control, Biodiversity and Conservation, Food Security and Value addition; and (4) Innovation Centre for Computing and Technological Solutions (iCCATS), which has the objective of the application of open data and analytics in enhancing research and its dissemination. The iCCATS subtaskforce started with development of a centralized computer centre which would act as the central backbone serving the entire university with all the ICT requirements. It is through these subtaskforces that the AFRICA-*ai*-JAPAN Project works to deliver a number of outputs as described in the Project Design Matrix document.

The first output includes strengthening the human capacity of JKUAT through long term (PhD and MSc) and Short term (Technical, education trips) trainings for JKUAT staff and students. It also extends to creation of a favourable environment for research through provision of state of art equipment for research, and repair and maintenance of existing infrastructure and equipment. It is foreseen that the outcome of this, will be a stable foundation for JKUAT to deliver on its PAUSTI mandate and to drive Scientific and Technological Innovations (STI) in Africa.

The second output is strengthening research in STI by providing funding support for new research and innovation projects undertaken by both postgraduate students and academic staff of JKUAT/PAUSTI. It is anticipated that this will open the door for more multidisciplinary research projects in the areas of agriculture, engineering, health and ICT, among others. The supported projects are aligned to the national development agenda (Vision 2030 and the Big Four) as well as Sustainable Development Goals of the United Nations.

The third output is development of a close academia-industry linkage necessary for sustainable technology transfer and commercialization of research and innovation outputs. The activities relating to this output include hosting of seminars on topical issues covering the thematic areas of the project. The topics covered include concepts on innovation, building of innovation culture, role of science, technology and innovation as drivers of African transformation and development, the emergence of FabLab concept in Africa and its contribution to development, experiences and

challenges in the manufacturing research arena, and the importance of continuous monitoring and evaluation of the project progress. It is anticipated that for JKUAT to remain relevant to societal needs, it needs to work closely with industry in providing scientific and technological solutions to existing problems.

The fourth output is the formation of global partnership to strengthen research collaborations with teaching and research institutions worldwide. These activities will enable JKUAT to bench mark with other institutions with a similar goal while sharing experiences and best practices with local, regional, continental and global partners. A special focus is given to capacity building and collaboration with African institutions as well as sharing development experience with ASEAN, Japanese, European and American institutions, among others. This is considered the lever that will support improvement in JKUAT human capital, research, and increased visibility through stronger outreach activities that have societal impact.

As a direct result of the research and innovation environment created and arising from the activities of the AFRICA-ai-JAPAN project phase II, many publications in peer reviewed journals were published over the period of **April 2022 to February 2023.** A highlight of the abstracts obtained in the last 2 years segregated by the sub-taskforce category, the year published and the publication serial number is provided in the subsequent section. A total of **229 publications** were documented and their distribution per year is provided in Table 1.

Table 1. Summary of abstracts from AFRICA-ai-JAPAN taskforce members and JKUAT staff

Year	**Task force**
2023	12
2022	217
Total	**229**

Yours Sincerely,

AFRICA-ai-JAPAN Project Director

Prof. Victoria Wambui Ngumi (PhD)

AFRICA-ai-JAPAN Project Manager

Prof. Robert Kinyua (PhD)

Acknowledgement

The Project appreciates the authors of the various abstracts from JKUAT within the period 2020 to 2022 who willingly shared their outputs with the compiling team. This is considered a good gesture for building the spirit of documentation which is critical in pelting JKUAT high in university ranking. The Project further expects JKUAT researchers to keep publishing in high impact factor journals and share their peer review journal publications with JKUAT library for consolidated archiving.

It is also a reminder that the genesis of the the first edition of the book of abstracts 2014-2019 for all peer review journal publication papers stemmed from the urge of providing evidence for the outcomes of the implementation of AFRICA-ai-JAPAN Projects. This additional third publication (2020-2022) confirms that the seed which was planted in 2018 is still growing. It is this conviction which led the Project to initiate work on collection of all peer review journal publications.

Lastly, special thanks are given to the JKUAT Management Team for providing a favorable environment towards implementation of AFRICA-ai-JAPAN Project Phase II. We treasure every single minute dedicated towards supporting the Project. Let's keep working together towards realization of the university vision through transforming the research and innovation culture of the university. It is our desire, through JKUAT management support, to keep documenting and showcasing the growth in Scientific and Technological Innovations within the University.

Yours Sincerely,

JICA Chief Advisor at JKUAT,
Prof. Hiroshi Koaze

AFRICA-ai JAPAN Project Chairman
Prof. Daniel Ndaka Sila

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Introduction

A summary of the abstract from the various sub-taskforce members is as indicated below for each of the teams that form the AFRICA-ai-JAPAN project.

a. Summary of Abtracts from iCB Subtaskforce

Year	**No**
2023	10
2022	157
Total	**167**

b. Summary of Abstracts from iCMoB Subtaskforce

Year	**No**
2023	2
2022	11
Total	**13**

c. Summary of Abstracts from iPIC Subtaskforce

Year	**No**
2023	0
2022	37
Total	**37**

d. Summary of Abstracts from iCCATS Subtaskforce

Year	**No**
2023	0
2022	12
Total	**12**

1.0. RESEARCH ABSTRACTS FROM AFRICA-ai-JAPAN PROJECT TASKFORCE

1.1. Compilation of Abstracts from iCB Subtaskforce

iCB 2023-01

Chemical and Pasting Properties of Potato Flour (*Solanum tuberosum* L.) in relation to Different Processing Techniques

Buzera, A., Nkirote, E., Abass, A., Orina, I., & Sila, D. (2023).
Journal of Food Processing and Preservation, *2023*. Article ID 3414760. https://doi.org/10.1155/2023/3414760

Abstract

Processing potato tubers into flour can be done using various methods, which can impact the flour's nutritional and pasting properties. This study evaluated the effects of five different processing methods, namely, low-temperature blanching, followed by oven drying (LTB_OD), high-temperature blanching followed by oven drying (HTB_OD), boiling followed by oven drying (Boiling_OD), freeze drying (FD), and oven drying (OD), on the nutritional and pasting properties of potato flour derived from Shangi potato variety. The relationships between the nutritional and pasting properties were determined using Pearson's correlation and principal component analyses (PCA). The results indicated that freeze-dried flour exhibited higher protein content (10.17%), sucrose (88.87 mg/100 g), and magnesium (44.90 mg/100 g) content, while Boiling_OD flour showed the lowest protein (6.41%), sucrose (15.34 mg/100 g), and magnesium (35.55 mg/100 g) content. All potato flour types demonstrated a decrease in apparent viscosity with increasing shear rate, with freeze-dried flour having the highest apparent viscosity. Freeze-dried flour showed the highest peak viscosity (7098.33 cP) and breakdown viscosity (2672.00 cP). The highest final viscosity (7989.00 cP) was recorded in HTB_OD flour. Protein (r = −0:92), fiber (r = −0:81), and fat (r = −0:83) negatively correlated with the peak viscosity, while sugars (glucose (r = 0:95), fructose (r = 0:93), and sucrose (r = 0:87)) and phosphorus (r = 0:86) positively correlated with pasting properties. The first two principal components explained 90.2% of the total variance. Oven drying and freeze drying were in close proximity in the PCA score plot, indicating that these two flour types have similar chemical and pasting properties. In conclusion, the different processing methods altered the chemical and pasting properties of the flour, therefore influencing their potential use in the food industry. Considering the correlations established in this study, it is likely that chemical properties could be used to predict the pasting properties of potato flour.

iCB 2023-02

Molecular Characterization of Doum Palm (*Hyphaene compressa*) from Selected Regions of Kenya using Chloroplast Simple Sequence Repeats (cpSSR) Markers

Borlay, A. J., Mweu, C. M., Nyanjom, S. G., Omolo, K. M., & Omire, A. (2023).
Pakistan Journal of Botany, *55*(3), 1013-1021.

Abstract

Doum palm (*Hyphaene compressa*) is an enduring member of the Arecaceae family of plants, an essential multipurpose plant with exceptional features that serve as a socioeconomic resource for people in the East Africa region. The unavailability of genetic and genomic data leads to

difficulties enhancing such a crop, thereby preventing the actualization of its agronomic and breeding potential, hence the need for characterization. This study included 64 genotypes of doum palm collected from four locations in Kenya and ten polymorphic chloroplast microsatellite markers. Locus Among the ten polymorphic cpSSRs studied, the OPCG13 locus exhibited the highest observed and expected heterozygosity. Across all loci, we detected the mean value of 10.145 for the gene flow parameter. The mean number of significant allele frequencies for the 79 alleles detected was 0.75, with a range of 0.531 to 0.89. The median was 0.0036, 0.341, and 0.275 for observed heterozygosity, predicted heterozygosity, and PIC, respectively. All 64 genotypes were sorted into three main categories using neighbor-joining clustering and STRUCTURE analysis. At the population level, PCoA analysis explained 51.66 percent of the variation. As a result of these findings, cpSSR markers were used for the first time to characterize selected doum palm germplasm, which signifies that such a marker helps study doum palms at the molecular level. Our findings indicate that doum palm species in Kenya have a reasonable genetic variation coupled with considerable heterozygosity; consequently, these doum palm genetic variations are essential for the genetic improvement, breeding, and conservation initiatives of doum palm genotypes in Kenya.

Key Words: Doum palm (*Hyphaene compressa*), Rural pastoralists, Arid and semi-arid Kenyans, Chloroplast SSR (cpSSR), Genetic diversity, Molecular characterization.

iCB 2023-03

Oral Acute, Sub-Acute Toxicity and Phytochemical Profile of *Brassica carinata* A. Braun Microgreens Ethanolic Extract in Wistar rats

Nakakaawa, L., Gbala, I. D., Cheseto, X., Bargul, J. L., & Wesonga, J. M. (2023). *Journal of Ethnopharmacology, 116121*.

Abstract

Ethnopharmacological relevance: Currently, there is a remarkable increase in the consumption of microgreens, (young edible vegetables or herbs), as potential nutraceuticals for the management of diseases. *Brassica carinata* A. Braun is one of the traditional leafy vegetables cultivated in various parts of Sub- Saharan Africa. The plant is revered for its efficacy in the treatment of wounds and gastrointestinal disorders among other medicinal benefits. It is therefore crucial to characterize *Brassica carinata* microgreens for their phytoconstituents and ascertain their safety for use.

Aim of the study: The study evaluated the oral acute and subacute toxicity of *Brassica carinata* microgreens ethanol extract (BMEE) in Wistar rats and identification of its chemical composition and profile.

Materials and methods: For acute toxicity (14 days), rats were grouped into four and received a single oral dose, the control group received distilled water, while others received 500 mg/kg, 1000 mg/kg, and 2000 mg/kg of BMEE. For the subacute toxicity (28 days), rats in four groups received daily doses of 250 mg/kg, 500 mg/kg or 1000 mg/kg and distilled water. Daily clinical observations like lethargy and mortality were conducted. Hematological, biochemical, and histopathological evaluations were performed at the end of each experiment. Phytochemical profile was determined using a UV-VIS spectrophotometer and Gas Chromatography coupled to Mass Spectrometry (GC-MS) analysis determined the potential bioactive components in the microgreens extract.

Results: In both acute and sub-acute toxicity studies, no mortalities, indications of abnormality, or any treatment related adverse effects were observed at doses of 2000 mg/kg, 1000 mg/kg, 500 mg/kg, and 250 mg/kg. The LD_{50} of BMEE was above 2000 mg/kg. No significant ($p > 0.05$) changes in the hematological and biochemical parameters of the treated groups compared to the control groups in both studies. Histopathological examination of the liver, kidney, lungs, and heart revealed a normal architecture of the tissues in all the treated animals. Phytochemical analyses revealed the presence of flavonoids (most abundant), phenols and alkaloids. Phytol, linoleic acid, and 9, 12, 15-octadecatrienoic acid, among other compounds, were identified by GC-MS analysis. Conclusion: The results showed that *B. carinata* microgreens ethanol extract is nontoxic and found to have several compounds with reported pharmacological significance suggesting safety for use.

Key Words: And GC-MS; Ethiopian kale; Nutraceutical; Toxicity.

iCB 2023-04

Strategic Business Decisions of Retailers in the Edible Insect Value Chain in Uganda

Donkor, E., Mbeche, R., & Mithöfer, D. (2023). *International Food and Agribusiness Management Review*, 1-20.

Abstract

Edible insect value chains are expected to contribute to sustainable food and nutrition security, poverty alleviation and job creation in Sub-Saharan Africa. However, there is little empirical evidence on the strategic business decisions of midstream-actors in edible insect value chain. This study fills this knowledge gap by analysing the factors that influence retailers' strategic business decisions, that is, choices of supplier, product to purchase, procurement strategy and the quantity of product purchased in the grasshopper value chain in central Uganda. Using a primary dataset collected from 500 randomly selected retailers from two districts in central Uganda, Cragg's tobit alternative and binary probit models are applied in the empirical analysis. Retailers mainly procure grasshopper products from wholesalers and collectors. The study shows that demographic, economic, transactional and processing-related factors significantly influence retailers' strategic business decisions in the grasshopper markets. Developing retailers' human capital in business management practices and collective action is important to enable them to make informed strategic business decisions in the agrifood chain.

Key Words: Edible insects, Market development, Strategic business decisions, Supply chain management, Traditional food retailing, Procurement strategy

iCB 2023-05

Environmental Exposure Assessment of Lead and Cadmium in Street Vended Foods Sold in Selected Locations in Kenya

Mwove, J., Imathiu, S., Orina, I. & Karanja, P. (2023). Food Science & Nutrition, 2023;00:1–10. DOI: 10.1002/fsn3.3344

Abstract

The preparation and handling practices, as well as raw materials for street food vending businesses, could be sources of toxic heavy metals in street vended foods (SVFs). The objective of this study was to assess the levels of lead (Pb) and cadmium (Cd) contamination in ready-to-eat SVFs sold

in selected locations within Thika town, Kenya. A total of 199 samples consisting of cereal- based foods, sliced fruits, salads, groundnuts, tubers, fresh fruit juices, eggs, smokies, and sausages were randomly collected for analysis. The concentration of Pb and Cd in street vended foods (SVFs) was determined by atomic absorption spectrophotometry. The results indicated that at least one of the food sample types was contaminated with Pb. The level of Pb contamination in SVFs ranged between 0.271 ± 0.070 and 1.891 ± 0.130 mg/kg with groundnuts recording significantly ($p < .0001$) higher levels (1.891 mg/kg) than all other food samples. Cadmium contamination levels in the SVF samples ranged between 0.001 ± 0.001 and 0.010 ± 0.003 mg/kg. Significantly ($p < .0001$) high levels of Cd were observed in cereal-based foods (0.010 mg/kg) and fresh fruit juices (0.008 mg/kg). The Pb concentrations reported in this study are a food safety concern since they exceed the maximum recommended limits set by the Joint Food and Agriculture Organization (FAO)/World Health Organization (WHO) food standards program. There is therefore a need for the establishment and enforcement of policies to govern the street food vending businesses to reduce heavy metal contamination in the SVFs.

iCB 2023-06

Role of Research and Innovation on Sustainable Development

Gicheha, M. G., Mwashi, V., Mbindyo, P., Maina, R. A., & Mugodo, C. (2023). *Journal of Agriculture, Science and Technology, 22*(1), 1-3.

Abstract

In recent years, the concept of sustainable development (SD) has attracted much attention from researchers, institutions, organizations, and societies. Sustainable development has gained much attention due to the problems arising in different areas like climate change, health, energy, and environmental conservation. Research and innovation have played a critical role in addressing issues related to healthcare, inequalities, job creation opportunities, enhancing productivity, and alleviating the negative impacts of climate change. This article highlights the significant roles of research and innovation in achieving sustainable development.

iCB 2023-07

Effect of Dried *Leucaena leucocephala* and *Manihot esculenta* Supplementation Leaves on Feed Intake, Milk Production, and Milk Composition of Holstein Friesian x Ankole Crossbred Cows

Barwani, D. K., Bacigale, S. B., Ayagirwe, R. B. B., Gicheha, M. G., Katunga, D. M., & Osuga, I. M. (2023). DOI: https://doi.org/10.21203/rs.3.rs-2440834/v1

Abstract

This experiment was conducted to investigate the effect of dried Leucaena (*Leucaena leucocephala*) and cassava (*Manihot esculenta*) leaves on feed intake, milk production, and milk composition of Holstein Friesian x Ankole crossbred cows. Three cows in early lactation, with initial milk production of 4 ± 1.20 kg/day and 359 ± 24 kg average live body weight, were randomly assigned to the experimental diet in a 3x3 Latin square design. Three 15-day experimental periods were adopted (1 to 10-day: diet adaptation and 11 to 15-day: data collection). Cows were fed on a freshly chopped Guatemala grass diet supplemented with 1.25 kg DM of brewers' spent grain (control). The experimental diets were similar to the control diet differing in the presence of dried Leucaena or cassava leaves, both at the inclusion rate of 20% of the basal

diet intake. Total dry matter intake, nutrient intake, milk production, and milk composition showed significant variation among treatments. Cows supplemented with dried cassava leaves had higher total dry matter intake and organic matter intake. Leucaena significantly increased ($p < 0.001$) daily milk production by 15% compared to cassava (3%). Leucaena had a higher milk fat content (38.44 g), while cassava and the control diet had higher milk protein (38.53 and 38.43 g), lactose (56.79 g and 56.111 g), and not-fat solids (102.41 g and 101.27 g). These results indicate that dried Leucaena and cassava leaves can be used as protein supplements for Guatemala grass basal diet for crossbred cows to improve milk production and quality.

Key Words: Dairy cows, Democratic Republic of the Congo, Forage, Nutrient intake, Protein Supplements

iCB 2023-08

Effects of Indigenous Arbuscular Mycorrhizal Fungi on Growth of Selected *Carica papaya* L. Hybrids in Kenya

Muiruri, J., Rimberia, F. K., Mwashasha, M. R., & Kavoo, A. (2023). *Journal of Agriculture, Science and Technology*, *22*(1), 70-82.

Abstract

Arbuscular Mycorrhizal Fungi (AMF) are naturally occurring root symbionts known to improve the uptake of essential nutrients by host plants due to their extra-radical hyphae. However, the effect of indigenous AMF inoculation on the growth of papaya hybrids has not been investigated. This study evaluated the effect of AMF inoculation on the growth characteristics of papaya hybrids (JKUAT and Malkia) at the vegetative stage. A greenhouse experiment consisting of three treatments—AMF inoculum, compost manure, and a combination of inoculum and compost manure—was set up in a completely random design and replicated six times. Non-treated seedlings were included as controls. Spores were isolated from rhizospheric soil samples and bulked in a potted sorghum crop for four months to obtain AMF inoculum. The treatments were applied to papaya seedlings between the second and third leaf stages. Growth parameters including plant height, leaf length, stem girth, and number of leaves were recorded every 4 weeks for a period of 20 weeks after planting (WAP). All data were subjected to one-way ANOVA at the $p \leq 0.05$ level, with significant and nonsignificant means separated using Tukey's HSD test in Genstat's 15th edition. Results showed that plants treated with a combination of compost manure and AMF inoculum were significantly different ($p \leq 0.05$) for all growth parameters tested, compared to compost manure alone and the control treatments. Malkia hybrids treated with a combination of compost manure and AMF inoculum (MIC) had the highest plant height of 53.2 cm at 20 WAP. JKUAT hybrids treated with AMF inoculum and composted manure and the control treatment had a root biomass of 49 and 11.80 grammes at 20 WAP, respectively. In conclusion, soil media amendment with compost manure and AMF inoculum enhanced overall papaya seedling growth, and the growth response was dependent on papaya hybrids.

Key Words: Compost manure, Indigenous AMF inoculums, Papaya hybrid response, Seedling growth effects

iCB 2023-09

Nutrient Content and Biochemical Analysis of Papaya (*Carica papaya* L.) Hybrids Grown in Central Kenya

Matsuane, C., Kavoo, A. M., Kiage, B. N., Karanja, J., & Rimberia, F. K. (2023). *Plant Science Today*, *10*(2), 263-268. DOI: https://doi.org/10.14719/pst.2117

Abstract

Papaya (*Carica papaya* L.) is a known powerhouse of nutrients and biochemi-cals which have health benefits necessary in a human diet. Mineral and vitamin deficiencies, like stunting, wasting and underweight in children, are common in Kenya yet available fruits like papaya can provide those nutrients. This study evaluated the nutritional and biochemical compositions, sugars and the 2,2-diphenyl-1-picryl hydrazyl (DPPH) radical scavenging activities of 2 newly developed papaya hybrids (JKUAT 7 and JKUAT 8) grown in Kenya and Solo variety, as control; in a completely randomised design which were subjected to one way ANOVA at $p<0.05$. Results from this study showed significant differences for JKUAT 8 with zinc, iron, potassium and vitamin C contents at 3.28, 3.62, 1145.10 and 448.30 mg/100 g respectively. Solo variety had significantly higher β-carotene (68.75 mg/100 g), lycopene (25.47 mg/100 g) and flavonoid (0.0178 g/100 g) contents. JKUAT 7 had more phenolic and tannins contents at 0.4434 g/100 g and 81.65 mg/100 g respectively. The DPPH activities ranged from 20 to 80 mg/mL with JKUAT 7 having the highest activity at 20 mg/mL and the least, Solo at 80 mg/mL. JKUAT 7 also exhibited higher total sugar contents in a range of 4.86 to 11.57%: with glucose and fructose at 5.74 and 5.83 % respectively. Our results suggested high nutritional and biochemical profiles of the newly developed JKUAT 7 and JKUAT 8 compared to Solo, the commercial variety. The high nutritional and biochemical contents recorded in the study papayas can be utilised in enhancing human nutrition and health thereby reducing metabolic disorders.

Key Words: Carica papaya hybrids, Mineral, Radical scavenging activity, Sugars, Vitamin

iCB 2023-10

Effect of In Vitro Calcium Fortification on Regeneration and Microtuberization of Three Selected Irish Potato Varieties

Mungai, S. W., Wainaina, C. M., Kavoo, A. M., & Mwajita, M. R. (2023). *International Journal of Horticultural Science and Technology*, *10*(4), 433-444.

Abstract

Potato is an important tuber crop that plays a key role in food security in sub-Saharan Africa. However, potato production faces challenges including limited clean seed and nutrient deficiencies of microplants. The availability of clean and viable seed is the most constraining challenge hence necessitating the development of new strategies for enhancing production. Understanding the link between in vitro nutrient enhancement and seedling vigor under field conditions may mitigate these challenges after microplant transplanting. In vitro experiments were set up to investigate the effect of calcium (Ca) fortification on potato varieties Shangi, Unica and Dutch Robjyn regeneration and microtuberization. Cuttings were subcultured onto modified MS media with five levels of Ca 8.8g/L, 10.4g/L, 12g/L, 13.6g/L and 15.2g/L CaCl2. Microtubers were initiated on media with 60g/L brown sugar and 6mg/L 6-Benzylaminopurine. The experiment was set up in a

completely randomized design replicated three times. The regeneration capacity of the tested varieties differed significantly, evidenced by shoot ($p=0.0002$) and root number ($p=<.0001$). Response to fortification was variably dependent with 10.4-13.6g/L leading to a significant increase ($p<0.05$) in root number in the three varieties. 13.6g/L CaCl2 led to an increase in root-zone and mid-stem Ca content by 45%, 202% and 165% for Shangi, Unica and Dutch Robjyn respectively compared to the control. Dutch Robjyn and Shangi showed better regeneration and microtuberization in comparison to variety Unica under 10.4-13.6g/L CaCl2. Results confirm the optimization of MS regeneration protocol by Ca enhancement as a potential technology for scaling up the production of clean quality seed.

Key Words: Micropropagation, Calcium, Clean seed, Potato, Fortification, Microtuberization

iCB 2022-01

A Piezoresistive Dual-tip Stiffness Tactile Sensor for Mango Ripeness Assessment

Christopher, C. T., Fath Elbab, A. M., Osueke, C. O., Ikua, B. W., Sila, D. N., & Fouly, A. (2022). *Cogent Engineering, 9*(1), 2030098.

Abstract

Fruit ripeness detection (FRD) has been a very important research area. FRD has focused more on colour segmentation, image processing, odor of fruits and its size. However, fruit stiffness can be an evidence of its ripening. Developing a sensor that focuses on the stiffness of fruit becomes very important. This work presents an approach of mango ripeness detection based on its stiffness using a tactile sensor. A resistance change-based micro tactile sensor is designed for FRD in which it utilizes two cantilevers with different stiffness to estimate mangoes ripeness levels based on their stiffness. The tactile sensor parameters were analyzed and selected to ensure high sensitivity and linearity of the sensor output (Force ratio). The sensor was developed and experimentally tested with five test pieces of known stiffness for proof-of-concept. A finite element analysis was carried out to test the sensor with the same stiffness values of test pieces to compare the results with the analytical results. The error between the analytical and experimental results of the test pieces did not exceed 7%, while the error between the analytical and simulation results of the stiffness of the test pieces did not exceed 2.7%. Finally, the sensor was tested with five mangoes at different ripeness levels, and the sensor clearly differentiated among the mangoes and obtained stiffness values of 1792.95 N/m, 1395.70 N/m, 1078.86 N/m, 317.15 N/m and 67.81 N/m from the stiffest to the softest mango (Mango A—Mango E), respectively. This tactile sensor can be used in fruit sorting industries to complement the existing fruit sorting approaches.

Key Words: Stiffness, Mango fruit, Tactile sensor, Force ratio

iCB 2022-02

Nutritional Composition and Antinutrient to Mineral Molar Ratios of Selected Improved Common Beans Grown in Kenya

Jepleting, N., Sila, D. N., & Orina, I. N. (2022). *Current Research in Nutrition and Food Science Journal, 10*(3), 1230-1239.

Abstract
A decline in common bean production has been ascribed to climate change. The adoption of improved beans aims to increase productivity, profitability, and consumption, thus reducing food and nutrition insecurity in the country. The aim of this study was to determine the proximate composition, antinutrient content, mineral content, and bioaccessibility of zinc and iron in two improved bean varieties grown in Kenya; Faida (biofortified) and RM 01 (drought tolerant)). The protein content of RM 01 (22.48%) was significantly higher than the Faida bean variety (20.90%). RM 01 bean variety had higher crude fat (4.20%) and crude fiber (4.31%) content compared to Faida which had 3.78% and 3.31% for crude fat and crude fiber respectively. Faida recorded significantly higher levels of iron (61.5 mg/kg) and zinc (26.8 mg/kg) content. Faida beans also had significantly high levels of phytates (11.70 mg/g) and tannins (4.39 mg CE/g). Phytate to iron ratio for Faida was 17.08 and RM 01 was 15.19 while the phytate-to-zinc ratio was 42.26 and 35.36 for Faida and RM 01 respectively. The RM 01 bean variety had iron bioaccessibility of 35% and zinc bioaccessibility of 65% compared to the Faida bean variety which had bioaccessibility of 29% and 42% for iron and zinc respectively. In conclusion, RM 01 variety is a better source of iron, zinc, and protein compared to the Faida variety.

Key Words: Bioaccessibility; Breeding; Biofortification; Common beans; Improved; Nutritional quality; Mineral deficiency

iCB 2022-03
(Bio) Chemical Reactions Associated with Ageing of Red Kidney Beans (*Phaseolus vulgaris*) during Storage Probed by Volatile Profiling: The Role of Glass Transition Temperature
Wainaina, I., Kyomugasho, C., Delbaere, S., Wafula, E., Van Loey, A., Sila, D., & Hendrickx, M. (2022). *Food Research International, 162*, 112102.

Abstract
During storage, common beans are susceptible to ageing leading to quality changes, in particular their cooking quality. In this study, kinetics of evolution of volatile compounds was assessed in order to gain insight into possible reactions occurring during ageing of beans. The evolution of volatile compounds of red kidney beans stored at varying conditions of temperature and moisture content relative to their glass transition temperature (Tg) were evaluated. Storage conditions highly influenced the evolution of volatile compounds whereby more volatile compounds and higher concentrations were detected in beans stored at higher temperature and moisture content. The volatile marker compounds identified are typical for protein degradation and lipid oxidation reactions, although for beans stored at the highest moisture contents (12.8 and 14.5%) the compounds obtained do not allow to exclude microbial activity. The rate of evolution of selected volatile marker compounds was highly correlated (benzaldehyde ($r = 0.58$), acetic acid ($r = 0.75$), 1-propano l,2-methyl ($r = 0.84$) and 2-butanone ($r = 0.89$)) with storage above Tg signifying that the rate and extent of these (bio)chemical reactions can be largely controlled by storing the beans at temperatures not exceeding 20 °C above their Tg. Volatile profiling showed to be an important approach to monitor quality changes of beans during storage by assessing the nature, rate and extent of (bio)chemical reactions occurring.

Key Words: Volatile compounds, Cooking quality, Kinetics, State diagrams

iCB 2022-04

Postharvest Treatments of Banana (*Musa acuminata* cv. 'Grand Nain', AAA) during Cold and Ripening Temperatures with Chitosan and Chitosan Nanoparticles to Alleviate Chilling Injury and Maintain Antioxidant Activity

Elbagoury, M. M., Turoop, L., Runo, S., Sila, D. N., & Madivoli, E. S. (2022). *Horticulture, Environment, and Biotechnology*, *63*(5), 677-699

Abstract

Banana (*Musa acuminate* cv. 'Grand Nain') is prone to chilling injury (CI) during cold storage, which limits extended storage and shelf life. In this study, we investigated the postharvest application of chitosan (CS) and chitosan nanoparticles (CSNPs) on the CI and quality of unpacked banana fruits during and after cold storage. CSNPs were synthesized using sodium tripolyphosphate (STPP), and analyzed using a Fourier infrared spectrophotometer (FT-IR) and a scanning electron microscope (SEM) to assess the changes in the functional groups and surface morphology. Reacting CS with STPP did not result in changes in the functional groups present but the size and morphology of CS were altered. For the treatments, banana fruits were dip coated in 0.5% (wt/vol) CS and 1.5 g/L CSNPs separately for 2 min in the presence of 1% Tween 80. The fruits were stored at 10 ± 2 °C or the optimal storage temperature of 14 ± 2 °C with relative humidity 85–90% for a 20-day period but subsets were transferred from cold storage on 5-day intervals to a storage rack to ripen at 22 ± 2 °C. The CI index, firmness, hue angle (H°), weight loss, total antioxidant activity (TAA) and total phenolic contents (TPC) were measured at each interval. Untreated fruits were used as a control. Application of CS or CSNPs reduced CI and weight loss but increased firmness, hue angle, TAA and TPC relative to the control samples. These results affirm that CS and CSNP applications maintain banana fruit quality by alleviating CI symptoms throughout cold and ripening temperatures.

Key Words: Nanoparticles, Firmness, Chilling injury, Antioxidant activity, Phenolic compounds

iCB 2022-05

Kinetics of Phytate Hydrolysis during Storage of Red Kidney Beans and the Implication in Hard-to-Cook Development

Wainaina, I., Wafula, E., Van Loey, A., Sila, D., Hendrickx, M., & Kyomugasho, C. (2022). *Food Research International*, *159*, 111581

Abstract

In this study, the kinetics of phytate (inositol hexaphosphate, $InsP_6$) hydrolysis by endogenous phytase in red kidney beans stored at varying conditions of temperature (25–42 °C) and moisture content (6.9–14.5%) was determined and the potential role in hard-to-cook (HTC) development was evaluated. In addition, the concept of glass transition temperature (T_g) was assessed and correlated against the rate of phytate hydrolysis. Under the conditions studied, phytate hydrolysis during storage was mainly influenced by storage temperature and time with limited influence of storage moisture content whereby the highest and lowest storage temperatures (42 °C and 25 °C) resulted in the highest and lowest hydrolysis rates (0.058 ± 0.003 and 0.003 ± 0.001 week^{-1}). Hydrolysis of phytate resulted in formation of lower inositol phosphates, inositol pentaphosphate ($InsP_5$) representing an intermediate whose concentration increased with storage time and temperature. The relationship between the rate of $InsP_6$ hydrolysis and storage above the overall

T_g ($T - T_g$) was moisture content dependent implying that this difference did not fully explain $InsP_6$ hydrolysis. Nevertheless, for each moisture content, the rates of $InsP_6$ hydrolysis during storage were strongly correlated ($r > 0.98$, $p < 0.05$) with rates of HTC development signifying that $InsP_6$ hydrolysis facilitates HTC development in beans.

Key Words: Inositol phosphates, Hydrolysis, Glass transition, HTC development rate

iCB 2022-06

Preferences and Willingness to Pay for Yogurt Product Attributes among Urban Consumers in Kenya

Ateka, J. M., Mbeche, R., Obebo, F., & Sila, D. (2022). *Journal of International Food & Agribusiness Marketing, 34*(4), 410-432.

Abstract

This paper assesses the preferences of yogurt attributes among urban consumers in Nairobi, Kenya. Data were collected through a survey of 190 urban consumers and analyzed using descriptive statistics and willingness to accept (WTA) regression models. The results show that preference for flavored yogurt was much stronger with fewer consumers (39%) willing to forgo the attribute compared to micronutrient fortification (45%), probiotic (46%), and real fruit yogurt (53%). The results also show that willingness to accept price reductions in order to forgo a preferred attribute was higher for nutrition compared to sensory attributes (such as taste and appearance). The findings indicate that in the face of numerous yogurt brands in the market, there is a need for targeted messaging on the nutritional value of yogurts. The paper uncovers the tradeoffs in preferences between sensory and nutritional attributes, a contribution that has received limited attention in the literature.

Key Words: Consumer preferences, Nutrition, Ordered probit, Willingness to accept, Yogurt.

iCB 2022-07

Storability of Irish Potato (Solanum tuberosum L.) Varieties Grown in Kenya, Under Different Storage Conditions

Gikundi, E. N., Buzera, A. K., Orina, I. N., & Sila, D. N**.** (2022). *Potato Research, 1*-22.

Abstract

Long-term use of fresh potatoes is constrained due to post-harvest losses and limited or poor storage systems. Loss of potato quality during storage is mostly due to weight loss, excessive sprouting, decaying, greening, pest attack and changes in sugar content which is a major concern for processors. The storability of three potato varieties namely Shangi, Unica, and Dutch Robijn was evaluated under four storage conditions: (1) room temperature (RT) (21.7 ± 5 °C) and ambient relative humidity (RH) (73.5 ± 6.7%); (2) 10 °C/75% RH; (3) 10 °C/ambient RH and (4) 7 °C/75% RH for 3 months. Parameters analysed included weight loss, sprouting, greening, rotting incidence and changes in simple sugars (sucrose, glucose and fructose) content. Shangi variety had the poorest storability having exhibited the highest weight loss, sprouting, greening and rotting rates among the varieties and in all storage conditions. In all the varieties, weight loss was highest at room temperature/RH (6.9–35.13%) and lowest at 7 °C/75% RH (1.6–3.7%). Sprouting rate was

highest at RT/RH (100%) and lowest at 7 °C/75% RH (2.0–45.2%). Greening incidence was highest at RT/RH (10.3–24.0%) and lowest at 7 °C/75% RH (2.0–16.1%). The tubers accumulated simple sugars during storage with the highest relative accumulation recorded at 7 °C/75% RH. Total reducing sugars increased by 3.8–9.3-fold at RT/RH to 26.0–68.5-fold at 7 °C/75% RH. Low-temperature storage minimized the rate of physical tuber deterioration with 7 °C/75% RH best preserving the potatoes' physical properties while it led to the highest accumulation of simple sugars.

Key Words: Potato, Sprouting, Storage, Sugars, Varieties, Weight

iCB 2022-08

Oligosaccharide and Antinutrient Content of Whole Red Haricot Bean Fermented in Salt–Sugar and Salt-Only Solutions

Kitum, V. C., Kinyanjui, P. K., Mathara, J. M., & Sila, D. N. (2022).
Legume Science, 4(2), e110.

Abstract

Common beans (*Phaseolus vulgaris* L.) are nutritious and confer numerous health benefits. However, they are also high raffinose family oligosaccharides (RFOs) and antinutrients. Appreciable amounts of RFOs and antinutrients remain after soaking and cooking, causing flatulence and lowered mineral bioavailability to bean consumers. Fermentation has been shown to lower RFOs and antinutrients in bean flours and milk. However, beans are majorly consumed as whole grains. The purpose of this study was to develop a protocol for fermenting whole common beans. We fermented boiled whole red haricot beans and evaluated their effect on RFOs, tannins, and phytates. A factorial research design was used. Beans were sorted, soaked for 15 h, and boiled for 1 h. The beans were then fermented in 2% salt–sugar solution (SSF) and 2% salt-only solution (SOF) for 120 h. Microbial growth and pH were monitored every 24 h during fermentation. After fermentation, the beans were dried, milled, and the flours subjected to biochemical analysis. Fermentation favored the growth of lactic acid bacteria (LAB), lowering the pH to 3.88 and 5.26 in SSF and SOF batches, respectively. Tannin content reduced significantly by 64.70% and 73.19% in the SSF and SOF batches, respectively. Phytates reduced by 58.88% and 68.85%, respectively. Raffinose reduced significantly by 96.40% and 95.01%, respectively, whereas stachyose reduced by 95.92% and 94.11%, respectively. The highest reduction of antinutrients and RFOs occurred between 24 and 72 h of fermentation. Higher antinutrient losses occurred in the SOF batch, whereas higher RFO losses occurred in the SSF batch.

Key Words: Santinutrients, Common bean, Fermentation, Raffinose Family Oligosaccharides

iCB 2022-09

An Integrated Kinetic and Polymer Science Approach to investigate the Textural Stability of Red Kidney Beans during Post-Harvest Storage and Subsequent Cooking

Wainaina, I., Kyomugasho, C., Wafula, E., Sila, D., & Hendrickx, M. (2022).
Food Research International, 154, 110988.

Abstract
Evaluation of food quality and stability during storage and processing necessitates understanding the kinetics of food functional property changes and the underlying reactions. In this study, textural stability of beans during storage and subsequent cooking was evaluated through an integrated kinetic approach. Red kidney beans stored for different periods at various conditions of temperature (25 °C – 42 °C) and moisture content (6.9% − 14.5%) relative to their glass transition temperature (T_g) (above and around the T_g) were studied in detail. Consequently, kinetics of softening during subsequent cooking were investigated and the dependence of these rate constants on storage time (representing the hard-to-cook (HTC) development rate) as a function of storage temperature and moisture content was evaluated. All parameters investigated, moisture content, temperature and storage time, had a significant ($p < 0.05$) influence on the cooking rate of beans. It was revealed that the HTC development rate of beans during storage increases with increase in temperature and moisture content, these parameters showing a synergistic effect. In addition, the rate of HTC development during storage of beans was controlled by the difference between storage temperature and T_g, showing the important role of glass transition in textural stability of beans during storage.

Key Words: Common beans, Texture evolution, Hard-to-cook, Glass transition, Cooking behavior, Kinetics

iCB 2022-10

Development of a Computer Model Simulation for Predicting the Performance of a Near Infrared Reflecting Charcoal Cooler for on Farm Storage of Mangoes

Korir, M. K., Mutwiwa, U., Kituu, G. M., & Sila, D. N. (2022, March). In *Proceedings of the Sustainable Research and Innovation Conference* (pp. 178-181).

Abstract
Mango (*Mangifera indica* L.) fruit is a valuable fruit in Kenya due to its nutritive value and economic importance. However, at least 40 to 45% of mango fruit is lost during post-harvest handling primarily due to inadequate storage facilities for mango fruit preservation. In this study an improved evaporatively cooled store was developed. The external surfaces of the cooler were sprayed with near infrared reflecting paint (NIR). The mixing ratio of NIR paint and water was 1:2. The dimensions of the cooler were 0.84m x 0.84m x 1.5m. The cooler had a storage space of 0.75m3 and was constructed from locally available materials including hardwood and charcoal. A 12V fan was used to draw air into the cooler. The charcoal was kept moist by water dripping by gravity from horizontally laid pipes on the roof. A computer simulation model for predicting the performance of the cooler was developed on java platform. The input parameters of the model were inlet air conditions, water conditions and charcoal cooler characteristics. The output parameters of the model included saturation efficiency, dry bulb temperature of the inlet air and cooling capacity. The predicted performance parameters of the cooler included saturation efficiency which ranges from 66.87% to 68.97%, dry bulb temperature of the outlet air which ranges from 24.54oC to 24.67oC and cooling capacity which ranges from 105726.44kW/h to 136680.9kW/h. The model results showed that saturation efficiency decreases with increase in inlet air velocity while the cooling capacity increases with increase in inlet air velocity.

Key Words: Computer model simulation, Mango fruits, Near infrared reflecting charcoal cooler

iCB 2022-11

Effect of Pretreatments and Drying Methods on Physical and Microstructural Properties of Potato Flour

Buzera, A., Gikundi, E., Orina, I., & Sila, D. (2022). *Foods*, 11(4), 507.

Abstract

This study evaluated the effects of pretreatments (blanching (60 and 95 °C) and boiling) and drying methods (freeze-drying and oven drying) on the quality characteristics of potato flour derived from three potato varieties, namely, Shangi, Unica, and Dutch Robjin. The percentage flour yield, color, particle size distribution, flow characteristics, microstructural and functional properties of the potato flour were determined. Unica recorded the least peeling loss, while the Dutch Robjin variety had the highest. Color parameters were significantly affected ($p < 0.05$) by the pretreatments and drying methods. Freeze drying produced lighter potato flour (L* = 92.86) compared to the other methods. Boiling and blanching at 95 °C followed by oven drying recorded a low angle of repose and compressibility index, indicating better flow characteristics. The smallest particle size (56.5 µm) was recorded for the freeze-drying treatment, while boiling followed by oven drying had the largest particle size (307.5 µm). Microstructural results indicate that boiling and blanching at 95 °C, followed by oven drying resulted in damaged starch granules, while freeze-drying and low-temperature blanching (60 °C) maintained the native starch granule. Particle size and the solubility index of potato flour showed strong positive correlation. This study revealed that the pretreatments and drying methods affected potato flour's physical and microstructural parameters differently, resulting in changes in their functionality.

Key Words: Potato flour; Pretreatments; Drying methods; Particle size distribution; Flow characteristics; Microstructural properties

iCB 2022-12

Evolution of Microbial Communities and Nutritional Content of Fermented Amaranthus sp. Leaves

Misci, C., Taskin, E., Vaccari, F., Dall'Asta, M., Vezzulli, F., Fontanella, M. C., Bandini, F., Imathiu, S., Sila, D., Bertuzzi, T. and Cocconcelli, P.S., & Puglisi, E. (2022). *International Journal of Food Microbiology*, *362*, 109445.

Abstract

Amaranth (*Amaranthus* sp.) is a promising indigenous leafy vegetable plant capable of contributing to food security in sub-Saharan Africa, thanks to its adaptability to diverse soils and its drought tolerance. Its edible parts such as leaves are characterized by high nutrient content. Food losses along the supply chain due to spoilage, however, especially of fresh produce is a challenge facing most of the sub-Saharan African countries in tackling food insecurity in the region. This calls for innovative yet inexpensive solutions such as natural fermentation to preserve the quality and safety of the commodity. To demonstrate the feasibility of natural fermentation in the preservation of vegetable amaranth, leaves were submerged (1:0.5 w/v) in distilled water with 3% sucrose and 3% NaCl dissolved. Control batches were prepared using only distilled water

(1:0.5 w/v) with amaranth leaves. Samplings of both treated leaves and controls occurred at 0, 24, 48, 72, and 168 h to measure the pH and determine microbial population changes using culture and molecular-based techniques. Furthermore, the effects of treatment on nutritional content were assayed at the end of the process to determine the levels of B-group vitamins, β-carotene, lutein, and anti-nutrient phytic acid from unfermented fresh air-dried and 3% sucrose and 3% NaCl treated amaranth leaves. Finally, a visive and olfactive analysis was carried out to evaluate the acceptability of the final product. The significant drop of pH and the correct growth of *Lactobacillaceae* occurred only in treated batches, although *Lactococcus* was found in both treated and control samples. Furthermore, mean counts observed on selective media for controls and molecular high-throughput sequencing (HTS) analyses confirmed that in control samples, the undesired bacteria represented more than 60% of the microbial population. In treated amaranth leaves the amount of thiamin, riboflavin, vitamin B_6, β-carotene and lutein content were higher compared to the fresh unfermented air-dried leaves, and phytic acid content diminished after 7-days treatment. These findings suggest that treatment of amaranth leaves using 3% sucrose and 3% NaCl does not only preserve the commodity by arresting the growth of undesired microorganisms involved in spoilage and fosters the lactic acid bacteria but also improves the nutritional content of the fermented end product that has been warmly welcomed by panelists.

Key Words: Lactic acid fermentation, High-throughput sequencing, Lactic acid bacteria, Sub-Saharan Africa, Amaranth

iCB 2022-13

Enhancing Partnerships for Industry-led Vocational Training and Education (e-pivot) in the Horticulture Value Chains of Kenya

Odhiambo, R. O., Masinde, P., Arimi, J., Owiti, B., Maitethia, D., Nawiri, P., Wesonga, J., De Groote, B. & Koomen, I. (2022). *African Journal of Science, Technology and Social Sciences*, *1*(1).

Abstract

Horticulture is the fastest growing sub-sector in Kenya. It is expected to contribute the most towards the envisioned poverty reduction, and overall food security. It is generally a labour-intensive industry with high demand of skilled workers, trained supervisor and professional managers. Over six million Kenyans are directly and indirectly employed in horticulture, women constitute 75% of the labour force in the horticulture industry. Some of the limiting factors to the sector are availability of water and climate change. The current ATVETs and associated education institutions have a very general focus and there is lack of specialized workforce in horticulture. Through a consortium of 6 ATVETS and MUST we aimed to close those gaps, strengthening the capacity of the ATVETs through a strong collaboration between the education institutions and the private sector, strengthening linkages among the various actors to enable practical learning and innovation in the horticulture sector. This is being done through integrating the curriculum for horticulture, water and climate to suit the needs of the students and tailoring it to the local context. Each of the participating colleges invested in hands-on training through dedicated agricultural innovation hubs and creating strong links with the local stakeholders. To compliment curricula developed by the Curriculum Development Assessment and Certificate Council (CDACC), training manuals have developed for selected courses. The manual provides a practical way of

integrating competence based training principles. In addition, tutors have been trained to enhance their capacity to design, deliver and evaluate competence based education. Problem based learning in the Kenyan context as well as joint learning session between Kenyan and Dutch students are non-traditional pedagogy methodologies being explored. While the project is still ongoing working in a consortium led by MUST is highly beneficial to the colleges and surrounding communities, and the quality of the teaching. There has increased interactions between the ATVET tutors and partners within the partnerships created by the project. Additionally, the ATVETs also created more partnerships relevant to their training and practical work.

Key Words: Competence based education, Problem based learning, Internationalization, Horticulture, CBC, CBE

iCB 2022-14

IoT Based Smart Irrigation System for Communal Use

Maitethia, D., Arimi, J., Odhiambo, R. O., Masinde, P., Owiti, B., Nawiri, P., P., Wesonga, J., De Groote, B. & Koomen, I. (2022).

African Journal of Science, Technology and Social Sciences, 1(1).

Abstract

Kenya is experiencing a rapid human population growth and consequently rising demand for food. This is happening at the backdrop of adverse climatic changes currently being experienced. The problem is further aggravated by the fact that more than 80% of the country's landmass is classified as Arid and Semi-Arid Lands (ASALs). In order to meet the food demand, there is need to divorce from rain-fed agriculture and put most of the arable land under irrigation. Since Kenya is a water scarce country, efficient irrigation systems are required. An efficient irrigation system that promotes use of rain water harvesting technologies and maximizes crop water productivity through use of appropriate sensors and wireless communication technology has been developed. The innovation involves use of farmers' earth pans for harvesting and storing rain water and irrigating fields through drip lines. In addition, smart soil moisture sensors are fitted to each field under irrigation for real-time monitoring of soil moisture content and automatically notifying an irrigation administrator through mobile phone when crops require watering. The administrator is equipped with a tricycle fitted with solar powered water pumping system for pumping water from the earth pan to the crops. When the operator receives a signal request from water sensors in field he/she moves with the tri-cycle and services it. The smart sensors (IoT based) installed in the field will then notify him/her when sufficient amount of water has been received so that irrigation can be stopped. The operator waits for the next request from another farmer's field to service. The technology has been tested in different portions of the university land under irrigation. The results indicate that crops receive timely watering and show no water stress. The innovation has the potential of making high tech irrigation system accessible to small scale farmers at an affordable cost and enhance food production and in turn food security in the country.

Key Words: IoT, Smart Irrigation systems, Soil moisture sensors

iCB 2022-15

Agronomic Performance of Kale (*Brassica oleracea*) and Swiss Chard (*Beta vulgaris*) Grown on Soil Amended with Black Soldier Fly Frass Fertilizer under Wonder Multistorey Gardening System

Abiya, A. A., Kupesa, D. M., Beesigamukama, D., Kassie, M., Mureithi, D., Thairu, D., Wesonga, J., Tanga, C. M. & Niassy, S. (2022). *Agronomy*, *12*(9), 2211.

Abstract

The wonder multistorey garden (WMSG) is an innovative vertical farming system tailored for urban settings that can be constrained by the irrigation regime, and by types and levels of fertilizer application. This study evaluated the effects of applying NPK fertilizer and black soldier fly frass fertilizer (BSFFF) under different irrigation regimes on the growth, yield, and pest infestation of kale (*Brassica oleracea*) and Swiss chard (*Beta vulgaris*). The fertilizers were applied at rates equivalent to 371 kg N ha^{-1}. For each crop, the BSFFF or NPK was applied to supply 100% of the N required (100% BSFFF), and then a combination of BSFFF and NPK was applied so that each fertilizer supplied 50% of the N required (50% BSFFF + 50% NPK). Crops' water requirements were provided using three irrigation regimes: daily, every two days, and every three days. The control treatment was not amended with any fertilizer, while water was provided ad libitum. The results revealed that the irrigation regime significantly affected the leaf production of both vegetables. Irrigation regimes significantly influenced kale plant height, where plants provided with water daily achieved the highest average heights of 20 cm, 46 cm, and 54 cm at 14, 28, and 42 days after transplanting (DAT), respectively. Furthermore, the application of 100% BSFFF produced kale with significantly higher plant heights (55 cm) and number of leaves (9.9 leaves) at 42 DAT compared to other treatments. The interaction between irrigation regimes and fertilizer significantly influenced kale height at 14 DAT and 42 DAT. Use of daily irrigation regime and 100% BSFFF produced the tallest kale plants of 59 cm at 42 DAT. Application of 50% BSFFF + 50% NPK or 100% BSFFF with daily irrigation achieved the highest values of kale and Swiss chard leaf chlorophyll concentration, recorded at 42 DAT. Fertilizer application significantly affected pest population, with the lowest pest infestation being recorded from kale and Swiss chard grown in soil amended with BSFFF. The application of 100% BSFFF or NPK, together with daily irrigation, significantly increased the fresh shoot weight and leaf dry matter of kale and Swiss chard, as compared with the control. The fresh shoot yields of kale and Swiss chard achieved through using a combination of 100% BSFFF and daily irrigation were 14–69% and 13–56% higher than those of NPK, respectively. The same treatment combination also produced kales and Swiss chard with 8–73% and 16–81% higher leaf dry matter compared to NPK, respectively. It was noted that soil amendment with BSFFF maintained higher values of kale (41–50%) and Swiss chard (33–49%) leaf dry matter compared with NPK treatments, during periods of water stress. Our study has demonstrated the high potential of single (100% BSFFF) or combined applications of BSFFF (50% BSFFF + 50% NPK) with a daily irrigation regime to improve the growth, yield, and pest management in Swiss chard and kale under vertical farming. Our study advocates for the scaling of WMSG and BSFFF for sustainable food systems in urban settings.

Key Words: Vertical farming innovation; Urban agriculture; Organic vegetable; Insect frass fertilizer; Irrigation scheduling; Food security

iCB 2022-16

Co-creation of a Scalable Climate Service for Kenyan Smallholder Farmers

Van Der Horst, S., Goosen, H., Van Selm, M., Koomen, I., Matsaba, E. O., Wesonga, J., & Koge, J. (2022). *Frontiers in Climate*, *4*, 48.

Abstract

Climate change is already impacting the horticulture sector in Kenya. Even though the effects of climate change will be severe, adaptation to climate change still has little priority at the local and county level. This paper discusses the development of the agricultural climate atlas for Kajiado and Kiambu counties in Kenya as a climate information service to support the horticulture sector. This climate service for smallholder farmers aims to bridge the gap between climate research and data provision and the uptake by farmers and farmer organizations on the ground. Rather than developing a generic service for the whole of the country, we followed a local, bottom-up approach. Working at the county level, we tried to capture local needs. The result is a co-created atlas for two counties, for specific crops. The approach can be scaled up to other counties and other crops. We elaborate on our approach, and discuss lessons learned, challenges, and future work opportunities. The development of the climate atlas shows the importance of co-creation and user engagement. In addition, flexibility in the output and process was crucial. The main challenge remains to keep engagement high after completion of the project.

Key Words: Kenya, Climate services, Horticulture, Adaptation, Smallholder farmers, Climate change, Climate atlas

iCB 2022-17

Biocontrol Potential of Chitin and Chitosan Extracted from Black Soldier Fly Pupal Exuviae against Bacterial Wilt of Tomato

Kemboi, V. J., Kipkoech, C., Njire, M., Were, S., Lagat, M. K., Ndwiga, F., Wesonga, J. M. & Tanga, C. M. (2022). *Microorganisms* 2022, *10*, 165.

Abstract

Globally, *Ralstonia solanacearum* (Smith) is ranked one of the most destructive bacterial pathogens inducing rapid and fatal wilting symptoms on tomatoes. Yield losses on tomatoes vary from 0 to 91% and most control measures are unaffordable to resource-poor farmers. This study investigated the antimicrobial activities of chitin and chitosan extracted from black soldier fly (BSF) pupal exuviae against *R. solanacearum*. Morphological, biochemical, and molecular techniques were used to isolate and characterize *R. solanacearum* for in vitro pathogenicity test using disc diffusion technique. Our results revealed that BSF chitosan significantly inhibited the growth of *R. solanacearum* when compared to treatments without chitosan. However, there was no significant difference in the antibacterial activities between BSF and commercial chitosan against *R. solanacearum*. Soil amended with BSF-chitin and chitosan demonstrated a reduction in bacterial wilt disease incidence by 30.31% and 34.95%, respectively. Whereas, disease severity was reduced by 22.57% and 23.66%, when inoculated tomato plants were subjected to soil amended with BSF chitin and chitosan, respectively. These findings have demonstrated that BSF pupal shells are an attractive renewable raw material for the recovery of valuable products (chitin and chitosan) with promising ability as a new type of eco-friendly control measure against bacterial

wilt caused by *R. solanacearum*. Further studies should explore integrated pest management options that integrate multiple components including insectbased chitin and chitosan to manage bacterial wilt diseases, contributing significantly to increased tomato production worldwide.

Key Words: Tomato bacterial wilt disease; Insect pupal shell; Organic soil amendment; Integrated Pest Management; *Ralstonia solanacearum*

iCB 2022-18

Understanding the Nexus between Forest Dependence and Willingness to Pay for Forest Conservation: Case of Forest Dependent Households in Kenya

Waruingi, E., Ateka, J., Mbeche, R., & Herrmann, R. (2022). Forestry Economics Review, (ahead-of-print). DOI 10.1108/FER-02-2022-0003

Abstract

Purpose: Forests support human livelihoods and mitigate against climate change, yet they are at a risk of irreversible loss due to high degradation rates. The success of forest conservation mechanisms depends on involvement and support by forest dependent communities. In this paper, the authors assess forest dependent household's willingness to pay (WTP) labour or cash for a conservation programme seeking to restore degraded forestland in Mount Elgon Forest, Kenya.

Design/methodology/approach: Data were collected from 919 households in Mt Elgon forest reserve, Kenya. A double bounded contingent valuation approach was used to examine households' WTP and an ordered probit model to estimate the determinants of WTP.

Findings: The findings of the study show a higher WTP for conservation through labour days (12 days/month, equivalent to 1800 KES/month) compared to cash (KES 450/month). Forest dependence has a significant influence on households' willingness to support conservation activities. A higher WTP was observed amongst households with higher vulnerability (high shocks value, low asset value and those in the poorest wealth categories) implying that they are more willing to contribute for forest conservation.

Originality/value: While emerging literature on WTP for forest conservation is growing, few studies have paid attention on the influence of forest dependence on WTP for forest conservation. There are limited studies on use of in-kind contribution as a payment vehicle for WTP. The study's findings show a high WTP in form of labour suggesting the importance of embracing in-kind contribution as a mechanism of supporting forest conservation in contexts of developing countries.

Key Words: Contingent valuation, Ecosystem restoration, Willingness to pay, Forest dependence

iCB 2022-19

To Sell or Store? Assessing Smallholder Farmers' Willingness to Pay for Potato Cold Storage in Kenya

Ateka, J. M., & Mbeche, R. (2022). *Food and Energy Security*, e439.

Abstract

Storage of food commodities for some time after harvest can play an important role in alleviating the downside of price fluctuations in developing countries. While storage can offer smallholder farmers substantial inter-temporal arbitrage opportunities, existing evidence shows that many farmers in developing countries store little of their harvest. Using a cross sectional survey of 502

households in Nyandarua and Bomet Counties of Kenya, this paper assessed smallholder farmers' willingness to pay (WTP) for cold storage and compares their WTP with the arbitrage opportunities. Our results reveal that the storage of potato was generally limited with only 26% storing in the season preceding the study. Using a hypothetical scenario with double-bounded contingent valuation formats, our findings show that a considerable proportion of households (70.7%) were willing to rent cold storage facilities. The WTP for storing a 90 kg bag of Shangi, a common variety with a short shelf life (1 month) was Kenya shillings (KES) 104 (1.16/kg/month) compared KES 96.4 (1.07/kg/month) for the Unica variety (slightly longer shelf life). The probit model results show that gender (being female), and transaction costs associated with access to markets (e.g., geographical location and distance to the road) were positively associated with WTP. Furthermore, household endowment, reflected in household expenditure, income and level of potato commercialization had a positive influence on WTP to store. In addition, institutional characteristics of collective action, previous experience with storage and use of certified seed (often associated with extension) enhanced households WTP for potato storage. The results on potato prices over a 5-year period (2014–2019) show that seasonal price gaps were higher than the estimated WTP, suggesting that potato storage could be economically viable. These findings have significant policy implications not only for commodities whose harvest is perishable and season bound (e.g., vegetables, fruits) where arbitrage may offer price stabilization.

Key Words: Arbitrage, double- bounded contingent valuation, ordered probit, potato cold storage, price fluctuation, willingness to pay

iCB 2022-20

Smallholder Farmers' Intention to Use Insect-based Feed in Dairy Cattle Diet in Kenya

Odinya, D. W., Ateka, J. M., Mbeche, R. M., & Gicheha, M. G. (2022).
International Journal of Tropical Insect Science, *42*(6), 3695-3711.

Abstract

Limited access to good quality, adequate and affordable livestock feed impose a major challenge to livestock production in developing countries. In order to improve access to good quality and adequate livestock feed, policymakers, practitioners, and researchers are promoting the utilization of alternative feed sources. While insects have been promoted as an alternative source of protein, their production and utilization is low across smallholder livestock systems in sub-Saharan Africa. This study assessed smallholder farmers' intention to use insect-based feed to supplement dairy cattle diets in Murang'a County in Kenya. The study employed the Theory of Planned Behaviour (TPB) and collected data from a random sample of 378 dairy farming households. A heteroscedastic probit (hetprobit) regression model was used to assess determinants of smallholder dairy farmers' intention to use insect-based feed. Findings show that while only a small proportion of dairy farmers (11%) were aware of the use of insects as an alternative source of livestock feed, a considerable proportion (76%) were willing to use insect-based feed when they become available. The results of the hetprobit model revealed that the three TPB constructs; attitude, subjective norm and perceived behavioural control positively and significantly determined the likelihood of farmers' intentions to use insect-based feed. Of the three constructs, attitude had the highest influence on the farmers' intention to utilise insect-based feed, followed by perceived behavioural control and subjective norms. While age of the farmer, flock size, access to extension

services and wealth status were positively associated with farmers' intention to use insect-based feed, gender (being a male-headed household) of the farmer and farming experience had a negative influence on the likelihood of farmers' intention. The study discusses the implications of these findings in scaling up the production and utilization of sustainable alternative protein feed sources.
Key Words: Livestock feed, Alternative protein sources, Insect-based feed, Theory of planned behavior, Hetprobit model

iCB 2022-21

Determinants of Irish Potato (*Solanum tuberosum*) Commercialization and Market Participation by Farmers in Nyandarua County, Kenya

Wakaba, D., Ateka, J., Mbeche, R., & Oyugi, L. (2022). *Journal of Agriculture and Food Research*, *10*, 100382.

Abstract

Agricultural commercialization has been promoted as a pathway for enhancing household welfare in developing countries. This paper assesses the extent and determinants of commercialization among smallholder potato farming households in Nyandarua County, Kenya. Data were collected through a survey of 388 potato-producing households and analysed using a crop commercialization index (calculated as a share of the value of produced potato that is marketed) and the Tobit regression model. The average commercialization index was 0.4, implying that only a smaller share of the produced potato is marketed. The extent of potato commercialization varied across gender, education level, productivity, size of potato plots, and farmers' knowledge of production and marketing. The findings also show that household characteristics (such as gender (being male), age, education of the household head, household income) and transaction costs (such as distance to the market) negatively influenced potato commercialization. Conversely, the scale of potato production, knowledge of potato production and marketing, participation in Farmer Field Business School (FFBS) and group membership were positively associated with potato commercialization. Based on the findings, interventions to strengthen women's empowerment and the institutional arrangements for collective action and extension are encouraged.

Key Words: Agricultural commercialization, Market participation, Potato, Tobit model, Kenya

iCB 2022-22

Comparing Farmers' Willingness to Pay with Costs of Clean Sweet Potato Seed Multiplication in Kenya

Mwangi, C. W., Ateka, J., Mbeche, R., Oyugi, L., & Ateka, E. (2022). *Food Security*, *14*(5), 1279-1293.

Abstract

The production of sweet potato has the potential to address food insecurity and malnutrition in the context of climate change. However, sustainable production of sweet potato is hampered by poor access to quality seed. We assess the level and determinants of farmers' willingness to pay (WTP) for clean seed among smallholder sweet potato farmers and compare the estimated WTP with the cost of seed multiplication. Data for the paper were collected from 383 sweet potato farmers and 30 sweet potato seed multipliers in Kenya. WTP was estimated using the double bounded contingent valuation method while the determinants of WTP were analysed using an ordered probit

regression model. Results show that the mean WTP for clean seed was KES 578.94 (about US$ 5.68) for a 90 kg bag with variations in WTP observed across geographical regions and prior use of clean seed. Results further show that WTP increases with prior use of clean seed and experience in sweet potato production. The net cost of clean seed multiplication was KES. 444.81 (US$ 4.36), which is lower than the estimated WTP. These results suggest that seed multiplication business may be economically viable but this will depend on other transaction costs and establishment of efficient distribution systems.

iCB 2022-23

Gender Differentials in Value Addition and Lean Season Market Participation in the Grasshopper Value Chain in Uganda

Donkor, E., Mbeche, R., & Mithöfer, D. (2022). *Food and Energy Security*, *11*(3), e411.

Abstract

Gender gaps in agrifood value chains are manifested in differential access to and control of productive resources, upgrading activities, market participation, farm productivity and food security among women and men. These gender gaps threaten economic development in sub-Saharan Africa. With low-resource requirements, edible insects have emerged as a promising agrifood value chain with income opportunities for women and men. However, it is not clear how gender gaps are manifested in the participation in value addition and lean season market of the edible insect value chain with a potential to improve household welfare. In this paper, we analyse the gender gaps of retailers' participation in value addition and lean season market in the grasshopper value chain in Uganda. Multivariate probit and tobit models are used in the empirical analyses. We find that women are 15% more likely to participate in primary value addition. However, there are no gender gaps in the participation in secondary value addition and the lean season market. The study also shows that grasshopper business is an important source of income for many retailers. Therefore, the development of the grasshopper value chain, especially the aspects of value addition and lean season market, could contribute to gender equality and improvement of livelihoods of women and men.

Key Words: Agrifood sector, edible insect value chain, food security, gender gap, upgrading strategies, value addition

iCB 2022-24

The Influence of Privatised Agricultural Extension on Downward Accountability to Smallholder Tea Farmers

Mbeche, R. M., Mose, G. N., & Ateka, J. M. (2022). *The Journal of Agricultural Education and Extension*, *28*(3), 341-362.

Abstract

Purpose: To assess the extent to which privatised extension service, which is premised to be demand-driven, delivers downward accountability to smallholder farmers who are both owners and users of agricultural services.

Design/methodology/approach: The research collected data through focus group discussions with smallholder tea farmers and key informant interviews after which the information were corroborated with semi-structured interviews with 104 smallholder farmers.

Findings: Our findings show that KTDA (Kenya Tea Development Agency) extension service has in recent years embraced methodologies that allow two-way information exchange and farmers' involvement in planning, implementing and evaluation of extension programmes. While this transition has provided opportunities for increased accountability and empowerment of smallholder farmers, downward accountability is limited by among others; presence of multiple accountabilities, a heavy top-down governance structure, higher incentives for upward accountability, limited resourcing of extension delivery, excessive workload and unrealistic targets on the part of extension staff and weak extension–research–farmer linkages.
Practical implications: The findings of this study may be used by policymakers, extension practitioners and organisations delivering extension services to improve downward accountability and quality of advisory services
Theoretical implications: The paper contributes to the debate on outcomes of privatisation on extension provision using the accountability lens in an area dominated by perceptions on costs and payment for the services.
Originality/value: The literature on downward accountability on privatised extension services is lacking. The paper also extends the framework for assessing the performance of pluralistic extension services to develop and apply a framework for assessing downward accountability in privatised extension.

Key Words: Privatised extension, Downward accountability, Smallholder farmers, Tea, KTDA, Kenya

iCB 2022-25

Determinants of Adoption of Climate Smart Agricultural Technologies among Potato Farmers in Kenya: Does Entrepreneurial Orientation Play a Role?

Andati, P., Majiwa, E., Ngigi, M., Mbeche, R., & Ateka, J**.** (2022). *Sustainable Technology and Entrepreneurship*, *1*(2), 100017.

Abstract

Climate-smart agriculture (CSA) is an important strategy for supporting farmers against climate change challenges. However, CSA adoption among smallholder farmers particularly in Sub-Saharan Africa (SSA) remains low. This article investigates the factors that influence CSA adoption among smallholder potato farmers in Nyandarua County, Kenya. We specifically focus on the role of the farmers' entrepreneurial orientation (reflected in the farmers' innovativeness, proactiveness, and risk-taking), a contribution that has received limited research attention. Data were collected through a cross-sectional survey of 350 potato farming households and analyzed using descriptive statistics, principal component analysis (PCA) and a multivariate probit regression model. Based on PCA analysis, the study considered six categories of CSA practices; soil nutrient management, crop management, crop protection, seed management, water harvesting, and crop quality improvement. The multivariate probit results show that farmers' entrepreneurial orientation had mixed influence on CSA adoption. While farmers' innovativeness had a positive influence on crop management and improvement practices uptake, its influence on water harvesting technologies was negative. Similarly, proactive farmers were more likely to adopt seed management practices, whereas risk-takers were more likely to adopt protection and water harvesting technologies. Potato producers' willingness to engage in seed multiplication was linked

to use of crop protection, seed management, and water harvesting technologies, indicating a path that could help potato farmers' access clean seed. Other important factors influencing CSA adoption included access to financing through mobile-based applications, gender, land size, trust in extension officers, household income, and farm characteristics. The study discusses the implications of these findings.

Key Words: Climate change, Climate-smart agriculture, Entrepreneurial orientation, Potato farming, Multivariate probit

iCB 2022-26

Transparency and Community Participation in Forest Resource Governance in Mt. Elgon Region, Kenya

Wanjala, P., Mbeche, R., & Hitimana, J. (2022). *Journal of Forests, 9*(1), 9-20.

Abstract

The practice of good forest governance has been associated with reductions in poverty and community empowerment. This study assessed how the implementation of transparency and participation promote forestry practices under the plantation establishment for livelihood improvement scheme (PELIS) in the Mt. Elgon region. A sample size of 288 members of the Community Forest Associations (CFAs) and forest station managers drawn from three forest stations namely Saboti, Kimothon and Kaberwa were selected for the study. Focused group discussions and interviews administered through respondent assisted questionnaires were carried out to assess how the implementation of transparency and participation affect participants in PELIS. Local indicator variables were developed to assess transparency and participation. Chisquare tests of independence ($\alpha = 0.05$) were performed to examine the relationship between the local indicator variables among sites based on the hypotheses that there were no significant differences in the implementation of transparency and participation among the sites. The study found statistical significance in accessibility to necessary information and decisions ($p = 0.001$) and involvement in decision-making processes ($p = 0.002$). Electoral related vices, conflicts and minimal women representation in executive committees undermines CFAs governance. The findings of this study indicates that CFAs governance systems directly affect forest conditions. The study generates information to support the formulation of policies and laws that can strengthen governance systems to minimize developmental deficits among CFAs and enhance socio-economic stability. Improved governance of CFAs will contribute in implementing agroforestry programmes that promote sustainable forest management in Kenya.

Key Words: Transparency, Participation, Forest governance, PELIS system, PES, Participatory forest management.

iCB 2022-27

Isolation and Characterization of *Bacillus velezensis* from Lake Bogoria as a Potential Biocontrol of *Fusarium solani* in *Phaseolus vulgaris* L.

Wekesa, T. B., Wekesa, V. W., Onguso, J. M., Wafula, E. N., & Kavesu, N. (2022). *Bacteria, 1*(4), 279-293.

Abstract

The common bean (*Phaseolus vulgaris* L.) is a significant vegetable crop, grown because it is a rich source of protein, carbohydrates, and vitamin B complex. *Fusarium solani* and *Rhizoctonia solani* are the most widely known pathogens contributing to large yield losses for this crop. The use of cultural and chemical control practices has been ineffective. Therefore, a sustainable, affordable, and effective control method is urgently required. In this study, we aimed to isolate and characterize *Bacillus velezensis* from Lake Bogoria as a potential biocontrol agent for *Fusarium solani*. Bacteria were isolated from soil and sediments using the serial dilution technique. Molecular characterization was performed using the 16S rRNA gene. A total of 13 bacteria were isolated from soil and sediments. Based on the partial sequences, BLAST analysis showed two isolates, B20 (*Bacillus velezensis strain* QH03-23) and B30 (*Bacillus velezensis strain JS39D*), belonging to *Bacillus velezensis*. Other isolates were identified as *Bacillus tequilensis*, *Brevibacillus brevis*, *Bacillus subtilis*, *Bacillus amyloliquefaciens*, and *Bacillus licheniformis*. The effectiveness of their antifungal properties was determined via co-culturing, and we found mycelial inhibition rates of 28.17% (for B20) and 33.33% (for B30) for the *Fusarium solani* isolates. The characterization of the *Bacillus velezensis* strain revealed that they were Gram-positive and grew well at pH 7.0 and 8.5, although growth was recorded at pH 5.0 and 10.0. In terms of temperature, the optimal temperature conditions were 30−35 °C, with an optimum salinity of 0–0.5 M NaCl. When these isolates were tested for their ability to produce secondary metabolites, they were found to produce phosphate, pectinase, chitinase, protease, indole -3- acetic acid (IAA), and hydrogen cyanide (HCD), making them potential biocontrol agents.

Keywords: Isolation; Bacillus velezensis; Fusarium solani; Biocontrol; Characterization

iCB 2022-28

Potential of Pseudarthrobacter Chlorophenolicus BF2P4-5 as a Biofertilizer for the Growth Promotion of Tomato Plants

Issifu, M., Songoro, E. K., Onguso, J., Ateka, E. M., & Ngumi, V. W. (2022).
Bacteria, *1*(4), 191-206.

Abstract

BF2P4-5 was isolated from the rhizosphere soil of tomato plants, and its potential to promote plant growth was investigated in tomato plants. An in vitro test revealed that the strain could fix nitrogen, solubilize phosphate and potassium, and synthesize indole acetic acid. The bacterial strain was identified and characterized as a kind of *Pseudarthrobacter chlorophenolicus* based on the analysis of culture characteristics, physiological and biochemical characteristics, and 16S rRNA gene sequence (GenBank accession number OP135548.1). pH 7.0, 15% NaCl, and 35 °C temperature were ideal for optimal strain growth under culture conditions. Tomato plants grown on a cocopeat substrate were inoculated with BF2P4-5 suspension (OD_{600} 2.0). Positive control plants were inoculated with Nitrogen Phosphorus Potassium (NPK) fertilizer. This BF2P4-5 strain and NPK treatments were complemented with a negative control, in which only tap water was applied to tomato roots, thus, establishing three distinct treatment modalities with five replications each. Two months of greenhouse trials of inoculated tomato plants improved growth parameters. Interestingly, in most of the growth metrics evaluated, tomato plants treated with strain BF2P4-5 showed little to no variation with NPK fertilizer treatment, including plant height, stem length,

girth, leaf number per plant, and chlorophyll content, when compared to uninoculated plants. Furthermore, the conditions for the cocopeat plants, including pH, EC, and moisture, were within acceptable limits. Furthermore, inoculation with BF2P4-5 increased the nitrogen, phosphorus, and potassium content available in the cocopeat medium. The results showed that the strain exhibited traits for the promotion of plant growth and could be deployed as an eco-friendly microbial biofertilizer for tomatoes and probably other essential crops.

Keywords: *Pseudarthrobacter chlorophenolicus*; NPK fertilizer; Microbial biofertilizer; Cocopeat; Tomatoes

iCB 2022-29

Culturable Bacterial Endophytes Associated with Shrubs growing along the Draw-down Zone of Lake Bogoria, Kenya: Assessment of Antifungal Potential against *Fusarium solani* and Induction of Bean Root Rot Protection

Mutungi, P. M., Wekesa, V. W., Onguso, J**.**, Kanga, E., Baleba, S., & Boga, H. I. (2022). *Frontiers in Plant Science, 12*, 3394.

Abstract

Vascular shrubs growing along the draw-down zones of saline lakes must develop adaptive mechanisms to cope with high salinity, erratic environmental conditions, and other biotic and abiotic stresses. Microbial endophytes from plants growing in these unique environments harbor diverse metabolic and genetic profiles that play an important role in plant growth, health, and survival under stressful conditions. A variety of bacterial endophytes have been isolated from salt tolerant plants but their potential applications in agriculture have not been fully explored. To further address this gap, the present study sought to isolate culturable bacterial endophytes from shrubs growing along the draw-down zone of Lake Bogoria, a saline alkaline lake, and examined their functional characteristics and potential in the biocontrol of the bean root rot pathogen, *Fusarium solani*. We collected shrubs growing within 5 m distance from the shoreline of Lake Bogoria and isolated 69 bacterial endophytes. The endophytic bacteria were affiliated to three different phyla (*Firmicutes*, *Proteobacteria*, and *Actinobacteria*) with a bias in the genera, *Bacillus*, and they showed no tissue or plant specificity. All selected isolates were positive for catalase enzyme grown in 1.5 M NaCl; three isolates (B23, B19, and B53) produced indole acetic acid (IAA) and only one isolate, B23 did not solubilize phosphate on Pikovskaya agar. Isolates, B19 and B53 exhibited more than 50% of mycelial inhibition in the dual culture assay and completely inhibited the germination of *F. solani* spores in co-culture assays while two isolates, B07 and B39 had delayed fungal spore germination after an overnight incubation. All isolates were able to establish endophytic association in the roots, stems, and leaves of been seedlings in both seed soaking and drenching methods. Colonization of bean seedlings by the bacterial endophytes, B19 and B53 resulted in the biocontrol of *F. solani* in planta, reduced disease severity and incidence, and significantly increased both root and shoot biomass compared to the control. Taxonomic identification using 16S rRNA revealed that the two isolates belong to *Enterobacter hormaechei* subsp., *Xiangfangensis* and *Bacillus megaterium*. Our results demonstrate the potential use of these two isolates in the biocontrol of the bean root rot pathogen, *F. solani* and plant growth promotion.

Keywords: Lake Bogoria, salinity, endophyte, Bacillus megaterium, Enterobacter hormaechei, biocontrol, growth promotion

iCB 2022-30

Identification and in vitro Characterization of Plant Growth-promoting Pseudomonas spp. Isolated from the Rhizosphere of Tomato (*Lycopersicum esculentum*) Plants in Kenya

Issifu, M., Songoro, E. K., Niyomukiza, S., Ateka, E. M., Onguso, J., & Ngumi, V. W. (2022). *Universal Journal of Agricultural Research, 10(*6), 667 - 681. DOI: 10.13189/ujar.2022.100608.

Abstract

The rhizosphere is a rich environment for microbial communities and plays a crucial role in many plant-microbe interactions. This research aimed to isolate, identify, and in vitro characterize plant growth-promoting Pseudomonas species from the rhizosphere of field-grown tomato plants. Twenty-five soil samples were taken from tomato plants grown under various management conditions, isolated with population densities greater than 104 cells g-1 and obtained from N-free semisolid media. Important plant growth-promoting processes in vitro were identified and defined in the ten bacterial strains, which were then phylogenetically classed. Screening for their PGP properties revealed that seven (18%) isolates exhibited nitrogen-fixing ability in solid medium, nine (24%) isolates were able to solubilize phosphate, and five (13%) isolates were able to produce hydrogen cyanide. Only one isolate (3%) was capable of synthesizing IAA. The maximum potassium solubilization was achieved in KCl (16%) and K2SO4 (13%). The isolates showed more comprehensive levels of tolerance to pH (5 to 9), temperature (200 C to 400 C), and salt (0% to 15%). Based on this, rhizobacterial isolates with numerous plant growth-promoting potentials were discovered based on their 16S rRNA gene sequencing, and the phylogenetic analysis of the isolates was evaluated, and all selected isolates as being similar to members of the genus Pseudomonas spp. Therefore, based on the plant growth-promoting properties assessed in vitro, the selected bacterial isolates have the potential to boost plant growth and biofertilizer production.

Keywords: *Plant* Growth-promoting Rhizobacteria, Phylogeny, *Pseudomonas* sp., Rhizospheric Soil, Tomato, 16S rRNA Sequencing

iCB 2022-31

Morphological Characterization of Baobab Fruit (*Adansonia Digitata* L.) in Makueni, Taita Taveta, Kilifi and Kwale Counties in Kenya

Murage, M., Onguso, J. M., Remmy, W., & Wekesa, T. B. (2022). *World Journal of Agricultural Research, 10*(3), 82-93. doi: 10.12691/wjar-10-3-4.

Abstract

Baobab (*Adansonia digitata* L.) is a multipurpose tree with a long lifespan which grows throughout sub-Saharan Africa in the semi-arid and humid regions. The Fruit pulp, which is an important part, is used by locals as a food additive and at times the pulp is consumed directly by children and adults. In Kenya, the fruit pulp is consumed directly in some parts of the country while other parts of the country, mostly coastal regions add value to it and sell to earn an income. Baobab's natural habitat is under threat yet both the morphological and genetic diversity is not well documented. The aim of this study was to determine morphological characteristics of baobab fruit in Makueni, Taita Taveta, Kilifi and Kwale counties. Sixty-four trees (one tree per farm) were randomly

selected, and 10 fruits were picked that were used for morphological characterization using 29 qualitative and 15 quantitative descriptors modified from those given for mango by the International Plant Genetic Resources Institute (IPGRI). The results indicated ellipsoid fruit shape was dominant (2.0-3.6) with acute apex (2.8-6.4) and slightly-oblique (4.0-8.4). Baobab fruit had perceptible fruit beak (ranging 4.4-10.0). The results also showed hierarchical clustergram in terms of hair, color, surface, shell hairness and shell surface texture whereby Kilifi and Kwale were clustered together and differed from Makueni and Taita Taveta. In terms of shell hardness to crack, most of the baobab was hard (6.0-8.0) with intermediate adherence of fibre to fruit (6.0-8.0) and intermediate amount of fibre in fruit (2.4-6.0). The seed shape was very reinformed (2.0-9.6), coarse seed testa texture and hard seed testa. The results indicated that fruit length ranged from 12.18-25.06cm, fruit diameter from 7.10-9.08cm. Fruit weight ranged 101.74-319.16g, fibre weight (1.86-5.17G0 and shell weight (46.30-159.68g).

Key Words: Baobab, Characterization, Conservation, Descriptors, Domestication, Morphological

iCB 2022-32

Physiological and Biochemical Evaluations for Identification of Drought Tolerance Potential in Doum Palms (*Hyphaene Compressa*) under Water Deficit Treatment

Borlay, A. J., Mweu, C. M., Nyanjom, S. G. & Omolo, K. M. (2022). *Universal Journal of Agricultural Research 10*(5): 474-487, DOI: 10.13189/ujar.2022.100503

Abstract

There is an increasing concern over global warming, which has changed climate and weather patterns resulting in adverse abiotic situations such as drought stress to crop plants and the general vegetation area. This has posed a threat to food security and ecosystem structure, thus it's needed to identify resistant cultivars that can survive the propagation stress. Three (3) varieties (H1, H2, and H3) of Doum palms were subjected to water regimes: sufficiently irrigated, moderate, and severe water shortage conditions for 65 days to assess the drought adaptation ability. Findings revealed that the water status of the plant was noticeably affected by water shortage in all the studied genotypes. Drought stress imposed for 65 days significantly reduced ($P \leq 0.05$) the physiological and biochemical characteristics of the experimental Doum plant, such as relative leaf water content (RLWC), membrane stability index (MSI), starch content, and a relative decrease in chlorophyll content. Water stress induced a significant ($P \leq 0.05$) increase in leaf proline, total soluble sugar (TSS), total free amino acid (TFAA), and glycine betaine. The findings, therefore, present the first step in understanding how doum palms react to harsh water conditions. Physiological and biochemical characteristics such as RLWC, MSI, leaf proline, TSS, TFAA, glycine betaine, and starch content are indicators when prospecting for drought tolerance doum palms.

Key Words: Doum Palm, Glycine Betaine, Proline, Drought Potential, Starch Content

iCB 2022-33

Plant Regeneration from Leaf Mesophyll derived Protoplasts of Cassava (*Manihot esculenta* Crantz)

Mukami, A., Juma, B. S., Mweu, C., Ngugi, M., Oduor, R. & Mbinda, W. M. (2022). PLoS ONE 17(12): e0278717. https://doi.org/10.1371/journal.pone.0278717

Abstract

A high yield of isolated protoplast and reliable regeneration system are prerequisite for successful somatic hybridization and genome editing research. However, reproducible plant regeneration from protoplasts remains a bottleneck for many crops, including cassava. We evaluated several factors that influence isolation of viable protoplasts form leaf mesophyll, induction of embryogenic calli, and regeneration of plants in three cassava cultivars; Muchericheri, TMS60444 and Karibuni. A relatively higher protoplast yield was obtained with enzyme mixture containing 5 g/L Macerozyme and 10 g/L cellulase. Muchericheri recorded relatively higher protoplast yield of $20.50\pm0.50\times10^6$ whereas TMS60444 ($10.25\pm0.25\times10^6$) had the least protoplast yield in 10 g/L cellulase and 4 g/L cellulase. Freshly isolated protoplast cells were plated on callus induction medium (CIM) solid medium containing MS basal salt, 60 g/L D-glucose, 30 g/L sucrose, B5 vitamins, 100 mg/L myo-inositol, 0.5 mg/L copper sulphate, 100 mg/L casein hydrolysate, 4.55 g/L mannitol, 0.1 g/L MES, 10 mg/L picloram and 3 g/L gelrite to induce protoplast growth and development. The three cultivars reached colony formation but no further development was observed in this culture method. Protoplast growth and development was further evaluated in suspension culture using varying cell densities (1, 2 and 3×10^5 p/mL). Development with highest number of minicalli was observed in cell density of 3×10^5 p/mL. Minicalli obtained were cultured on CIM supplemented with 10mg/L picloram. Callus induction was observed in all cell densities with the cultivars. Highest somatic embryogenesis was observed in 2×10^5 p/ml while no somatic embryogenesis was observed in cell density of 1×10^5 p/mL. Somatic embryos were matured in EMM medium supplemented with 1 mg/L BAP, 0.02 mg/L NAA and 1.5 mg/L GA_3 then germinated in hormone free medium for plant regeneration. This protocol which used simple mixture of commercial enzymes is highly reproducible and can be applied in biotechnology research on cassava.

iCB 2022-34

Genetic Diversity and Population Structure of Doum Palm (*Hyphaene compressa*) Using Genotyping by Sequencing

Omire, A., Neondo, J., Budambula, N. L., Wangai, L., Ogada, S., & Mweu, C**.** (2022). *Frontiers in Genetics*, *13*, 762202.

Abstract

Doum palm (*Hyphaene compressa*) is a perennial economic plant primarily growing in Kenya's Arid and Semi-Arid Lands (ASALs). It is heavily relied upon for food, animal feed, construction materials and medicine, making it an ideal plant for resource sustainability. However, the limited information on its genetic resources has hindered its breeding and conservation studies. This study used the genotyping by sequencing approach to identify Single Nucleotide Polymorphisms. These SNPs were further used to assess the genetic diversity and population structure of 96 *H. compressa* accessions from Coastal, Northern and Eastern ASAL regions of Kenya using two approaches; reference-based and *de novo*-based assemblies. STRUCTURE analysis grouped the sampled accessions into two genetic clusters (Cluster 1 and Cluster 2). Cluster 1 included accessions from the Northern region, whereas Cluster 2 included all accessions from Eastern and Coastal regions. Accessions from Kwale (Coastal) had mixed ancestry from both Cluster 1 and Cluster 2. These STRUCTURE findings were further supported by principal components analysis, discriminant analysis of principal components and phylogenetic analysis. Analysis of molecular variance

indicated greater genetic variation within populations (92.7%) than among populations (7.3%). An overall FST of 0.074 was observed, signifying moderate genetic differentiation among populations. The results of this study will provide information useful in breeding, marker-assisted selection and conservation management of *H. compressa.*

Key Words: Genetic diversity, GBS, Single nucleotide polymorphisms, Population structure, *Hyphaene compressa*, Doum palm

iCB 2022-35

Targeted Mutagenesis of the CYP79D1 Gene via CRISPR/Cas9-mediated Genome Editing Results in Lower Levels of Cyanide in Cassava

Juma, B. S., Mukami, A., Mweu, C., Ngugi, M. P., & Mbinda, W. (2022). *Frontiers in Plant Science*, 4236.

Abstract

Cassava is the world's most essential food root crop, generating calories to millions of Sub-Saharan African subsistence farmers. Cassava leaves and roots contain toxic quantities of the cyanogenic glycoside linamarin. Consumption of residual cyanogens results in cyanide poisoning due to conversion of the cyanogens to cyanide in the body. There is a need for acyanogenic cassava cultivars in order for it to become a consistently safe and acceptable food, and commercial crop. In recent years, the CRISPR/Cas system, has proven to be the most effective and successful genome editing tool for gene function studies and crop improvement. In this study, we performed targeted mutagenesis of the MeCYP79D1 gene in exon 3, using CRISPR/Cas9, via *Agrobacterium*-mediated transformation. The vector design resulted in knockout in cotyledon-stage somatic embryos regenerated under hygromycin selection. Eight plants were recovered and genotyped. DNA sequencing analysis revealed that the tested putative transgenic plants carried mutations within the MeCYP79D1 locus, with deletions and substitutions being reported upstream and downstream of the PAM sequence, respectively. The levels of linamarin and evolved cyanide present in the leaves of mecyp79d1 lines were reduced up to seven-fold. Nevertheless, the cassava linamarin and cyanide were not completely eliminated by the MeCYP79D1 knockout. Our results indicate that CRISPR/Cas9-mediated mutagenesis is as an alternative approach for development of cassava plants with lowered cyanide content.

Key Words: Cassava, CRISPR/Cas9, Cyanide, MeCYP79D1, Targeted mutagenesis

iCB 2022-36

Distribution Patterns and Factors Influencing Adoption of Improved Mango Varieties in Lower Eastern Kenya

Ngulu, J., Wanzala, F., Mukundi, J. B., & Adimo, A. O. (2022). *African Journal of Horticultural Science, 20*.

Abstract

Varietal distribution and performance of mango **(***Mangifera indica* L.) along rainfall and temperature gradients in Kenya is largely undocumented. The objective of this study was to document the distribution patterns and factors influencing adoption of improved mango varieties across a broad spectrum of agro-ecological zones (AEZs). Data on mango distribution, cultivation

and farm characteristics were collected from 280 farms in 28 quadrats spread in four transects of Makueni, Kitui, Machakos, Embu, Tharaka-Nithi and Meru Counties. The 29 different mango varieties found belonged to three categories: Floridan (F), Kenyan Large (KL) and Kenyan Small (KS). The varieties in the 'F' and 'KL' categories have small tree canopy, bear large sized high-quality fruits and are improved mango varieties (IMVs). The varieties in the 'KS' category (traditional landraces) have large canopy and bear small sized, low quality fruits. Mean mango tree density per farm was 65 and Apple variety had highest abundance of 35%. While all varieties occurred below 1500 m a.s.l. only 19 varieties were found above 1500 m a.s.l. Spearman's rank correlation and stepwise linear regression analysis indicated that altitude, farmers' selection of planting material, availability of profitable and reliable market and farmer's perception that rainfall had decreased all had significant ($p < 0.001$) positive influence on the abundance of IMVs adopted. These findings suggest that farmer's adoption of IMVs was not a passive process. The wide range of AEZs versatility of the IMVs indicates farmers' increased adoption of suitable IMVs can provide higher quality mango fruit to mitigate poverty and food insecurity as an adaptation to climate change.

Key Words: Mango varieties, Distribution, Agro-ecological zones, Adoption, Farm characteristics

iCB 2022-37

Occurrence Level of Urban and Peri-Urban Farming Activities Across major Network Links of Nairobi County, Kenya

Ogendi, M., Mukundi, J. & Githiri, S. (2022).
International Journal of Agronomy and Agricultural Research, 18 (4), 25-37

Abstract

Urban and peri-urban agriculture can play a crucial role in the economy, social and dietary life of urban dwellers. The city of Nairobi is going through urbanization challenges including provision of food, especially in slum areas where majority of urban poor lives. Reliable data on extent of urban/peri -urban areas being used for farming in Nairobi County, spatial distribution of such areas, type of crops, animals and proximity to market places are lacking. The aim of this study was to determine occurrence level of farming activities across four major network links of Nairobi County. Purposive sampling was applied in selecting four major network links (road transects). Semi-structured questionnaires were administered to farmers through face-to-face interviews. Data was collected on socio-economic characteristics, agricultural enterprises and consumption patterns. Data was analyzed at 5% level of significance, using descriptive statistics and chi-square test was performed. Farming activities generally increased with an increase in distance from the city center towards the Nairobi outskirts along three road transects. Crops only (90%) was the main farming enterprise practiced. More occurrences of farming activities were on Mombasa (33%) followed closely by Ngong (26%) and Thika superhighway (25%) road transects. Least farming activities were observed on Waiyaki way transect (16%).Fruits (27%) and vegetables (19%) topped the crop produce grown while poultry (38.5%) and cattle (34.6%) were the most reared livestock. These research findings will supplement to Nairobi City planners' decision making process concerning urban and peri-urban agriculture in regard to land use allocation.

Key Words: Urban and peri-urban agriculture, Urban farming households, Farming enterprises, Roadside farms, Road transects, Nairobi City

iCB 2022-38

The Effect of Foliar Application of Zinc Oxide Nanoparticles and *Moringa oleifera* Leaf Extract on Growth, Biochemical Parameters and in Promoting Salt Stress Tolerance in Faba Bean

Ragab, S. M., Losenge, T., Runo, S. & Nyanjom, S. (2022). *African Journal of Biotechnology*, *21*(6), 252-266.

Abstract

Salinity is major abiotic stress limiting plant growth worldwide. Plant adaptation to salinity stress involves diverse physiological and metabolic pathways. In this study, we assessed the effects of foliar application of zinc oxide nanoparticles (ZnONPs) and *Moringa* leaf extract (MLE) on salt tolerance in faba beans (cultivar, Sakha 4). Morphological, chemical, and biochemical parameters of plants grown under saline condition (50 and 100 mM NaCl) were assessed 60 days after sowing. Salt stress caused a remarkable reduction in growth traits, photosynthetic pigments, proline, minerals, total phenol, and enzyme activity of the faba bean variety. The results showed that foliar spraying of MLE and ZnONPs on faba bean grown under salt-stressed conditions promoted growth parameters (that is, shoot length, numbers of leaves, relative water content, shoot, roots fresh and dry weights), photosynthetic pigments (that is, chl a, b, total chlorophyll and carotenoids), proline, mineral elements (Na+, K+, Ca+2, and Zn+2), total phenol and enzyme activity (POX, PPO, APX, and CAT) compared to control plants. Based on these findings, the potential of foliar spraying application of MLE and ZnONPs may help alleviate the negative effect of salinity on growth, photosynthesis efficiency, and biochemical properties of faba bean.

Key words: Faba bean, *Moringa oleifera*, Antioxidant enzyme activity, ZnO nanoparticles, Salt stress, Proline.

iCB 2022-39

Nanoparticle Treatments Based on Zinc Oxide and *Moringa oleifera* Leaf Extracts Alleviate Salinity Stress in Faba Bean (*Vicia faba* L.)

Ragab, S. M., Turoop, L., Runo, S., & Nyanjom, S. (2022). *Journal of Agricultural Chemistry and Environment*, *11*(1), 42-65.

Abstract

Salinity stress limits crop growth and productivity, including legumes in various regions worldwide. The impact of foliar-applied zinc nanoparticles (ZnNPs) and combined zinc nano-loaded with moringa extracts (ZnONPs) on salt tolerance in faba beans (cultivar, Giza-716) grown under saline soil (50 and 100 mM NaCl) was investigated. *Moringa oleifera* extract has been used as a chelating agent to synthesize zinc oxide nanoparticles. The crystalline structure, morphology, and chemical composition of ZnO nanoparticles were studied using various characterization techniques, including UV-visible spectroscopy (UV), Fourier Transform Infrared Analysis (FTIR), scanning electron microscopy (SEM), and X-ray diffraction (XRD). Morphological, chemical, and biochemical parameters of plants at 60 and 90 days after sowing were assessed. Salinity stress caused a remarkable reduction in growth traits, photosynthetic pigments and proline levels of the

faba bean. Foliar spray with ZnNPs and ZnONPs on faba bean grown under saline soils promoted plant growth parameters (*i.e.*, shoot length, numbers of leaves, relative water content, shoot and roots fresh and dry weights), photosynthetic pigments (Chl a, b, total chlorophyll, and carotenoids), proline and mineral elements (Na^+, K^+, Ca^{2+}, and Zn^{2+}) compared to control. However, at 100 mM NaCl, there were no significant variations in the mentioned parameters. This study suggested that there is potential for foliar spraying with ZnNPs and ZnONPs in improving growth parameters, photosynthesis efficiency and biochemical aspects of faba bean plants under saline conditions.

Key words: Faba Bean, Green Synthesis, ZnO Nanoparticles, Salinity Stress, Proline

iCB 2022-40

Excessive Gluconeogenesis Causes the Hepatic Insulin Resistance Paradox and its Sequelae

Onyango, A. N. (2022). *Heliyon*, e12294.

Abstract

Background: Hepatic insulin signaling suppresses gluconeogenesis but promotes de novo lipid synthesis. Paradoxically, hepatic insulin resistance (HIR) enhances both gluconeogenesis and de novo lipid synthesis. Elucidation of the etiology of this paradox, which participates in the pathogenesis of non-alcoholic fatty liver disease (NAFLD), cardiovascular disease, the metabolic syndrome and hepatocellular carcinoma, has not been fully achieved.

Scope of review: This article briefly outlines the previously proposed hypotheses on the etiology of the HIR paradox. It then discusses literature consistent with an alternative hypothesis that excessive gluconeogenesis, the direct effect of HIR, is responsible for the aberrant lipogenesis. The mechanisms involved therein are explained, involving de novo synthesis of fructose and uric acid, promotion of glutamine anaplerosis, and induction of glucagon resistance. Thus, gluconeogenesis via lipogenesis promotes hepatic steatosis, a component of NAFLD, and dyslipidemia. Gluconeogenesis-centred mechanisms for the progression of NAFLD from simple steatosis to non-alcoholic steatohepatitis (NASH) and fibrosis are suggested. That NAFLD often precedes and predicts type 2 diabetes is explained by the ability of lipogenesis to cushion against blood glucose dysregulation in the earlier stages of NAFLD.

Major conclusions: HIR-induced excessive gluconeogenesis is a major cause of the HIR paradox and its sequelae. Such involvement of gluconeogenesis in lipid synthesis rationalizes the fact that several types of antidiabetic drugs ameliorate NAFLD. Thus, dietary, lifestyle and pharmacological targeting of HIR and hepatic gluconeogenesis may be a most viable approach for the prevention and management of the HIR-associated network of diseases.

Key words: Polyol pathway, Hexosamine biosynthetic pathway, Reactive oxygen species, Endoplasmic reticulum stress, Reductive stress, Reductive carboxylation

iCB 2022-41

Beyond Nutrition: Social–Cultural Values of Meat and Meat Products among the Borana People of Northern Kenya

Dabasso, B. G., Makokha, A. O., Onyango, A. N., & Mathara, J. M. (2022).
Journal of Ethnic Foods, *9*(1), 46.

Abstract

To most indigenous communities, livestock plays important socio-cultural roles in addition to sustenance. Like many other communities in the world, the Borana people regard livestock and livestock products not only as nourishment but as an integral part of their cultural identity and social construct. The Borana are Cushitic-speaking people who reside in northern Kenya and southern Ethiopia and practise pastoralism as the primary way of livelihood. Livestock is reared by Borana people to obtain meat, milk and other by-products further to socio-cultural roles that were important for communal prosperity and resilience. The aim of this paper was therefore, to describe the various role of cattle and its significance to Borana people. For data collection, qualitative methods such as key informant interviews and focus group discussions were used. The interviews were audio recorded, transcribed and analysed. The results showed that cattle and particularly bulls were slaughtered for meat consumption, rituals and high-value ceremonial purposes. Moreover, as a desired form of wealth, cattle provide numerous resources to the owners and the prestige associated with herd of cattle accelerates social status and identity among the Borana community. Thus, according to participants' discussions and views, cattle are highly symbolic and have cultural meaning not only as the primary source of food but also in shaping social–cultural values embedded in their social structure. The various role of cattle and its products had significant implications on food security; the traditional practice of livestock wealth sharing shielded the Borana community in times of need and the practice of commensality led to greater social bonds. However, the changing socio-cultural environment caused by recurrent droughts has affected the traditional coping mechanism and led to alternative forms of livelihood.

Key words: Cattle, Meat, Social–cultural, Borana people, Values, Food security

iCB 2022-42

Effect of Incorporation of Snail Meat Powder on Sensory Attributes and Consumer Acceptability of Sorghum-Wheat Buns

Agengo, F. B., Onyango, A. N., Serrem, C. A., & Okoth, J. K. (2022).
Food Science & Nutrition, *10*(6), 1820-1829.

Abstract

Formulation of foods from –low-lysine cereals fortified with animal protein is a potentially sustainable approach to enhance protein quality in diet due to nutritional compensation while buns are valuable vehicles to deliver nutrients to human body because of their relatively noble eating quality and extended shelf life. The aim of this study was to evaluate the sensory attributes and consumer acceptability of sorghum-wheat buns containing snail meat powder (SMP). Buns were prepared by replacing 5, 10, 15, 20, and 25% of sorghum-wheat composite flour with SMP. Principal component analysis (PCA) revealed 99% total variation of 23 attributes for buns scored by a descriptive sensory panel, of which 98% was due to the proportion of SMP that replaced sorghum-wheat composite flour in buns and the remainder 1% was due to the buns' physical appearance. Compositing sorghum-wheat buns with SMP imparted positive consumer attributes of fine crumb, sponginess, and crumby texture. It also resulted in buns with reasonably high sensory acceptability as evaluated by 8- to 9-year-old school children. The buns can serve as supplementary rich sources of protein for alleviating the menace of protein energy malnutrition in sub-Saharan Africa.

Key words: Buns, Compensation, Consumer acceptability, Low-lysine, Protein, Sensory attributes

iCB 2022-43

Physico-Chemical and Postharvest Quality Characteristics of Intra and Interspecific Grafted Tomato Fruits

Walubengo, D., Orina, I., Kubo, Y., & Owino, W. (2022).
Journal of Agriculture and Food Research, 7, 100261.

Abstract

The objective of this study was to evaluate the physico-chemical and postharvest quality characteristics of intra- and interspecific grafted tomato fruit. Anna F1, a commercial tomato variety was interspecifically (Tomato Scion and African eggplant rootstock (*Solanum aethiopicum)*) and intraspecifically (Tomato Scion and bacterial wilt resistant hybrid tomato rootstock) grafted. The tomatoes were grown in a greenhouse and harvested at mature green, turning and ripe stages respectively. The tomatoes were analyzed for size, weight, cumulative weight loss, color changes, texture, respiration and ethylene gas production rates, vitamin C and lycopene content. Interspecific grafting on Manyire green, AB2, and intraspecific grafting on Armada, and B.B rootstocks significantly improved physical and physiological attributes of the tomato fruit. There was significant difference ($p < 0.05$) in size and weight of grafted tomatoes and control at all the three maturity stages. Intraspecific grafted tomato fruits on Armada rootstocks had the best quality characteristics in terms of firmness, low weight loss, respiration and ethylene production rates which are associated with extended postharvest shelf-life. Intraspecific grafting reduced respiration and ethylene gas production rates with tomatoes grafted onto Armada rootstocks attaining the least climacteric peaks of 20.20 ml CO_2 $Kg^{-1}h^{-1}$ and 0.34 Ml C_2H_4 $Kg^{-1}h^{-1}$ respectively at mature green stage, thus leading to extendend postharvest life of these tomatoes. Tomatoes grafted onto B.B rootstock had the highest vitamin C content (28.11 mg/100 g). In general, intraspecific grafting recorded the best quality traits over the interspecific grafting. However interspecific grafting of tomato onto African eggplant Manyire and AB2 rootstocks had lower but comparable fruit quality to intraspecific grafting.

Key words: Maturity stage, Respiration rate, Ethylene, Vitamin C, Lycopene

iCB 2022-44

Determination of Total Aflatoxin and Aflatoxin B1 in Groundnuts and Cereal-Based Street Vended Foods Sold in Selected Locations in Thika Town, Kenya: Total Aflatoxin and Aflatoxin B1 in Street Vended Foods

Mwove, J., Imathiu, S., Orina, I., & Karanja, P**.** (2022).
Journal of Food and Dietetics Research, 2(3), 1-7.

Abstract

Objective: Food contamination with mycotoxins such as aflatoxin in street vended foods is a public health concern in Kenya. The objective of this study was to determine the level of aflatoxins in street vended foods sold in six locations within Thika Town, Kenya.

Methods: A total of 36 samples consisting of cereal and cereal based foods and groundnuts were randomly collected for analysis. Screening for aflatoxins was done using NEOGEN®'s Reveal® Q+ for Aflatoxin test kit while quantification of aflatoxin B1 and total aflatoxin was done through a competitive direct enzyme-linked immunosorbent assay (ELISA).
Results: Total aflatoxin and aflatoxin B1 in street vended groundnuts averaged between 4.420 - 14.241 µg/kg and 3.431-11.289 µg/kg, respectively. Thika town center had significantly ($p=0.0012$) highest total aflatoxin and aflatoxin B1 level in groundnuts. On average 16.7% and 44.4% of groundnut samples had total aflatoxin and aflatoxin B1 levels above the regulatory limits of 10 µg/kg and 5 µg/kg established by the Kenya Bereau of Standards as limits for total aflatoxin and aflatoxin B1 in groundnuts, respectively. Compared to the 4 µg/kg and 2 µg/kg limit set by the European Union for total aflatoxin and aflatoxin B1, 72.2% and 100% of the samples were above these limits, respectively.
Conclusion: This abundance of high levels of aflatoxins, especially aflatoxin B1, highlights the need for Kenya to take the necessary steps to effectively manage aflatoxins in ready to eat foods.

Key Words: Total aflatoxin; Aflatoxin B1; Enzyme-linked immunosorbent assay; Street vended foods; Food safety

iCB 2022-45

Effect of Storage Condition on Retention of Vitamins in Selected Commercial Fortified Maize Flour in Kenya

Chepkoech, B., Sila, D. N. & Orina, I. N**.** (2022).
Current Research in Nutrition and Food Science, 10(3), 1140-1149

Abstract

Food fortification is one strategy that has been used to overcome micronutrient deficiencies among vulnerable populations. Maize, a common staple food in Kenya, has been used as a suitable fortification vehicle. However, several factors, including storage conditions, impact micronutrient stability in fortified maize flour. This study aimed to assess the influence of storage condition on the retention of retinol and B-vitamins in selected commercial fortified maize flour. Fresh samples of fortified maize flours from two brands (codedXX1 and XY2) were sampled from the manufacturers at the point of production. The storage stability of retinol and B-vitamins in the two brands (XX1 and XY2) was monitored for 6 months at 25°C/ 75% relative humidity and 35°C/ 83% relative humidity. Retinol and thiamine were the least stable vitamins in both flour brands, while riboflavin and folate were relatively stable. Niacin was the most stable vitamin. Retinol was the least stable vitamin for brand XXI at both 25 °C/75% RH and 35 °C/83% RH, followed by thiamine, riboflavin, folate, and niacin. However, brand XY2 showed that under both storage conditions, thiamine was the least stable vitamin, followed by retinol, riboflavin, folate, and niacin. Vitamin retention was higher in samples stored at a lower temperature and relative humidity (25°C/ 75%RH) than in samples stored at higher temperature and relative humidity (35°C/ 83% RH) for both brands. In conclusion, thiamine and retinol were generally more susceptible to storage losses. Although the vitamin content in the flour samples decreased during storage, the changes in both storage conditions (except for riboflavin) and both brands were not significantly different.

Key Words: Food safety, Heavy metal exposure assessment, Human health, Lead and cadmium, Street vended foods

iCB 2022-46

Prevalence of *Campylobacter* Species on Cattle Breeding Farms in Zimbabwe

Mahlangu, P., Marambe, S. T., Mutengwa, I. K., Saidi, B., Makaya, P. V., & Kagira, J. (2022). *Veterinary Medicine International*, *2022*.

Abstract

Infertility remains a challenge in breeding herds in most developing countries. In the current study, 104 penile sheath washes were collected from bulls of different breeds and ages from different cattle breeding farms in Zimbabwe. The samples were submitted to the Central Veterinary Laboratory, Zimbabwe, for screening of *Campylobacter* species using the polymerase chain reaction (PCR). Based on the PCR results, the animal-level prevalence was 25.96% (range 0–73.98%) and all the positive samples came from four (57.14%) of the 7 herds tested. The current study shows that *Campylobacter* spp. could be a causative agent in infertility observed in a number of herds in Zimbabwe. Strategies for treatment and control of campylobacteriosis should be enhanced in the country. More research and surveillance are needed to determine the epidemiology of *Campylobacter* species in Zimbabwean cattle herds.

iCB 2022-47

Prevalence and Antibiogram of *Escherichia coli* and *Staphylococcus* spp. Isolated from Cattle Milk Products Sold in Juja Sub-County, Kenya

Sombie, J. I., Kagira, J., & Maina, N. (2022).
Journal of Tropical Medicine, *2022*.

Abstract

Dairy ruminant milk provides a conducive environment for bacterial proliferation. In animals, these bacteria are exposed to antibiotics, whose overuse has led to increased cases of drug resistance. A cross-sectional study was conducted on milk and milk products vended in Juja Sub-County, Kenya to determine the prevalence of bacteria and antibiogram of *Staphylococcus* spp. And *Escherichia coli*. A total of 169 milk samples were obtained from various outlets in the study area. Milk samples were cultured and isolated bacteria were identified using standard bacteriological procedures. Various bacteria (15 species) were isolated in different proportions. *Staphylococcus* spp. and E. *coli* were isolated from 25.4% and 11.8% of the collected samples, respectively. The highest number of *Staphylococcus* spp. were isolated from raw milk ($n = 34$) while the highest number of E. *coli* where isolated from fermented milk ($n = 15$). *Staphylococcus* spp. and E. *coli* isolates were subjected to antimicrobial susceptibility tests using CLSI guidelines. The *Staphylococcus* spp. isolates were highly resistant to penicillin G (93%) but susceptible to norfloxacin (100%), gentamicin (90.6%), and chloramphenicol (86%). The E. *coli* isolates were highly resistant to cephalexin (85%) and ceftazidime (60%) but susceptible to chloramphenicol (100%), norfloxacin (95%), gentamicin (95%), azithromycin (95%) and cefepime (80%). Furthermore, 44.3% of *Staphylococcus* spp. and 50% of *E. coli* isolates had a Multiple Antibiotic Resistance (MAR) Index greater than 0.2. This implies that these bacteria were high-risk bacteria whose treatment with current antibiotics would be challenging. The high prevalence and multidrug

resistance patterns shown by the *Staphylococcus* spp. and E. *coli* isolated from milk products in Juja Sub-county highlights the importance of proper handling and processing of milk from the farm to consumers. This will in turn reduce the possibility of zoonotic transfer of multidrug-resistant bacteria.

iCB 2022-48

Prevalence, Risk Factors and Antibiogram of Bacteria Isolated from Skin of Human having close Contact with Dairy Cows in Small-holder Farms in Gatundu Sub-County, Kenya

Otenga, F. O., Kagira, J. M., Waititu, K., Kiboi, D. M., Ngotho, M., & Maina, N. (2022). *International Journal of Community Medicine and Public Health*, *9*(11), 4039.

Abstract

Background: Antimicrobial resistance is a global health crisis which needs surveillance especially in people having close contact with animals.

Methods: A total of 120 skin swabs from around the neck region were obtained from human respondents and subjected to bacteriological analyses. Antimicrobial susceptibility test was done using Kirby Bauer disk diffusion method and results were interpreted according to the Clinical and Laboratory Standard Institute guidelines.

Results: The results showed that the skin was colonized by *Staphylococcus aureus* (49.4%), coagulase-negative staphylococci (CoNS) (16.9%), *Pantoea* spp. (13%), *Serratia* spp. (13%), *Bukholderia cepacian* (3%), *Enterobacter* spp. (3%), *Yersinia enterocolitica* (1.3%) and *Pasteurella aerogenes* (1.3%). The CoNS were mostly resistant to gentamycin (100%), clindamycin (84.6%), erythromycin (84.6%) and ciprofloxacin 84.6% and sensitive to sulphamethoxazole-trimethoprim (76.9%). For S. aureus, most isolates were resistant to gentamycin (86.8%), oxacillin (86.8%) and vancomycin (73.7%) but susceptible to amoxycillin-clavulanic acid (89.5%) amongst other antibiotics. The multiple antibiotic resistance index for S. aureus and CoNS was 0.92 and 0.92, respectively. Respondents aged more than 40 years had higher burden of AMR compared to the other respondents ($p = 0.011$, OD=1.745). Similarly, the AMR burden was higher in respondents who had previous history of using medication compared to those who had not ($p=0.025$, OD=0.204).

Conclusions: The study showed a high prevalence of antibiotic resistance in CoNS and S. aureus isolates from skin of people having regular contacts with dairy cows in the study area. Interventions strategies to stem the emergence of AMR should be undertaken.

Key Words: Prevalence, Human, Risk-factors, Antibiotics, Antimicrobial resistance, *Staphylococci* spp., *Enterobacteriaceae*

iCB 2022-49

Occurrence of Antibiotic Resistance in Bacteria Isolated from Milk of Dairy Cows in Small-Holder Farms in Juja Sub-County, Kenya.

Kagira, J. M., Ngotho, M., Mugo, E., Kiplimo, M., & Maina, N. (2022).
Asian Journal of Research in Animal and Veterinary Sciences, *9*(3), 36-45.

Abstract
Sub-clinical mastitis (SCM) remains a serious hindrance to small-holder dairy farms in Kenya. A cross-sectional study was conducted to determine the risk factors associated with occurrence of SCM and antibiotic resistance in smallholder dairy farms in a peri-urban set-up area of Juja Sub-county, Kenya. Milk samples was obtained from 120 lactating dairy cows in 60 farms and screened for SCM using California mastitis test (CMT). Positive CMT samples were cultured and bacteria identification was done using standard methods. A questionnaire survey was administered at the household level to assess the risk factors associated with SCM. Sensitivity of the Staphylococcus aureus and Escherichia coli isolated from milk against commonly used antibiotics was determined using disc diffusion method. The prevalence of SCM at cow and udder level was found to be 66.7% and 61.3%, respectively. The highest prevalence of SCM was in Kalimoni (88.8%), Murera (82.7%) and Witeithe (71.4%) wards. The least affected area being Juja (60%) and Theta (44.4%) wards. Sub-clinical mastitis was significantly higher (p=0.007) in Friesian (74.1%) and Guernsey (66.7%) breeds as compared to the indigenous breed (53.8%). Cows with parity of four and above had higher (p=0.001) prevalence of SCM (73.7%) as compared to those of lower parity stage. Additionally, the prevalence (81%) of SCM in cows at late lactation was higher (P=0.002) compared to early (61.5%) and mid-lactation (56.4%), respectively. Higher prevalence (59%) of SCM was found in cows kept in less frequently cleaned housing compared to those more frequently cleaned (10%). The bacterial organisms isolated from the milk were Staphylococcus spp. (41.7%), Klebsiella spp. (24.5%), Pseudomonas spp. (22.1%), Escherichia coli (6.8%), Shigella spp. (1.8%) and Salmonella spp. (3.1%). The isolated Staphylococcus spp. and E. coli were most resistant to Oxytetracycline (79%, 100%, respectively) and Streptomycin (44%, 90%, respectively). Multidrug resistance (MDR) involving a combination of oxytetracycline, tetracycline, streptomycin and chloramphenicol and gentamycin was observed amongst Staphylococcus spp. (29.4%) and E. coli (45.5%) isolates. In conclusion, the study showed that large proportion of dairy cows was affected by SCM and the antibiotic resistance (AR) was high. This calls for animal health extension experts and other relevant stakeholders in the industry to train farmers on efficient control of SCM and emerging cases of AR.

Key Words: Sub-clinical mastitis; Milk; Risk factors; Peri-urban; Antibiotic resistance; Kenya.

iCB 2022-50
Isolation and Cryopreservation of *Toxoplasma gondii* Isolates from Cats and Chickens from Selected Households in the Thika Region, Kenya
Njuguna, A., Maina, N., Kagira, J., Karanja, S., Kamau, D., Ngotho, M., Mose, J. & Mutharia, L. (2022). *Journal of Applied Life Sciences International*, *25*(3), 18-24.

Abstract
There is a shortage of information in Africa regarding the genotypic and phenotypic characteristics of the Toxoplasma gondii circulating in domestic cats (Felis catus) and the intermediate hosts such as chicken. The situation is compounded by a lack of collection of well-stored isolates. The present study was aimed at creating a cryobank of T. gondii bradyzoites, tachyzoites, and oocysts. The parasites were isolated from cats and chickens kept in households in the Thika region, Kenya. Eight (8) cat fecal samples positive for T. gondii oocysts and 38 chicken brain tissue cysts (bradyzoites) were obtained and used for propagation in mice before cryopreservation. For each

sample from the cats, (two donors) BALB/c mice were infected orally with 1 x 104/ml of oocysts. From each chicken sample, (two donors) BALB/c mice were infected intraperitoneally with 20-30 tissue cysts. On the third day after infection, tachyzoites were harvested from the peritoneal cavity of one donor mouse. The other two infected mice were further monitored for eight weeks, euthanized and the brain tissue harvested for toxoplasma cysts which were purified and cryopreserved. From the mice infected with oocysts from the cats' samples, 2 (25%) tachyzoites but a higher 8 (100%) isolation was obtained from brain tissue cysts. On the other hand, from chicken samples generated 18 (47.3%) tachyzoites and 38 (100%), tissue cysts were obtained. The isolated oocysts (from cats), tachyzoites, and tissue cysts (from mice) were cryopreserved using 15% glycerol as cryoprotectant and stored in liquid nitrogen (-196oC). After 6 months of cryopreservation, the viability of the isolates was tested using Trypan blue dye exclusion on a manual hemocytometer. Viability (99.5% - 96%) of the cryopreserved samples was maintained for the three toxoplasma stages and there was no significant change ($p>0.05$) in the viability of the parasites before and after cryopreservation. The cryobank will serve as a repository for subsequent studies on molecular and phenotypic characterization of T. gondii isolates from Kenya.

Key Words: Chicken; cat; Cryopreservation; Tissue cyst; Oocyst; Tachyzoites; Thika

iCB 2022-51

Non-Intrusive and Effective Positioning of Precision Livestock Monitoring System for Cattle

Aloo, P. O., Murimi, E. W., Mutua, J. M., Kyalo, M. N., & Kagira, J. M. (2022, April). In *Proceedings of the Sustainable Research and Innovation Conference* (pp. 111-117).

Abstract

Livestock farmers in Kenya face a number of challenges such as diseases and the inability to accurately identify oestrus and calving windows. These factors hinder productivity and lead to high livestock mortalities. Precision Livestock Farming systems are the solution to this, ensuring effective management of the livestock farming process. Existing systems have been able to monitor animal temperatures, location and movement of animals within the farms, and deliver this to the farmer visually, allowing them to observe the state of their animals in real-time and affordably. Positioning of sensors on livestock is critical in ensuring correct livestock data is collected. The placement of these sensors is dependent on three factors; the thermal windows on the animal's surface, fastening of the sensor and the power supply. Real time data on sensor temperature readings from various parts of a cow's body was obtained and analysed. The results were then compared alongside data from literature to come up with a preferred positioning of PLF sensor systems. By comparing the placement of the sensor on the cow's leg, dewlap and harness, it was noted that the harness provided for a more suitable placement of the particular PLF sensor, allowing for continuous and accurate collection of data.

Key Words: Precision livestock farming, Machine learning algorithm, Livestock, Sensor positioning

iCB 2022-52

In vitro Anthelmintic Efficacy of Nano-encapsulated Bromelain against Gastrointestinal Nematodes of Goats in Kenya

Daiba, A. R., Kagira, J. M., Ngotho, M., Kimotho, J., & Maina, N. (2022). *World's Veterinary Journal*, *12*(1), 95-104.

Abstract

Gastrointestinal nematodes (GIN) significantly affect goats' productivity, and thus farmers carry out regular deworming to manage the infections. The emergence of anthelmintic resistance and the high cost of current drugs call for the development of alternatives, including medicinal plant extracts. The current study aimed to assess the anthelmintic efficacy of chitosan encapsulated bromelain (EB) against a selected range of GIN affecting goats in Kenya. Bromelain was extracted using standard laboratory methods from peels of ripe pineapples and thereafter encapsulated with chitosan. The GIN eggs were isolated from goat feces using the flotation method and were then subjected to PCR to identify the species. Adult worms were collected from the gastrointestinal tract of goats slaughtered at the nearby Ruiru abattoir. The PCR showed the extracted strongyle eggs consisted of 7 species of nematodes, including *Haemonchus contortus*, *Oesophagostomum* spp., *Nematodirus filicollis*, *Ostertagia ostertagi*, *Trichostrongylus vitrinus*, *Trichostrongylus colubriformis*, and *Trichostrongylus axei*. The *in vitro* assays showed that chitosan EB had an IC50 of 0.184 mg/mL, 0.116 mg/mL, and 0.141 mg/mL for the egg hatch inhibition, larval, and adult mortality assays, respectively. In all the assays, EB indicated better activity than non-encapsulated bromelain. The EB affected the eggs and worms through softening and embrittling the cuticle and shell as well as damaging the blastomeres and causing the death of the growing embryo. According to the results of the current study, EB has high anthelmintic activity on a large range of GIN and has the potential to contribute to the management of these parasites of small ruminants.

Key Words: Anthelmintic activity, Bromelain, Chitosan, Goats, Nano-encapsulation, Nematodes

iCB 2022-53

The Pathogenicity of Blood Stream and Central Nervous System Forms of *Trypanosoma brucei rhodesiense* Trypanosomes in Laboratory Mice: A Comparative Study

Ndungu, K., Thuita, J., Murilla, G., Kagira, J., Auma, J., Mireji, P., Ngae, G., Okumu, P., Gitonga, P., Guya, S. & Mdachi, R. (2022). *F1000Research 2022*, 11:260 https://doi.org/10.12688/f1000research.75518.1

Abstract

Background: Human African trypanosomiasis (HAT) develops in two stages namely early stage when trypanosomes are found in the blood and late stage when trypanosomes are found in the central nervous system (CNS). The two environments are different with CNS environment reported as being hostile to the trypanosomes than the blood environment. The clinical symptoms manifested by the disease in the two environments are different. Information on whether blood stream are pathologically different from CNS trypanosomes is lacking. This study undertook to compare the inter-isolate pathological differences caused by bloodstream forms (BSF) and central nervous system (CNS) of five *Trypanosoma brucei rhodesiense* (*Tbr*) isolates in Swiss white mice.

Methods: Donor mice infected with each of the five isolates were euthanized at 21 days post infection (DPI) for recovery of BSF trypanosomes in heart blood and CNS trypanosomes in brain supernatants. Groups of Swiss white mice (n = 10) were then infected with BSF or CNS forms of each isolate and monitored for parasitaemia, packed cell volume (PCV), body weight, survivorship, trypanosome length, gross and histopathology characteristics.
Results: Amplification of SRA gene prior to trypanosome morphology and pathogenicity studies confirmed all isolates as *T. b. rhodesiense*. At 21 DPI, CNS trypanosomes were predominantly long slender (LS) while BSF were a mixture of short stumpy and intermediate forms. The density of BSF trypanosomes was on average 2-3 log-scales greater than that of CNS trypanosomes with isolate KETRI 2656 having the highest CNS trypanosome density.
Conclusions: The pathogenicity study revealed clear differences in the virulence/pathogenicity of the five (5) isolates but no distinct and consistent differences between CNS and BSF forms of the same isolate. We also identified KETRI 2656 as a suitable isolate for acute menigo- encephalitic studies.

Key Words: Trypanosoma, rhodesiense, BSF, CNS, Morphology, pathogenicity.

iCB 2022-54

Development of Loop-Mediated Isothermal Amplification Combined with Lateral Flow Dipstick Assay for a Rapid and Sensitive Detection of Cystic Echinococcosis in Livestock in Kenya

Badoul, N. A., Kagira, J., Ng'ong'a, F., & Dinka, H. (2022). *Journal of Tropical Medicine, 2022*.

Abstract

Background. Cystic echinococcosis is a zoonotic disease caused by the metacestode stage of *Echinococcus granulosus* and occurs worldwide, causing considerable economic losses and public health problems. The currently available methods for the diagnosis of animal hydatidosis are time-consuming and require well-equipped laboratories which make them incompatible with testing in resource-poor settings. This study developed and evaluated a rapid, more sensitive, and specific loop-mediated isothermal amplification combined with a lateral flow dipstick assay for the rapid and sensitive detection of cystic echinococcosis.
Results. In this study, a specific primer set and FITC-labeled probe targeting the conserved region of the NADH-1 gene were designed. The LAMP reaction was performed at 60°C for 40 minutes, and the amplification products were successfully visualized by LFD strips. The analytical sensitivity of LAMP-LFD was determined using 10-fold serial dilutions of *E. granulosus* DNA. The minimal concentration detected was 10 fg/μl, and no cross-reactivity was observed with DNA extracted from *Taenia solium*, *Taenia saginata*, and *Fasciola hepatica*. The ability of the developed LAMP-LFD assay to detect cystic echinococcosis was further evaluated with 62 cyst samples from slaughtered cattle in Juja Abattoir, Kiambu County, Kenya. The LAMP-LFD was able to detect 59/62 (95.2%, 95% CI 0.87–0.98) as positive samples of *E. granulosus* compared to 53/62 (85.5%, 95% CI 0.75–0.92) by nested PCR assay. *Conclusion*. Our results indicated that the developed LAMP-LFD technique was more sensitive than the nested PCR assay, rapid, and easy to perform with a simple visual detection of products. Therefore, it could be an important point-of-care diagnostic tool for cystic echinococcosis.

iCB 2022-55

In vitro Anticoccidial Activity of Nanoencapsulated Bromelain against _Eimeria_ spp. Oocysts Isolated from Goats in Kenya

Daiba, A. R., Kagira, J**.** M., Ngotho, M., Kimotho, J., & Maina, N. (2022). *Veterinary World, 15*(2), 397-402. DOI: 10.14202/vetworld.2022.397-402

Abstract

Background and Aim: The emergence of drug-resistant strains of *Eimeria* spp. calls for the development of novel anticoccidial drugs. Plant extracts provide a possible natural source for such drugs. This study aimed to investigate the *in vitro* anticoccidial activity of encapsulated bromelain (EB) in chitosan nanocarriers on *Eimeria* spp. oocysts isolated from goats kept by farmers in Kenya.

Materials and Methods: Bromelain was extracted from the peel of ripe pineapples using standard methods. *Eimeria* spp. oocysts were isolated from the feces of goats using a flotation method. The inhibition of sporulation was assayed after exposing the oocysts to solutions of EB, non-EB (NEB), and diclazuril (positive control) at concentrations between 4 mg/mL and 0.125 mg/mL for 48 h. The oocysts were examined under a microscope (40x) to determine the effects of the drugs on the sporulation process. The percentage of sporulation inhibition was calculated after 48 h and the inhibition concentration 50% (IC_{50}) was determined by probit analysis.

Results: Bromelain manifested anticoccidial activity through the inhibition of the sporulation of coccidia oocysts. EB achieved inhibition with a lower dose compared with NEB. The IC_{50} values of diclazuril, EB, and NEB were 0.078 mg/mL, 0.225 mg/mL, and 0.575 mg/mL, respectively. There were significant differences ($p<0.01$) between the IC_{50} of EB and NEB compared with the standard treatment drug.

Conclusion: This preliminary study showed that EB has anticoccidial activity supporting further evaluation at an *in vivo* level to develop a novel drug for the management of coccidiosis in goats.

Key Words: Anticoccidial activity, Bromelain, Chitosan, Coccidia, Goat, Nanoencapsulation

iCB 2022-56

Risk Factors Associated with Sub-Clinical Mastitis and Antibacterial Resistance in Small-Holder Dairy Farms of Kajiado North Sub-County, Kenya

Ngotho, M., Kagira, J., Nkoiboni, D., Njoroge, J., & Maina, N. (2022).
Journal of Veterinary Physiology and Pathology, *1*(3), 49-55.

Abstract

Introduction: Worldwide, there is a paucity of literature on subclinical mastitis, and antimicrobial resistance patterns of bacteria isolated from dairy animals kept in peri-urban areas. This study aimed at determining the prevalence of sub-clinical mastitis (SCM) and the sensitivity of the isolated bacteria to selected antibiotics in dairy cows kept by smallscale farmers in Kajiado North Sub-County, Kenya. Simultaneously, a questionnaire was administered to determine and assess the risk factors associated with mastitis.

Materials and methods: Milk was obtained from all quarters of 101 lactating dairy cows, sampled from 50 farms, and screened for SCM using California Mastitis Test. The samples were cultured and bacteria identified using standard bacteriological methods. Antibacterial sensitivity of

Staphylococcus spp. and *Escherichia coli* isolates were tested using the Kirby-Bauer disk diffusion method, against commonly used antibiotics.
Results: The prevalence of SCM at cow and udder quarter levels were 51.2% and 47.5%, respectively. The prevalence of the bacteria was *Staphylococcus* spp. (51.4%), *Klebsiella* spp. (40.5%), *Pseudomonas* spp. (34.6%) and *E. coli* (11.8%). The risk factors significantly associated with SCM were breed, parity, lactation stage, and milking hygiene. The highest prevalence of SCM was found in cows in late-stage lactation (78%) with the lowest in those in early-stage lactation (37.5%). A higher prevalence of SCM was found in cows housed in farm structures having poor hygiene (95%). The highest prevalence of SCM was in Friesian breeds (67.3%) and the least affected were the indigenous cows (27.3%). Cows in the fourth and higher parities were the most (64.7%) affected by SCM. Most of the *Staphylococcus* spp. isolates were found to exhibit resistance to oxytetracycline (73%) but had high sensitivity to gentamycin (69%). All *E. coli* isolates showed resistance to oxytetracycline while a 75% were sensitive to Chloramphenicol. In conclusion, the study showed that a large proportion of cows were affected by SCM, with the main causative agent being *Staphylococcus* spp.
Conclusion: The study shows that antibiotic resistance was alarmingly high in the study animals. The predisposing factors should be further investigated with a view of developing necessary intervention

Key Words: Antibiotic sensitivity, Antibiotic resistance, Breeds, Lactation, Sub-clinical mastitis

iCB 2022-57
Constraints and Opportunities in Smallholder Dairy Goat Production Systems in the Kenya
Gicheha, M. G., Osuga, I. M., Maindi, C. N., & Mwashi, V. (2023).
Journal of Agriculture, Science and Technology, *22*(2), 83-99.

Abstract
Dairy goat's production plays a significant role in improving the livelihoods of poor smallholder farmers in developing countries. Goats sector productivity and profitability has been low despite its importance. The overall objective of any livestock producer is to maximize on animal productivity and subsequently the enterprise profitability. Various attempts have been made to achieve this goal in smallholder dairy goat production systems in Kenya without much success. We hypothesised that one of the main cause of the failure is lack of holistic approach to evaluation of the opportunities and constraints encountered in the sector. This leads to design of intervention strategies that are suboptimal. This study addressed this weakness by using different data capture approaches mainly survey, observation, focus group discussion (FGD) and expert's opinions to determine and critically analyse the opportunities and challenges limiting the expansion of smallholder dairy goats sector in Kenya. Approximately 70% of the respondents identified market as the key challenge. This is best captured from an excerpt by a participant during a FGD meeting "*.... if only there was reliable market for milk and the replacement stock, I think the other constraints would sort themselves out*". Fourty percent of the smallholder dairy goat producers (SDGPs) interviewed attested to use of crossbreeding aimed at improving the dairy goats' performance. This is despite the fact that 100% of the SDGPs interviewed indicated that they did not care which breeds were involved as long as they were both exotic "*... we use any good buck in the neighbourhood or within a farmers group for the purposes of upgrading*". Use of different

data collection, analysis and interpretation approaches provided accurate and reliable information usable in choice of intervention measures aimed at increased production and profitability in smallholder dairy goat systems in the tropics.

Key Words: Dairy, goat, Milk, Smallholder, Constraints, Opportunities.

iCB 2022-58

Effect of *Desmodium intortum* and Black Soldier Fly Larvae (*Hermetia illucens*) Based Meal on Sensory and Physicochemical Properties of Broiler Chicken Meat in Kenya

Mutisya, M. M., Baleba, S. B. S., Kinyuru, J. N., Tanga, C. M., Gicheha, M**.**, Hailu, G., Salifu, D., Egonyu, J., Cheseto, X. & Niassy, S. (2022).
Journal of Insects as Food and Feed, *8*(9), 1001-1013.

Abstract

We evaluated the effect of dietary inclusion of different ratios of *Desmodium intortum* (DI) and black soldier fly larvae meal (BSFLM) on sensory traits and physicochemical qualities of broiler chick's meat. Three formulations: T1:75%BSFL:25%DI; T2:50%BSFL:50DI, and T3:25BSFL:75% DI as a protein source were tested. A conventional feed was used as the control diet. On day 42, the chickens were slaughtered, and thigh muscles were used for sensory and physicochemical evaluations. T1 was preferred for its flavour and tenderness, T2 for its juiciness and T3 for its colour, flavour, taste and overall acceptability scores. In terms of physical properties, all three types of meat had significantly lower moisture content and a higher water holding capacity than the control. T3 had the lowest moisture content, cooking loss and pH, whereas the meat from control diet had the highest cooking loss and pH. No significant differences were found in terms of meat lightness; however, meat from control diet showed the highest redness value, and T3 had the highest yellowness value. Dietary inclusion of DI-BSFL affected the fatty acid and cholesterol profiles of the meats. A holistic Principal Component Analysis indicated that the tested meats were distinct in their sensory and physicochemical properties. These variations in physicochemical properties may account for the difference in organoleptic perception, especially for T3. Further research should focus on feed modulation in relation to consumers' preference and potential health benefits.

Key Words: *Desmodium*, *Hermetia illucens*, Insect-based feed, Broiler chickens, Meat quality

iCB 2022-59

Nutritional Characterization of Eight Trees and Shrubs Used as Livestock Feeds in the Eastern Democratic Republic of the Congo

Barwani, D. K., Bacigale, S. B., Kibitok, N. K., Webala, A. W., Gicheha, M. G., Katunga, D. M., & Osuga, I. M. (2022). *Livestock Research for Rural Dev*elopment *34*(10).

Abstract

The poor nutritional quality of natural pastures is one of the main constraints smallholder cattle farmers encounter in the eastern Democratic Republic of the Congo (DRC). Information on the nutritive values of the tree and shrub species most used by farmers is insufficient. This study aimed to assess the chemical composition and *in vitro* gas production profiles of eight selected trees and shrubs forages from the territories of Kalemie and Kabare in the eastern DRC. The forage samples

were analysed for dry matter, ash, crude protein (CP), ether extract (EE), neutral detergent fibre (NDF), acid detergent fibre (ADF), and acid detergent lignin (ADL) and, condensed tannins (CT). The metabolisable energy, *in vitro* organic matter digestibility (OMD) and short-chain fatty acids were also estimated. Data obtained were analysed using a one-way analysis of variance in a completely randomised design. The results revealed that the nutrient parameters analysed and calculated differed significantly ($p<0.05$) between the various species of trees and shrubs and also between the territories within the same species of tree or shrub. The CP ranged from 217 g kg-1 DM in *Mangifera indica* to 402 g kg-1 DM in *Leucaena leucocephala* in Kalemie, while from 270 g kg-1 DM in *M. indica* to 417 g kg-1 DM in *Calliandra calothyrsus* for samples obtained from Kabare. The forages had moderate NDF ranging from 265 g kg-1 in *C. calothyrsus* found from Kabare to 690 g kg-1 DM in *Erythrina abyssinica* found in Kalemie. The condensed tannin content was highest in *C. calothyrsus* (122 g kg-1 DM) obtained from Kalemie compared to *M. indica* (68.3 g kg-1 DM) from Kabare. The potential gas production and *in vitro* OMD were high and comparable between the species such as *L. leucocephala, Vernonia amygdalina* and *E. abyssinica*. From this study, it can be concluded that tree and shrub forages had higher CP content and in vitro digestibility, which suggests their suitability for use as protein supplements in livestock diets, particularly during the dry season.

Key Words: Animal feeds, Condensed tannins, Digestibility, Nutritive value, Tree leaves

iCB 2022-60

Effect of Drying Methods on the Nutrient Content, Protein and Lipid Quality of Edible Insects from East Africa

Yisa, N. K., Osuga, I. M., Subramanian, S., Ekesi, S., Emmambux, M. N., & Duodu, K. G. (2022). *Journal of Insects as Food and Feed*, 1-14.

Abstract

This study investigated the effect of different drying methods on nutrient composition and quality of three edible insects from East Africa. *Ruspolia differens* (grasshopper), *Gryllus bimaculatus* (cricket) and *Bunea alcinoe* (caterpillar) were freeze dried, oven dried, sun dried, direct solar cabinet dried, boiled before sun dried or direct solar cabinet dried. Proximate composition, available lysine, and protein digestibility were not significantly affected by drying methods. The protein digestibility corrected amino acid score was lower in boiled dried cricket and caterpillar than the other dried forms. Boiled and dried insects had lowest proportions of linoleate and α-linolenate. Despite these losses in boiled dried insects, the essential amino acid scores and lipid quality indices of differently dried insects were within desirable limits for human nutrition. Sun drying and solar cabinet drying on their own or with prior boiling could be cost-effective and affordable alternatives to freeze drying and oven drying for preserving edible insects.

Key Words: Nutritional profiling, Available lysine, Sun-drying, Solar cabinet drying

iCB 2022-61

Evaluating the Growth and Cost-Benefit Analysis of Feeding Improved Indigenous Chicken with Diets Containing Black Soldier Fly Larva Meal

Waithaka M. K., Osuga, I. M., Kabuage, L. W., Subramanian, S., Muriithi, B., Wachira, A. M. & Tanga, C. M. (2022). *Frontiers in Insect Science, 2*:933571. doi: 10.3389/finsc.2022.933571

Abstract
The high cost of feed has been the major hindrance to a hindrance to the growth, sustainability, profitability, and expansion of poultry production. Black soldier fly larva (BSFL) meal is one of the most promising alternative protein sources widely accepted globally. This study evaluated the growth performance of improved indigenous chicken (IIC)-fed diets containing different inclusion levels of BSFL meals. The BSFL meal inclusion rates included 0% (Diet0), 5% (Diet1), 10% (Diet2), 15% (Diet3), and 20% (Diet4) as replacement to the expensive fish meal in chick and grower diets. Our results showed that diet significantly affected the average daily feed intake, feed conversion ratio, and average daily weight gain of the chicks. The average daily weight gain and feed conversion ratio, except average daily feed intake of the growers, was not significantly affected by diets. The gross profit margin, cost–benefit ratio, and return on investment of feeding birds with BSFL meal varied significantly. The highest cost–benefit ratio of 2.12 was recorded for birds fed on Diet4. Our findings demonstrate that insect-based feeds can successfully and cost-effectively replace fish meal up to 20% without compromising the growth performance of the birds. Therefore, BSFL meal could be incorporated as an essential part of poultry feed production for IIC, potentially reducing the total feed cost while maintaining optimal production and reducing the cost of meat and egg products.

Key Words: Insects, Alternative protein ingredients, Poultry feed, Feed intake, Cost-effectiveness, Improved indigenous chicken, Food security

iCB 2022-62

Occurrence and Density of the Stink Bug *Antestiopsis thunbergii* Gmelin 1790 (Heteroptera: Pentatomidae) and Related Egg-Parasitoids in Burundi Coffee Agroecosystems

Mugishawimana, J., Murungi, L. K., Ndihokubwayo, S., Nibasumba, A., Haran, J., & David, G. (2022). *International Journal of Tropical Insect Science*, *42*(5), 3465-3480.

Abstract
Antestiopsis thunbergii is the most important coffee pest in Burundi causing yield losses of up to 30%. The aim of this study was to estimate its occurrence and density and to assess the species diversity of native egg-parasitoids associated to this pest in coffee agroecosystems. Our study was carried out in four coffee growing agro-ecological zones of Burundi namely; the humid west escarpments, the humid central highlands, the sub-humid central highlands and the sub-humid southeastern and northern depressions. In total, 600 coffee trees, randomly selected in 40 coffee plots of 20 communes were investigated at three phenological stages of the crop viz. October 2019 (coffee was flowering), January 2020 (coffee berries were immature green) and April 2020 (cofee berries were mature green and red). The results showed a permanent presence of *A. thunbergii* with an increasing occurrence and density with time. Densities were above the economic threshold (one antestia bug per tree), except in the humid west escarpments. Differences were highly significant among the four agro-ecological zones at each time of sampling. The humid central highlands zone registered the highest densities with 1.55, 1.31 and 2.67 antestia bugs per tree in October, January and April, respectively. The humid west escarpments zone recorded lower densities of 0.38, 0.44 and 0.88 antestia bugs per tree, for the same periods respectively. From the 4,776 eggs collected from the field, 199 egg-parasitoids of *A. thunbergii* were obtained and

identifed, namely *Trissolcus* sp. (59.2%), *Telenomus seychellensis* (29.6%), *Gryon fulviventre* (2.9%), *Anastatu*s sp. (8.1%) and *Acroclisoides africanus* (0.2%).

Key Words: Arabica coffee, *Antestiopsis thunberghii*, Occurrence, Density, Egg-parasitoid

iCB 2022-63

Efficacy of *Tagetes minuta* and *Tithonia diversifolia* Formulations against *Meloidogyne incognita* using a Novel Release Application Technique in Tomato

Macharia, R. M., Murungi, L. K., Nyambura, G. W., & Haukeland, S. (2022). *African Journal of Horticultural Science*, *20*.

Abstract

Tomato (*Solanum lycopersicum*) is an economically important crop in East Africa and is produced largely by small-scale farmers. The root-knot nematode, *Meloidogyne incognita* (Kofoid and White) Chitwood, causes serious constraints in tomato production in the African continent. Organic additives of plant origin have been known to control nematodes. The efficacy of different formulations of these additives dispensed as a slow-release in filter bags against *M. incognita* remains unknown. This study investigated the efficacy of two formulations; powder, and pellet from leaves and stems (above parts) and roots (below parts) of *Tithonia diversifolia* and *Tagetes minuta* on *M. incognita* in tomato. The filter bags were made of non-woven interfacing fusible fabric, and they contained the extracts used in the experiments. The experiment was laid out in a completely randomized design with 18 treatments and replicated four times. Tomato seedlings were inoculated with about 1500 freshly hatched second stage juveniles of *M. incognita* five days after seedling transplant. Data was collected on root galling, number of egg masses per root, root-knot nematode second-stage juveniles in the soil, and tomato yield and subjected to analysis of variance (ANOVA). Treatment means were compared using the Tukey Studentized Range Test at a 5% probability level (P = 0.05). Results showed that all formulations significantly (P= <0.001) reduced nematode populations relative to the untreated control. However, untagged (without filter bag) formulations were about five times better than the tagged (with filter bag) in both the preventive and curative trials at 42- and 84-days post-inoculation (DPI). No significant differences were observed at 126 DPI. Powder formulations of *T. minuta* roots (79%) and *T. diversifolia* leaves (78%) significantly (P = <0.001) reduced *M. incognita* juvenile populations followed by pellet formulations of *T. minuta* leaves (74%) and *T. diversifolia* roots (72%) relative to the positive control (70%) Bionematon® Powder formulations (79%) reduced RKN populations better than the pellet formulations (73%) but the yield was higher (70.7 t/ha) in the latter. Tagged powder formulations of *T. diversifolia* roots recorded a 7% decrease in yield in the preventive trial compared to the curative trial. However, within the same trial, tagged pellets of *T. minuta* roots and the positive control recorded more than 10% increase in yield relative to the curative trial. These findings indicate that formulations of *T. minuta* and *T. diversifolia* incorporated in filter bags can be used for management of RKNs in tomato and other vegetable crops

Key Words: Filter bags, Mexican marigold, Mexican sunflower, Management, Plant parasitic nematodes

iCB 2022-64

Comparison of Deep Learning Architectures for Late Blight and Early Blight Disease Detection on Potatoes

Arnaud, S. E., Rehema, N., Aoki, S., & Kananu, M. L. (2022).
Open Journal of Applied Sciences, *12*(5), 723-743.

Abstract

Potato late blight and early blight are common hazards to the long-term production of potatoes, impacting many farmers around the world, particularly in Africa. Early detection and treatment of the potato blight disease are critical for promoting healthy potato plant growth and ensuring adequate supply and food security for the fast-growing population. As a result, machine-driven disease detection systems may be able to overcome the constraints of traditional leaf disease diagnosis procedures, which are generally time-consuming, inaccurate, and costly. Convolutional Neural Networks (CNNs) have been shown to be effective in a variety of agricultural applications. CNNs have been shown to be helpful in detecting disease in plants because of their capacity to analyze vast volumes of data quickly and reliably. However, the method hasn't been widely used in the detection of potato late blight and early blight diseases, which reduce yields significantly. The goal of this study was to compare six cutting-edge CNN architectural models, taking into account transfer learning for training and four hyperparameters. The CNN architectures evaluated were AlexNet, GoogleNet, SqueezeNet, DenseNet121, EfficientNet b7, and VGG19. Likewise, the hyperparameters analyzed were the number of epochs, the batch size, the optimizer, and the learning rate. An open-source dataset containing 4082 images was used. The DenseNet121 architecture with a batch of 32 and a Stochastic Gradient Descent (SGD) optimizer with a learning rate of 0.01 produced the best performance, with an accuracy of 98.34% and a 97.37% f1-score. The DenseNet121 model was shown to be useful in developing computer vision systems that aid farmers in improving their disease management systems for potato cultivation.

Key Words: Image Classification, Convolutional Neural Networks, Transfer Learning, Hyperparameters

iCB 2022-65

Repellency Potential of Tomato Herbivore-induced Volatiles against the Greenhouse Whitefly (*Trialeurodes vaporariorum*) (Hemiptera: Aleyrodidae)

Deletre, E., Matu, F. K., Murungi, L. K., & Mohamed, S. (2022).
Journal of Economic Entomology, *115*(2), 565-572.

Abstract

The greenhouse whitefly, *Trialeurode vaporariorum*, is among the key pests of tomato (*Solanum lycopersicum*) in sub-Saharan Africa with *Tuta absoluta*, spider mite, thrips, and fruitworms. To understand the interaction between the pest and the plant's herbivory-induced plant volatile (HIPVs), we investigated the repellency of four tomato cultivars (Kilele F1, Assila F1, Red Beauty F1, and Nemonneta F1) upon infestation by *Trialeurode vaporariorum*. We analyzed the behavioral response of *T. vaporariorum* to infested and uninfested tomato plants of these cultivars using olfactory bioassays followed by gas chromatography–mass spectrometry (GC–MS) analyses of emitted volatiles. *Trialeurode vaporariorum* was attracted to uninfested plants of all four tomato

cultivars. However, two cultivars Kilele F1 and Red Beauty F1 were no longer attractive to the whitefly when they were already infested by the pest. GC–MS analyses identified 25 compounds, 18 monoterpenes, 3 sesquiterpenes, 2 xylenes, 1 aldehyde, and 1 carboxylic compound in the 4 uninfested and infested cultivars. Based on the insects' behavioral response, 1,8-cineole, p-cymene, and limonene did not attract *T. vaporariorum* at varying concentrations when combined with Red Beauty F1, the most attractive tomato cultivar. This repellence behavioral response can be used as a basis for improvement of other vegetable crops for the management of arthropod pests as for odor masking technique.

Key words: Olfactometer, GC–MS, HIPV, Repellent, IPM

iCB 2022-66

Determinants of Farmers' Choice of Pigeon Pea Marketing Channels in Machakos County, Kenya

Musyoka, C. N., Otieno, G. O., & Muendo, K. (2022).
East African Agricultural and Forestry Journal, *86*(3 & 4), 8-8.

Abstract

Markets play an essential role in agricultural transformation. Access to markets is therefore critical in expanding the commercialization of pigeon peas. Despite the strategies put in place to improve the commercialization of cereal crops, there is limited access to efficient marketing channels. This study sought to determine factors influencing the choice of marketing channels for pigeon peas in Machakos County. Data was collected using a structured questionnaire from a sample of 310 respondents. Focus group discussions from farmer groups and key informants were also undertaken to provide more insights. Data were analyzed using descriptive statistics and the Multinomial logit model. Results showed that the choice of marketing channels for pigeon peas was significantly influenced by socioeconomic factors such as the distance to the extension services, the number of household members, the quantity produced, and land size. The study concluded that the commercialization of pigeon peas requires marketing channels where farmers can access higher prices and low transaction costs to maximize their profits. The study recommends that policymakers should identify improved farmer-trader relations such as connecting farmers to sellers and buyers from other counties and exporters to improve marketing channels. There is a need for policies to promote and improve access to information and linkages to formal markets. Selling through farmer groups should be encouraged to improve pigeon peas commercialization.

Key Words: Choice, Marketing channels, Multinomial logit model, Pigeon peas

iCB 2022-67

Marketing of Dairy Goat Products in Kenya: A Survey of the Dairy Products in Selected Supermarkets in Nyeri, Meru and Kiambu Counties

Majiwa, E., Otieno, G., & Ngugi, C. (2022).
Journal of Agricultural Extension and Rural Development, *14*(2), 73-78.

Abstract
Dairy goat farming is a significant source of income, particularly for low-income families. However, 75% of the dairy goat products business is still unorganized in Kenya, making its marketing difficult. This study surveyed dairy products in selected supermarkets in Nyeri, Meru and Kiambu counties. The purpose was to identify the types of dairy products sold in supermarkets, the sales preferences, reasons for stocking and not stocking the dairy goat products and perceptions about the dairy goat products. The study targeted all the supermarkets that sold dairy products, excluding those that did not sell dairy products or were not willing to be surveyed. A sample of 40 supermarkets and 5 milk dealers in the three counties was obtained through purposeful sampling. Close-ended questionnaires were administered to managers or appointees of the outlets. According to the findings, 10 types of dairy products were stocked by the outlets as follows: Raw cow milk (11%), pasteurized cow milk (87%), long life cow milk (82%), cow milk yoghurt (93%), ghee (24%), cow mil ice cream (67%), cow milk butter (31%), cow milk cheese (36%), cow sour milk (76%) and pasteurized goat milk. Out of the 45 supermarkets/milk vendors surveyed only 5 outlets sold the dairy goat products (pasteurized milk) which thus indicate the gap in the marketing of dairy goat milk and its products in the study counties. The dairy goat products were not stocked because the products were not available (63%), lack of customers' awareness (40%), they were not preferred by customers (18%) and high price (10%). The dairy goat milk was stocked due to customers' preferences (100%). The general perception of the supermarkets was that dairy goat milk was moderately preferred (36%), highly (4%) and not preferred (60%) mainly due to lack of customers' awareness. Thus, measures should be put in place to promote dairy goat milk as an alternative to dairy cow milk due to its high nutritive value and potential.

Key Words: Dairy goat products, Marketing, Supermarkets, Sales, Preferences, Stocking.

iCB 2022-68
KAZNET: An Open-Source, Micro-Tasking Platform for Remote Locations
Chelanga, P., Fava, F., Alulu, V., Banerjee, R., Naibei, O., Taye, M., Berg, M., Galgallo, D., Gobu, W., Lepariyo, W. and Muendo, K. & Jensen, N. (2022).
Frontiers in Sustainable Food Systems, *6*, 730836.

Abstract
Field surveys are the workhorse of social and environmental research, but conventional collection through monitors or enumerators are cost prohibitive in many remote or otherwise difficult settings, which can lead to a poor understanding of those environments and an underrepresentation of the people living in them. In such cases, micro-tasking can offer a promising alternative. By activating in-situ data collectors, micro-tasking avoids many of the large expenses related to conventional field survey processes. In addition to relaxing resource constraints, crowd-sourcing can be flexible and employ data quality protocols unheard-of for conventional methods. This study assesses the potential of using micro-tasking to monitor socioeconomic and environmental indicators in remote settings using a new platform called KAZNET. KAZNET leverages the network of people with smartphones, which are becoming ubiquitous even in the remote rural settings, to execute both long-term and short-term data collection activities, with flexibility to adjust or add tasks in real-time. It also allows for multiple projects, requiring different data types, to be rolled out in the same platform simultaneously. For the data-collector, KAZNET is

effectively a wrapper for the commonly used and open source, Open Data Kit (ODK) software, which specializes in offline data collection. A web interface allows administrators to calibrate, deploy, and validate tasks performed by contributors. KAZNET has been used in several projects to collect data in remote pastoral regions of East Africa since its inception in 2017. KAZNET has shown to be effective for collecting high frequency and repeated measures from markets, households and rangelands in remote regions at relatively low cost compared to traditional survey methods. While the successes of micro-tasking are promising, there are clear trade-offs and complementarities between micro-tasking and standard surveys methods, which researchers and practitioners need to consider when implementing either approach.

Key Words: Data collection, Drylands, Pastoralists, Micro-tasking, Open-source

iCB 2022-69

Effects of Strategic Planning Practices on Success of Non-Governmental Organization in Turkana County: A Case of Save the Children

Solomon, L. E., & Sije, A. (2022).
Journal of Business and Strategic Management, 7(1), 29 48

Abstract

Purpose: The study focused on determining the impact of strategic planning practices on the success of Save the Children International. The study examined the impact of budgetary allocation on the success of Save the Children, strategic decision-making practices, strategic communication, and environmental analysis. Theory of Resource Dependency, Theory of Stakeholders, and Strategy Fit Theory anchored the study.

Methodology: Description of the study's research design was used. The 46 employees of Save the Children were the target population which included program officers, communication and dissemination officers, administrative officers, and community workers. Census was used to collect data from all targeted respondents. Data was collected through questionnaires. SPSS version 25 was used to analyze data. This study used measures of central tendency to describe the data. Presentations were made in tabular form.

Findings: The study findings revealed that, both budgetary allocation, strategic decision making, environmental analysis and governance have a positive effect of the success of organizations. The study concluded that, budget practices in the organization is effective and has positively affected on the NGO performance. The study also concluded that, strategic decision-making practices have a greater impact on the senior management and the board it was also concluded that, strategic decision-making practices gives managers an opportunity to quickly identify challenges during implementation. The study concluded that, strategic communication enhances satisfaction and team success and can only be accomplished with effective communication. The study concluded that, the SCI has not adopted modern technology in communication. The study concluded that, the SCI operates in politically and culturally non-conducive environments which has affected their performance to a great extent.

Unique contribution to theory, practice and policy: The study recommended that, the SCI should provide enough funds for budgeting activities to enable them to run their budgeting effectively. Decisions should be made strategically with an aim of enhancing strategic performance by SCI. Before deciding on where to establish the NGO, the management should ensure that prosper

scanning is done to ensure that the organization is not affected with the area politics. Further studies should therefore be conducted to determine the effect of budget allocation, strategic communication, environmental analysis, and governance of the success of the NGOs.

Key Words: Budgetary Allocation, Strategic Decision-Making Practices, Strategic Communication, Environmental Analysis and Non-Governmental Organization

iCB 2022-70

Influence of Strategic Rebranding on Performance Sustainability of Commercial Banks in Kenya

Mola, V., & Sije, A**.** (2022).
Journal of Business and Strategic Management, 7(1), 49-68.

Abstract

Purpose: The general objective of the study was establishing the influence of strategic rebranding on performance sustainability of commercial banks. The study specifically focused on establishing the influence of brand identity, brand name, brand personality and brand element on performance sustainability of commercial banks in Kenya.

Methodology: The study was anchored on Customer-Based Brand Equity (CBBE) Theory, Planned Change Theory, Evolution Theory and Social Judgement Theory. A descriptive survey research design was adopted in the study. The target population comprised of a list of commercial banks that had undergone rebranding between 2015 and 2020. The unit of observation comprised of operational and direct marketing participants comprising of product and brand managers, sales managers, marketing service managers, and promotional managers. Census approach was employed. The study used both primary and secondary data where a five-point Likert scale questionnaire was used in gathering primary data while a secondary data collection sheet was used to collect secondary data. Both descriptive and inferential statistics were employed in analyzing the collected data with the help of SPSS and Ms Excel. The results of the study were displayed in form of tables and figures. Prior collection of data, a pilot study was conducted in one commercial bank to test the reliability and validity of the data collection instrument.

Findings: The study established that strategic rebranding such as brand identity and brand personality positively and significantly influences performance sustainability of commercial bank. Brand name and brand identity were found to positively but insignificantly influence performance sustainability of the commercial banks. The results imply that increasing each of the variable with one-unit results to an increase in the levels of performance sustainability of the commercial banks with the respective beta values.

Unique contribution to theory, practice and policy: The study recommended the commercial banks in Kenya to enhance their strategic rebranding aspects in areas of brand identity, brand name, brand personality as well as brand element since the practices bears a positive influence on the levels of performance sustainability of the institutions.

Key Words: Brand Identity, Brand Name, Brand Personality, Brand Element and Performance Sustainability

iCB 2022-71

Historical Analysis of Coffee Production and Associated Challenges in Kenya from 1893 to 2018

Wanzala, R. W., Marwa, N. W., & Nanziri, E. L. (2022). *S*
outhern Journal for Contemporary History, 47(2): 51-90

Abstract

Coffee is one of the most important export crops in Kenya, contributing about 22 per cent of the national income and is a source of livelihood for more than 700 000 households. However, despite its immense importance to the Kenyan economy, coffee exports have continued to shrink. This paper explores the introduction and upscaling production of coffee in Kenya from 1893 to 2018 and associated challenges. It assesses the role of white settlers and Kenyans in coffee production during the colonial period (1893-1962) and the post-independence period (1963-2018). This research showcases how a mismatch in policy direction at a local level and insufficient support to coffee farmers in Kenya have led to a downward trajectory of coffee production. The data was collected from secondary sources and was analysed chronologically to historicise coffee production and its associated challenges. The study concludes that the dismal performance of coffee production is partly attributable to coffee prices, marketing channels, coffee financing, coffee regulations, cost of production, management of cooperatives and processing of exported coffee. Thus, it is recommended that the Kenyan government harmonise existing policies regulating the coffee industry in terms of licensing, marketing, and making credit available to farmers.

Key Words: Coffee production; Modernisation theory, Dependency theory, Theory of comparative advantage

iCB 2022-72

Does Hiring a Manager Improve Efficiency–Owner vs. Non-Owner Management Control of Rice Mills

Majiwa, E., Lee, B., Månsson, J., & Wilson, C. (2022).
Journal of Economic Studies, (ahead-of-print). DOI 10.1108/JES-12-2021-0605

Abstract

Purpose – In this study, the impact of owner-operator and non-owner operator rice mills on productive efficiency is investigated.

Design/methodology/approach – Primary data collected from a survey of 111 rice mills in the Mwea region of Kenya are used. A metafrontier approach is employed to measure overall technical efficiency which is decomposed into managerial and organisational efficiency.

Findings – The results reveal no significant difference in overall technical and managerial efficiency between owner and non-owner operated mills. However, a significant difference exists in organisational efficiency of mills: non-owner operated mills were found to be performing significantly better than owner-operated.

Practical implications – The authors provide supporting evidence to the study and discuss some of the significant policy implications stemming from the study.

Originality/value – It is recognised that for owners to take the risk of divesting control to a hired manager rather than manage the firm themselves can have major strategic, financial and often emotional consequences. However, there is little empirical evidence on how production efficiency will develop as a result of hiring a manager with the underlying economic theory providing ambiguous guidance. Standard economic theory assumes that firms behave as profit maximisers, which can be achieved by operating efficiently. However, this may not always be the case and as the literature indicates, this may especially be so for small businesses in low-and middle-income countries.

Key Words: Performance measurement, Data envelopment analysis, Efficiency, Developing countries, Owner and non-owner operated mills

iCB 2022-73

Determinants of Access to Agricultural Credit among Smallholder Rice and Maize Farmers in the Eastern and Western Provinces of Rwanda

Taremwa, N. K., Macharia, I., Bett, E., & Majiwa, E. (2022).
Agro-Science, 21(2), 1-11. DOI: https://dx.doi.org/10.4314/as.v21i2.1

Abstract

Agricultural credit is believed to play a catalytic role in enhancing agricultural productivity; however, its access is limited for smallholder farmers in Rwanda. To investigate this phenomenon, this study sought to identify and assess the determinants of access to agricultural credit among rice and maize smallholder farmers in Rwanda. The study was conducted in the eastern and western provinces of Rwanda using a cross-sectional survey design. Sample districts, sectors, and cells were obtained using stratified random sampling techniques. Convenient and purposive samplings were used to sample households and farmers, respectively. Data were collected using structured interviews and questionnaires, and were analyzed using a binary logistic regression model. Model results indicated that both individual and institutional factors determine access to agricultural credit among smallholder maize and rice farmers in eastern and western provinces of Rwanda. The individual factors included: saving of money in commercial banks (Adjusted Odds Ratio (AOR) = 2.389), owning a size of land that is 0-0.1 ha (AOR = 0.127), and knowledge of the repayment terms of agricultural loans (AOR = 0.203), while the institutional factors included: having privately-owned finance institutions in the area (AOR = 0.287), offer of both long and short-term loans (AOR = 0.290), interest rate between 11-15% (AOR = 0.178), the process for obtaining agricultural credit not being too long (AOR = 2.026). Institutional factors were more important than the individual farmer characteristics in determining access to credit. Policy interventions aimed at bolstering agricultural credit access among the smallholder farmers should address institutional challenges such as information asymmetry and the lack of credit guarantees that hinder agricultural credit access.

Key Words: Smallholder farmers, Agricultural productivity, Agricultural credit, Access, Determinants

iCB 2022-74

Effects of Different Soil Management Strategies on Fertility and Crop Productivity in Acidic Nitisols of Central Highlands of Kenya

Otieno, E. O., Mburu, D. M., Ngetich, F. K., Kiboi, M. N., Fliessbach, A., & Lenga, F. K. (2023). *Environmental Challenges*, 100683. https://doi.org/10.1016/j.envc.2023.100683

Abstract

Managing soil fertility, especially nitrogen (N) and phosphorus (P), to sustain increased crop productivity is a complex challenge, especially in cultivated Nitisols. Experiments were conducted over eleven (11) cropping seasons in the acidic Nitisols to assess the impact of soil management strategies on soil N, P, and crop productivity. Fourteen treatments were laid out in a Randomized Complete Block Design. The treatments include; control (C), conventional tillage + inorganic fertilizer (CTF), conventional tillage + maize residues + inorganic fertilizer (CTCrF), conventional tillage + maize residues + inorganic fertilizer + goat manure (CTCrGF), conventional tillage + maize residues + *Tithonia diversifolia* + rock phosphate (CTCrTiR), conventional tillage + maize residues+ goat manure + *Dolichos lablab* (CTCrGL), conventional tillage + maize residues + *Tithonia diversifolia* + goat manure (CTCrTiG), minimum tillage (MT; no amendments), minimum tillage + inorganic fertilizer (MTF), minimum tillage + maize residues + inorganic fertilizer (MTCrF), minimum tillage + maize residues + inorganic fertilizer + goat manure (MTCrGF), minimum tillage + maize residues + *Tithonia diversifolia* + rock phosphate (MTCrTiR), minimum tillage + maize residues + goat manure + *Dolichos lablab* (MTCrGL), and minimum tillage + maize residues + *Tithonia diversifolia* + goat manure (MTCrTiG). Available P was significantly higher by 51, 48, 43, 38, 37, 36 and 27% under MTCrGF, CTCrGF, MTCrF, CTF, CTCrF, MTCrGL, and CTCrTiG than the control. Available soil N was significantly higher (59, 59, 59, 57, 57, 57, 55, 55, 55, 50, and 50%) under MTCrGL, CTCrGL, CTCrTiR, MTCrTiR, MTCrF, CTCrTiG, MTF, CTCrGF, CTF, MTCrTiG and MTCrGF compared to the control. Grain radiation use efficiency was significantly higher under CTCrGF, MTCrF, CTCrTiR, CTF, MTCrTiG, CTCrF, MTCrGF, CTCrTiG, and MTCrTiR than the control by 95, 93, 93, 93, 92, 92, 92, 91 and 88% during the SR2020 cropping season. In the LR2021 season, it was significantly higher under CTCrGL, MTCrGL, CTCrGF, CTF, MTCrGF, CTCrF, MTF, MTCrF, MTCrTiG, MTCrTiR, CTCrTiG and CTCrTiR than the control by 80, 79, 78, 77, 77, 74, 73, 72, 70, 67, 66 and 62%. Grain yield was significantly higher under CTCrGF, MTCrF, CTCrF, MTCrGF, MTCrTiG, CTCrTiR, CTF, CTCrTiG, and CTCrTiR than the control in the SR2020 season by 95, 93, 93, 93, 92, 92, 92, 92 and 88%. During LR2021, CTCrGF recorded the highest grain yield, which was 74% higher than the control, while CTCrGL, MTCrGF, MTCrGL, CTF, MTCrF, CTCrF, MTF, MTCrTiG, CTCrTiG, MTCrTiR, and CTCrTiR, had higher yields than the control by 73, 71, 70, 69, 69, 66, 65, 64, 58, 55 and 49%. Overall, CTCrGF, CTCrGL, MTCrGF, and MTCrGL had a comparative advantage regarding soil fertility and crop productivity in acidic Nitisols, strongly illustrating the concept of 'complementarity' in integrated soil fertility management.

Key Words: Soil fertility, Radiation use efficiency, Water productivity, Nitisols

iCB 2022-75

Environmental and Economic Impacts of Biodegradable Plastic Film Mulching on Rainfed Maize: Evaluations on Sustainability and Productivity

Cheruiyot, W. K., Wang, W., Zhu, S. G., Kavagi, L., Zhang, X. C., Mburu, D. M., Ma, M.S., Munyasya, A.N., Koskei, K., Indoshi, S.N., Nyende, A.B., Tao, H. Y. & Xiong, Y. C. (2022). *ACS Agricultural Science & Technology*, *2*(5), 908-918.

Abstract

Fully biodegradable (Bio) plastic film is an alternative option to replace widely used polythene film in semiarid rainfed regions. However, its productivity and environmental friendliness remain unclear. Field observations were conducted using maize variety Pioneer 335 to evaluate the effects of Bio film mulching on soil hydrothermal status, carbon sequestration, and water productivity in a semiarid site of northwest China from 2016 to 2017. Six treatments were designed as (1) CK-1, ridge and furrow (RF) without mulching, (2) CK-2, conventional flat planting without mulching, (3) RFT, RF with transparent polyethylene film mulching, (4) RFB, RF with black polyethylene mulching, (5) RFS, RF with wheat straw mulching, and (6) RFBIO, RF with Bio film mulching. The results indicated the growth prophase of maize from sowing to silking stage received 160 mm of rainfall in cool and wet 2016, but decreased to 119.8 mm in warm and dry 2017. Bio film degradation was advanced at the mid stages of maize growth by 10 days in 2017 compared with 2016. Similarly to RFT, RFBIO significantly improved soil hydrothermal conditions compared with RFS, CK-1, and CK-2; however, its magnitude decreased at the maturity stage ($P < 0.05$). Both RFT and RFB had significantly higher grain yields, economic benefits and water use efficiencies than RFBIO and RFS did across two growing seasons ($P < 0.05$). RFBIO led to a steady improvement in soil organic carbon, light fraction organic carbon, and carbon to nitrogen ratio, which were better than those of RFT. Therefore, Bio film mulching might be environmentally friendly but not highly productive.

Key Words: Biodegradable film, Polythene film, Climatic pattern, Productivity and profitability, Soil organic carbon, Semi-Arid area

iCB 2022-76

Integrated On-Site & Off-Site Rainwater-Harvesting System Boosts Rainfed Maize Production for Better Adaptation to Climate Change

Munyasya, A. N., Koskei, K., Zhou, R., Liu, S. T., Indoshi, S. N., Wang, W., Zhang, X. C., Cheruiyot, W. K., Mburu, D. M., Nyende, A. B. & Xiong, Y. C. (2022). *Agricultural Water Management*, *269*, 107672.

Abstract

Solving the disparity between rainwater supply and crop water demand is a fundamental issue in semiarid rainfed agriculture. Over the last decades, the ridge-furrow-plastic-mulching (RFM) farming system has been widely used as an on-site (in-situ) rain-harvesting farming strategy, providing a partial solution to the supply-demand mismatch of rainwater. The off-site rain-harvesting system (ex-situ water cistern) for supplemental irrigation has been little used. We established an integrated ex-situ rain-harvesting system incorporated into maize RFM in a semiarid site of northwest China from 2018 to 2019. Five treatments were designed as: (1) CK-1, flat

planting without mulching and irrigation, (2) CK-2, RFM without irrigation, (3) RFM60, RFM with 60 mm irrigation, (4) RFM105, RFM with 105 mm irrigation, and (5) RFM150, RFM with 150 mm irrigation. We found that supplemental irrigation treatments significantly increased grain yield, total biomass, and crop water productivity compared to CK-1 and CK-2 ($P < 0.05$) across two growing seasons, suggesting that ex-situ rain-harvesting irrigation can significantly promote field productivity based on widely used RFM system. The differences mentioned above were the greatest in RFM105 and RFM150, significantly greater than those of RFM60. No significant difference was observed between RFM150 and RFM105. Greater output in RFM150 and RFM105 was closely associated with improved soil water storage and thermal state in two growing seasons. Particularly, RFM150 and RFM105 harvested the highest soil organic carbon and total nitrogen after the second fallow period. The highest economic benefit was found in RFM105, followed by RFM150 and RFM60, the least in the two control groups. Our findings provided a critical case to solve the rainfall supply-demand mismatch. The ex-situ rainwater-harvesting supplemental irrigation can act as a promising solution to upgrade the current widely-used RFM farming system for better adaptation to climate change in the semiarid region.

iCB 2022-77

Greenhouse Gas Emissions Response to Fertilizer Application and Soil Moisture in Dry Agricultural Uplands of Central Kenya

Mosongo, P. S., Pelster, D. E., Li, X., Gaudel, G., Wang, Y., Chen, S., Li, W., Mburu, D. & Hu, C. (2022). *Atmosphere, 13*(3), 463.

Abstract

In sub-Saharan Africa, agriculture can account for up to 66% of anthropogenic greenhouse gas (GHG) emissions. Unfortunately, due to the low number of studies in the region there is still much uncertainty on how management activities can affect these emissions. To help reduce this uncertainty, we measured GHG emissions from three maize (*Zea mays*) growing seasons in central Kenya. Treatments included: (1) a no N application control (C); (2) split (30% at planting and 70% 1 month after planting) mineral nitrogen (N) applications (Min—100 kg N ha^{-1}); (3) split mineral N + irrigation (equivalent to 10 mm precipitation every three days—MI); (4) split mineral N + 40 kg N ha^{-1} added as manure (MM—total N = 140 kg ha^{-1}); and (5) split mineral + intercropping with faba beans (*Phaseolus vulgaris*—MB). Soil CO_2 fluxes were lower in season 1 compared to seasons 2 and 3 with fluxes highest in Min ($p = 0.02$) in season 2 and lowest in C ($p = 0.02$) in season 3. There was uptake of CH_4 in these soils that decreased from season 1 to 3 as the mean soil moisture content increased. Cumulative N_2O fluxes ranged from 0.25 to 2.45 kg N_2O-N ha^{-1}, with the highest fluxes from MI during season 3 ($p = 0.01$) and the lowest from C during season 1 ($p = 0.03$). The average fertilizer induced emission factor (0.36 ± 0.03%) was roughly one-third the default value of 1%. Soil moisture was a critical factor controlling GHG emissions in these central Kenya highlands. Under low soil moisture, the soils were CH_4 sinks and minimal N_2O sources.

Key Words: Nitrogen fertilization; Greenhouse gases; Sub-Saharan Africa; Small scale farmers

iCB 2022-78

Effect of Mineral N Fertilizer and Organic Input on Maize Yield and Soil Water Content for Assessing Optimal N and Irrigation Rates in Central Kenya

Aluoch, S. O., Li, Z., Li, X., Hu, C., Mburu, D. M., Yang, J., Xu, Q., Yang, Y. & Su, H. (2022). *Field Crops Research*, *277*, 108420.

Abstract

Maize (*Zea mays* L.) is an important food crop in Kenya, while low and erratic rainfall, and low nutrient input mainly result in low maize yield. This study were to assess optimal nutrient and irrigation management practice for maize in central Kenya based on field experiment combined with modeling simulation. On-farm experiment with four treatments including no fertilizer (N0), N applied at dose of 100 kg ha^{-1} only in the form of a chemical fertilizer (N100) or combined with animal manure (N100M) or straw (N100S) has been conducting since 2013 in central Kenya. The Decision Support System for Agro-technology Transfer–Cropping System Model (DSSAT–CSM) was firstly calibrated under the relative optimal treatment N100M, and it was then evaluated for the rest three treatments for 6 maize growing seasons from 2014 to 2018. The responses of grain yield to different irrigation and fertilizer regimes were simulated using the calibrated DSSAT–CSM. The combination of fertilizer and manure (N100M) resulted in the highest yield and that of fertilizer and straw (N100S), in the highest level of soil water content in each soil layer. The model (DSSAT-CSM) successfully predicted both grain yield (normalized root mean square error, or *nRMSE*, of 21–37% and the index of agreement, or *d*, of 0.89–0.93) and changes in water content of each soil layer (*Nrmse* < 20% and $d > 0.70$) in all treatments except N100S. The yield was most sensitive to any deficit in soil water content (dry spells) at the beginning of grain-filling stage, and the best regime for high yield, high water-use efficiency, and high agronomic efficiency comprised irrigation at 50–70 mm during that stage combined with fertilizer N at 100–120 kg ha^{-1}. The estimated magnitude yield gain with respect to optimal nutrition and irrigation ranged from 2 to 4 t ha^{-1} in different crop seasons. Optimal application of irrigation at the sensitive stage, fertilizer N, animal manure, and straw mulching holds great potential as an integrated farming practice for high grain yield and for efficient use of resources in maize cultivation in semi-arid parts of Kenya.

iCB 2022-79

Effectiveness of Common Preprocessing Methods of Time Series for Monitoring Crop Distribution in Kenya

Ni, R., Zhu, X., Lei, Y., Li, X., Dong, W., Zhang, C., Chen, T., Mburu, D.M**.** & Hu, C. (2022). *Agriculture*, *12*(1), 79.

Abstract

Accurate crop identification and spatial distribution mapping are important for crop production estimation and famine early warning, especially for food-deficit African agricultural countries. By evaluating existing preprocessing methods for classification using satellite image time series (SITS) in Kenya, this study aimed to provide a low-cost method for cultivated land monitoring in sub-Saharan Africa that lacks financial support. SITS were composed of a set of MODIS Vegetation Indices (MOD13Q1) in 2018, and the classification method included the Support Vector Machine (SVM) and Random Forest (RF) classifier. Eight datasets obtained at three levels of preprocessing from MOD13Q1 were used in the classification: (1) raw SITS of vegetation

indices (R-NDVI, R-EVI, and R-NDVI + R-EVI); (2) smoothed SITS of vegetation indices (S-NDVI); and (3) vegetation phenological data (P-NDVI, P-EVI, R-NDVI + P-NDVI, and P-NDVI-1). Both SVM and RF classification results showed that the "R-NDVI + R-EVI" dataset achieved the highest performance, while the three pure phenological datasets produced the lowest accuracy. Correlation analysis between variable importance and rainfall time series demonstrated that the vegetation index SITS during rainfall periods showed higher importance in RF classifiers, thus revealing the potential of saving computational costs. Considering the preprocessing cost of SITS and its negative impact on the classification accuracy, we recommend overlaying the original NDVI with the original EVI time series to map the crop distribution in Kenya.

Key Words: Kenya; Satellite image time series; MODIS; Random forest; Support vector machine; Cropland; TIMESAT; Phenometrics

iCB 2022-80

Assessment of the Impact of Environment Protection in Rwanda: A Case Study of Rugezi Marshland

Gaspard, N., Ogwal, H., Habinshuti, J. B., Protais, M., Munganyinka, J. P., Mburu, D. M., & Festus, M. (2022).

NASS Journal of Agricultural Sciences, 4(1): 59-55.

Abstract

Environmental protection is one of the most important measures to achieve the long run and sustainability of living organisms in the world. The study was conducted in Burera and Gicumbi districts with the main aim of assessing the impact of environment protection in Rwanda. A case study of Rugezi Marchland. Data were collected using a structured questionnaire and analyzed using SPSS statistical software version 20 and STATA statistical software vision 13. Off-farm income, occupation, educational level, age, and farm size, showed a positive relationship with Rugezi marchland protection. Variables such as value of product distance to Rugezi marchland, gender, and family size had a negative influence on Rugezi marchland protection. The study also indicated that factors such as water management, increase of grass species, increase of wild animals and birds, modern house construction, zero grazing keeping revealing a positive relationship with Rugezi marchland protection. Two most serious problems encountered are the lack of occupation and low level of education.

Key Words: Assessment, Impact, Environment protection, Rugezi Marshland

iCB 2022-81

The Effects of Lake Ol'Bolossat's Sediments Application on Soil-Chemical Characteristics and Productivity of Swiss Chard (*Beta vulgaris* L.)

Wagacha, W. P., Obiero, C., Waweru, G. & Ngamau, C. (2022).

Journal of Agriculture, Science and Technology, 21(3), 30-48.

Abstract

Sediments dredged from the lakes have emerged as successful soil amendment solutions, especially in alleviating soil fertility problems in poor soils. This study aimed to assess the effect

of sediments from Lake Ol'Bolossat on soil quality and the growth and yield of Swiss chard (*Beta vulgaris* L.). A pot experiment was carried out in January-April and July-October 2020 in a polyethylene greenhouse using a completely randomized design at the Jomo Kenyatta University of Agriculture and Technology. To achieve the study's objective, Swiss chard (Ford hook giant variety) was grown in pots, and five treatments were applied; (T1)- sediments from lake depth of 0-30 cm + soil, (T2)-sediments from lake depth of 30-60 cm + soil, (T3)-sediments from lake depth of 60-90 cm + soil, (T4)-inorganic fertilizer (NPK 150 kg/acre) + soil, (T5)-soil with no lake sediments or inorganic fertilizers, which acted as the control experiment. The sediments were mixed with soil at a ratio of 1:4. The study's results showed that the lake sediments had a significant impact on the soil's major nutrients. After soil amendment, T1, T2, and T4 resulted in a significantly higher nitrogen value than T3 and T5 (0.38 mg/g, 0.38 mg/g, 0.26 mg/g, 0.29 mg/g, and 0.04 mg/g, respectively). T1 and T2 recorded significantly high levels of potassium (3.8% and 3.9%). T1 and T2 had the highest phosphorus content (3.8 mg/g and 4.2 mg/kg, respectively). Lake sediment treatments, T1, T2, and T3, had significantly high total organic carbon values (13 mg/g, 13 mg/g, and 11 mg/g, respectively). pH was lower in T4 (4.3) and electro conductivity (E.C) was higher in the same treatment (0.5) than in the other treatments. This study also demonstrated significantly high values of plant height, leaf length, leaf width, and the number of leaves in T1 and T2 in both growing seasons. The average plant height values for the five treatments were 34.8cm, 34.9cm, 29.8cm, 29.6cm, and 24.8 cm, respectively, and the leaf length values were 25cm, 24.8cm, 23.9cm, 24.4 cm, and 23.1cm, respectively. The lake sediments obtained from 0-30cm and 30-60 cm depth had a significantly higher positive impact, and they resulted in better productivity and subsequently higher dry matter of Swiss chard (25.2g/plant and 25g/plant, respectively) compared to the productivity of Swiss chard grown using lake sediments from 60-90 cm depth, which was approximately 19g/plant. The study demonstrated that sediments play an essential role in improving the productivity of Swiss chard and the quality of agricultural soils.

Key Words: Lake sediment, *Beta vulgaris* L., Crop productivity, Soil nutrient quality.

iCB 2022-82

Farmers' Perception of Climate Change and their Adaptation Strategies in the Sagana-Gura Sub-watershed in the Upper Tana Catchment Area

Maundu, P. M., Obiero, C. C., & Adimo, A. O. (2022).
International Journal of Arts and Social Science, 5(6): 73-84

Abstract

Successful implementation of conservation programs in the Upper Tana Catchment Area (UTCA) can only be achieved through sustainable resource management and use. Thus, understanding farmers' perceptions of climate change is vital for promoting conservation programs. This study sought to understand farmers' perceptions of climate change and their adaptation strategies by comparing meteorological data with farmers' perceptions in the Sagana-Gura sub-watershed. A mixed method research design was used. This involved rainfall data from nine rain gauge stations and primary data on farmers' perceptions of climate change. Farmers' coping strategies were also examined. The primary data was collected through a survey based on a stratified sample of 284 heads of farm households upstream and downstream of the sub-watershed. A standardized precipitation index (SPI) was developed to examine the temporal variation in precipitation. The

study found that eight extremely dry months were recorded between 1980 and 2012, with five of these months occurring between 1999 and 2012. This result supports farmers' perception that precipitation has not only decreased but has also become erratic and unpredictable. As a result, farmers are increasingly resorting to irrigation and diversification of their economic activities by engaging in enterprises that also contribute to soil erosion and forest destruction.

Key Words: Catchment Area, Climate Change, Perception

iCB 2022-83

Effect of Using Mobile Phone Communication on Dietary Management of Type 2 Diabetes Mellitus Patients in Kenya

Theuri, A. W., Makokha, A., Kyallo, F., & Gichure, J. N. (2022).
Journal of Diabetes & Metabolic Disorders, 1-8.

Abstract

Purpose: Advancements in management of non-communicable diseases using regular reminders on lifestyle and dietary behaviors have been effectively achieved using mobile phones. This study evaluates the effects of regular communication using a mobile phone on dietary management of Type 2 Diabetes Mellitus (T2DM) among patients attending Kitui County Referral Hospital (KCRH) in Kenya.

Methods: Pre/post-study design among eligible and consenting T2DM patients visiting KCRH was used for this study. One hundred and thirty-eight T2DM patients were enrolled; 67 in the intervention group (IG) and 71 in the control group (CG). The IG received regular reminders on key dietary practices through their mobile phones for six months while the CG did not. The Net Effect of Intervention (NEI) and bivariate logistic regression were used to determine the impact of mobile phone communication intervention at $p < 0.05$. SPSS version 24 was used to analyze the data.

Results: The results revealed an increase of respondents who adhered to the meal plan in the IG from 47.8% to 59.7% compared to a decrease from 49.3% to 45.1% in CG with corresponding NEI increasing (16.1%) significantly ($p < 0.05$). The proportion of respondents with an increased frequency of meals increased from 41.8 to 47.8% in the IG compared to a reduction from 52.1% to 45.1% in the CG with corresponding NEI increasing (13.0%) significantly ($p < 0.05$).

Conclusion: Regular reminders on lifestyle and dietary behaviors using mobile phone communication improved adherence to dietary practices such as meal planning and frequency of meals in the management of T2DM.

Key Words: Type 2 Diabetes Mellitus, Dietary practices, Mobile phone technology, Regular communication

iCB 2022-84

Exploring the Status of Preference, Utilization Practices, and Challenges to Consumption of Amaranth in Kenya and Tanzania

Nyonje, W. A., Yang, R. Y., Kejo, D., Makokha, A. O., Owino, W. O., & Abukutsa-Onyango, M. O. (2022). *Journal of Nutrition and Metabolism, 2022. https://doi.org/10.1155/2022/2240724*

Abstract

African leafy vegetables such as amaranth have been utilized since time immemorial both as food and as medicine. These vegetables grew naturally in most rural environments, but currently most of them are cultivated both for home consumption and for sale. The aim of this study was to identify the most preferred amaranth species and cooking and utilization practices, as well as the beliefs and attitudes that encourage or discourage use of this vegetable. The study was carried out in seven counties of Kenya and in three regions in Tanzania. Twenty Focus Group Discussions (FGDs) with members of the community and twenty Key Informant Interviews (KIIs) with agricultural and nutrition officers were conducted in the study areas to obtain information on preferred varieties, sources of amaranth vegetables, common cooking methods, alternative uses, beliefs and taboos surrounding amaranth consumption, and the challenges experienced in production and consumption. The findings of the study showed that amaranth is one of the most commonly consumed indigenous vegetables in Kenya and Tanzania. The preference for varieties and cooking habits differs depending on the community and individuals. *Amaranthus dubius* and *Amaranthus blitum* were most common in Kenya, while *Amaranthus dubius* and *Amaranthus hypochondriacus* were most common in Tanzania. Most people consumed these vegetables because they were affordable and available or because of circumstance of lacking other foods. Regarding cooking, final taste was mostly considered rather than nutritional attribute. Several alternative uses of amaranth such as uses as medicine and livestock feed were also reported, as well as some beliefs and taboos surrounding the vegetable. Training on nutritional attributes and promotion of food preparation practices that ensure maximum nutrient benefits from amaranth is needed at the community level to realize the nutritional importance of the vegetables. Hands-on training and demonstrations were the most preferred modes of passing information.

iCB 2022-85

Camel Milk Products beyond Yoghurt and Fresh Milk: Challenges, Processing and Applications

Marete, P. K., Mariga, A. M., Huka, G., Musalia, L., Marete, E., Mathara, J. M., & Arimi, J. M. (2023). *Journal of Food Science and Technology*, 1-10.

Abstract

Camel (*Camelus dromedaries* and (*Camelus bactrianus*) are commonly domesticated in the arid and semi-arid regions because they are well adapted to live in harsh climatic conditions. Camel milk is widely consumed in these regions due to its high nutritional value and medicinal properties. It is rich in protein, minerals and vitamins. Moreover, it possesses therapeutic properties such as anti-microbial, anti-oxidants, anti-viral and anti-cancer. Camel milk can be processed into value added products with the aim of extending shelf life and diversifying its usage. However, there are various challenges experienced in processing of camel milk products. This study aims at reviewing published literature on camel milk products processing, processing challenges, the available solutions and applications. To achieve these aims, literature search was carried out using narrative methodology. Literature review provided information concerning processing of camel milk products, the challenges, how to overcome these processing challenges and applications. From this review of literature on camel milk products it can be concluded that it's possible to process these products with some challenges but scientific and technological solutions are available that are improving over time.

Key Words: Camel milk, Challenges, Processing, Applications

iCB 2022-86

Production and Characterisation of Camel Milk Yoghurt Containing Different Types of Stabilising Agents

Oselu, S., Ebere, R., Huka, G., Musalia, L., Marete, E., Mathara, J. M., Mwobobia, F. & Arimi, J. M. (2022). *Heliyon, 8*(11), e11816.

Abstract

As at 2020, Kenya was the best performing camel milk producer globally, with an annual production of 1.125 million tonnes. Despite the high production, about 50% of milk is wasted due to challenges affecting value addition to products such as yoghurt. The production of camel milk yoghurt faces multiple challenges, such as poor texture and weak structure, resulting in poor consumer acceptability. This study aimed to improve the physicochemical properties of camel milk yoghurt by adding different stabilising agents and calcium chloride. Yoghurt samples were processed using 3 L of camel milk, 6% sugar, 0.006% starter cultures, corn starch or modified starch and calcium chloride. The stabilisers were added at 2, 2.5, and 3% and Calcium Chloride at 0.075%. The milk was pasteurised at 90 °C for 30 min. Fermentation was performed for 6 h at 42 ±1 °C, and yoghurt was stored at 4 °C. The total titratable acidity, pH and viscosity were monitored hourly during fermentation and storage, while syneresis and water holding capacity were analysed at 1, 7, 14 and 21 days of refrigerated storage. The sensory evaluation was done using the 9-point hedonic scale to rate yoghurt samples' overall acceptability, colour, sweetness and thickness. The TTA of camel milk yoghurt increased with increasing fermentation time (0–6 h) and storage time from 1 to 21 days. The pH decreased with increasing fermentation time (0–6 h) and storage time from 1 to 21 days. The addition of stabilisers increased the viscosity of the yoghurt, with 3% corn starch exhibiting the highest viscosity throughout the fermentation and storage time. Corn starch had a higher effect on viscosity compared to modified starch. Calcium chloride further amplified the viscosity of the yoghurt. The addition of stabilisers reduced syneresis by over 44% compared to bovine yoghurt. In this study, the best results of viscosity, syneresis and sensory evaluation were observed when stabilising agents were added at the rate of 2.5% modified starch and 0.075% Calcium chloride.

Key Words: Corn starch, Modified starch, Camel milk yoghurt, Physicochemical properties, Rheological properties

iCB 2022-87

Lactic Acid Bacteria from African Fermented Cereal-Based Products: Potential Biological Control Agents for Mycotoxins in Kenya

Wafula, E. N., Muhonja, C. N., Kuja, J. O., Owaga, E. E., Makonde, H. M., Mathara, J. M., & Kimani, V. W. (2022). *Journal of Toxicology*, *2022*. Article ID 2397767.

Abstract

Cereals play an important role in global food security. Data from the UN Food and Agriculture Organization projects increased consumption of cereals from 2.6 billion tonnes in 2017 to

approximately 2.9 billion tonnes by 2027. However, cereals are prone to contamination by toxigenic fungi, which lead to mycotoxicosis. The current methods for mycotoxin control involve the use of chemical preservatives. However, there are concerns about the use of chemicals in food preservation due to their effects on the health, nutritional quality, and organoleptic properties of food. Therefore, alternative methods are needed that are affordable and simple to use. The fermentation technique is based on the use of microorganisms mainly to impart desirable sensory properties and shelf-life extension. The lactic acid bacteria (LAB) are generally regarded as safe (GRAS) due to their long history of application in food fermentation systems and ability to produce antimicrobial compounds (hydroxyl fatty acids, organic acids, phenyllactic acid, hydrogen peroxide, bacteriocins, and carbon dioxide) with a broad range of antifungal activity. Hence, LAB can inhibit the growth of mycotoxin-producing fungi, thereby preventing the production of mycotoxins. Fermentation is also an efficient technique for improving nutrient bioavailability and other functional properties of cereal-based products. This review seeks to provide evidence of the potential of LAB from African fermented cereal-based products as potential biological agents against mycotoxin-producing fungi.

iCB 2022-88

Application of Portable Near-Infrared Spectroscopy for Rapid Detection and Quantification of Adulterants in Baobab Fruit Pulp

Yegon, D., Ojijo, N. K., Tybussek, T., & Owino, W. (2023).
International Journal of Food Science & Technology, *58*(3), 1465-1473.

Abstract

Baobab fruit pulp powder (BFPP) is susceptible to economically driven adulteration owing to its incredible nutrient density and rapidly expanding demand worldwide. In this study, a portable NIR spectroscopy (wavelength 900–1700 nm) coupled with chemometrics was used for the detection of BFPP adulteration. BFPP samples separately adulterated with rice flour (RF), wheat flour (WF), and maize flour (MF) at 0%, 1%, 3%, 5%, 10%, 15%, 20%, 25%, 30%, 40%, 50% and 60% concentrations were subjected to NIR spectroscopy. Two-class models proved to be reliable with sensitivity and specificity of above 0.98 and an error of below 0.01. Four-class models attained sensitivity and specificity of above 0.68 and an error of below 0.276. The correlation coefficient (R2) and root mean square error (RMSE) of the prediction set were above 0.88 and below 6.20% respectively for PLSR models. The LODs were also below 13.79%. Therefore, NIR spectroscopy has a promising potential for rapid screening of BFPP adulterations.

Key Words: Authentication, Chemometrics, Flours, Food fraud, Multivariate analysis, Near-infrared spectroscopy

iCB 2022-89

Baobab Pulp Authenticity and Quality Control by Multi-Imaging High-Performance Thin-Layer Chromatography

Chepngeno, J., Imathiu, S., Owino, W. O., & Morlock, G. E. (2022).
Food Chemistry, *390*, 133108.

Abstract
Globalization of trade and increasing demand for baobab fruit pulp powder (*Adansonia digitata*) has led to more adulteration incidence with physically similar products, *e.g.* sifted cereal flours. In this study, 135 baobab samples drawn from trees in Kitui and Kilifi (Kenya) and North and South Kordofan (Sudan) were used as the reference and compared with adulterated (with 10–30% sifted rice, maize and wheat flours) baobab samples using multi-imaging by high-performance thin-layer chromatography. The ethanol – water extracts were separated on a normal phase. Any differences were detected via multi-imaging (UV/Vis/FLD) including diphenylamine alanine *o*-phosphoric acid, *p*-anisaldehyde sulfuric acid and *p*-amino benzoic acid reagents. Raffinose was identified as a marker compound for cereal-based adulteration. The method accuracy (recovery of 95%) and detection from 10–30% flour addition onwards are sufficient to curb economically motivated adulteration, to control product quality and to ensure consumer protection for local and international trade.

Key Words: Adulteration, Food product authentication, Food quality control, Food safety, Flour, Starch

iCB 2022-90

Effects of Supplementing Lactating Somali Camels with *Opuntia stricta* and Cottonseed Cake on Feed Intake, Milk Yield, and Milk Composition

Ikanya, L. W., Maina, J. G., Gachuiri, C. K., Owino, W. O., & Dubeux, J. C. B. (2022). In *X International Congress on Cactus Pear and Cochineal: Cactus the New Green Revolution in Drylands 1343* (pp. 171-180). DOI: 10.17660/ActaHortic.2022.1343.24

Abstract
Opuntia has been used as forage feed for livestock during dry seasons. In Kenya, *Opuntia* has invaded arid and semi-arid lands conservation areas, rangelands and cultivation areas covering hundreds of acres of land as a noxious weed with negative environmental impacts. The study was therefore conducted to determine the effects of supplementing lactating Somali camels with *Opuntia stricta* and cottonseed cake on feed intake and milk yield. Eight Somali lactating camels were selected and fed for 84 days using 4×4 Latin square design replicated twice, one square for each cladode growth stage (young and mature) to determine the effects of supplementing lactating grazing camels with *Opuntia stricta* and cottonseed cake on milk yield and milk composition. The supplements were offered to camels after grazing in the range for 4 h. The four treatments were: grazing only (control); grazing supplemented with *Opuntia stricta* only; grazing supplemented with *Opuntia stricta* plus cottonseed cake; grazing supplemented with cottonseed cake only. The young cladodes, mature cladodes, and cottonseed cake were analyzed for their chemical composition, fiber fractions and in vitro digestibility. The feed intake was determined, the dry matter and crude protein intake were monitored. The milk yield was determined using a digital weighing balance and milk composition using the Lacto scan milk analyzer system. The young cladodes had greater crude protein (15.8%), ether extract (2.5%), calcium (2.4%) and phosphorus (0.4%) concentrations than the mature cladodes (4.4, 1.6, 1.7, and 0.2%, respectively), on a dry matter basis. There was no difference in daily dry matter intake between camels fed on the different supplemental diets (P>0.05). The milk yield and milk composition were not affected by the treatments. The study concluded that young cladodes were nutritionally superior to the mature

cladodes. Supplementation of both the young and mature cladodes are recommended to counteract the nutritional difference.

Key Words: Cottonseed cake, Chemical composition, *in vitro* digestibility, Lactating camels

iCB 2022-91

Feed Intake, Milk Yield and Milk Composition of Somali Camels Supplemented with *Opuntia stricta* and Urea

Ikanya, L. W., Maina, J. G., Owino, W. O., & Dubeux, J. C. B. (2022). In *X International Congress on Cactus Pear and Cochineal: Cactus the New Green Revolution in Drylands 1343* (pp. 207-212). DOI: 10.17660/ActaHortic.2022.1343.28

Abstract

Opuntia stricta is regarded as an invasive species in arid and semi-arid land regions in Kenya where there is a growing number of Kenyans keeping camels. One of the challenges experienced in camel rearing is fodder shortage, especially during periods of prolonged drought. Cactus is drought resilient and tolerates severe utilization during prolonged droughts. This study was conducted to determine the effects of supplementing dairy camels with processed *O. stricta* and urea on feed intake, milk yield, and milk composition. Eight lactating dromedary Somali camels were kept under traditional management conditions and supplemented with processed *O. stricta* and urea in a 4×4 Latin square experimental design for 84 days divided into four periods of 21 d. Each experimental period included 14 d for adaptation of the animals to the experimental treatments and seven days for data collection. The supplementation was offered to camels for four hours before and after grazing in the range. The treatments were: grazing only (control); grazing supplemented with chopped *O. stricta*; grazing supplemented with milled *O. stricta*; grazing supplemented with milled *O. stricta* treated with 1% urea. Dry matter intake was evaluated. Milk yield was measured by weighing using a digital scale, and milk composition was determined using the Lacto scan milk analyzer system. There was a significant difference (P0.05). Milk yield increased with increase in dry matter intake of the supplemental diet. The use of cactus processing by a machine and mixed with urea to maximize dry matter intake is recommended.

Key Words: Dry matter, Intake, Lactating camels, Semi-arid, Rangeland

iCB 2022-92

Aflatoxin and Fumonisin Mycotoxins Contamination along the Maize Value Chain in the Eastern Democratic Republic of Congo

Matendo, R. E., Imathiu, **S.**, Udomkun, P., Mugumaarhahama, Y., Akullo, J., Ishara, J., Atehnkeng, J. & Owino, W. O. (2022). *African Journal of Food, Agriculture, Nutrition and Development, 22*(3), 19801-19821. DOI: 10.18697/ajfand.108.21695

Abstract

Aflatoxin and fumonisin contamination was assessed in different samples along the maize value chain in different territories of South Kivu province. Kabare and Ruzizi Plain were chosen as they represent two different agroecological areas where maize is mostly produced. Twelve districts and one town were selected across the province. The stakeholders were randomly selected, and 215 maize (139 maize grain and 76 maize flour) samples were taken for laboratory analysis. The Q +

kit was used to determine the total aflatoxins and fumonisins. Three categories of maize were examined: freshly harvested dry maize, stored maize (maize stored for 3 months ±1.5 month) and market maize. Aflatoxin was found in 100% of the maize samples with the least content of 0.3 µg/kg detected in freshly harvested dry maize with mean 3.2+0.3 and levels ranging from 0.3 to 18.5 µg/kg. The average level of aflatoxin in stored grain samples was 97.9±182 µg/kg within a range of 1.16 to 841.5 µg/kg, and the mean level of aflatoxin in stored flour was 148.9±164.5 µg/kg with levels ranging from 2.05 to 905.1 µg/kg. The mean level of aflatoxin maize collected from the market was 95.1 ±164 µg/kg, with levels ranging from 1 to 823.2 µg/kg. Almost all the maize flour collected from the three areas had a high contamination level that exceeded the maximum tolerable limit of 10 µg/kg. Fumonisin was detected in all samples. However, the levels of fumonisin do not follow a specific trend with the duration of storage. The freshly harvested dry maize concentration was 2.4±5.1 µg/g, with levels ranging from 0.03 to 20.9µg/g. About 37% of freshly harvested maize samples contaminated by fumonisin exceeded the maximum tolerable limit of 4 µg/kg. There was a difference between total fumonisin in grain and flour; the average level of fumonisin in stored maize grain was 1.4±0.9 µg/g with levels ranging from 0.18- 4.7 µg/g while in flour, the level was 2.1±1.3 µg/g with levels ranging from 0.3-4.5 µg/g. Almost all the maize samples collected from the three areas had a degree of contamination that did not exceed the maximum tolerable limit of 4 µg/g. These results indicate that the two mycotoxin levels, particularly aflatoxin, were high in the different samples collected at specific nodes. Therefore, preventing mycotoxins accumulation in maize by post-harvest prevention of contamination and growth of toxigenic moulds by promoting proper grain drying and storage should be encouraged among the actors of the maize value chain.

Key Words: Aflatoxins, Fumonisins, Food value chain, Maize, South Kivu

iCB 2022-93

Effect of Harvest Stage and Nitrogen Fertilization on the Postharvest Shelf Life of Black Nightshade (*Solanum nigrum* L.) and Collard (*Brassica oleracea var. acephala* L.)

Gitau, K., Ambuko J., Chemining'wa, G. & Owino, W. (2022).
African Journal of Food, Agriculture, Nutrition & Development, 22(6): 20737-20751

Abstract

Leafy vegetables play a crucial role in the human diet providing numerous nutrients and health benefiting compounds. Leafy vegetables like collard (*Brassica oleracea var. acephala*) and black nightshade (*Solanum nigrum l.*) are commonly consumed leafy vegetables in Kenya. However, their high perishability and short shelf life (usually 1-2 days at ambient temperature) limits their utilization resulting in significant high postharvest losses. This study assessed the effect of harvest stage and nitrogen fertilization on the postharvest shelf life of collard and black nightshade. Experiments were conducted at Kabete field station, University of Nairobi, using collard and black nightshade. Field experimental layout was a 4 x 3 factorial arrangement in randomized complete block design with three replicates. Factors were nitrogen levels and harvest stage. Four levels of nitrogen (0, 30, 60 and 90 kg N/ha) were applied on black nightshade and (0, 55.5, 111.1 and 166.6 kg N/ha) in collard where 0 kg N/ha was the control. Collard and black night shade were harvested at three harvest stages: 4 weeks, 6 weeks and 8 weeks after transplanting. The harvested vegetables were kept at ambient room condition (20 ºC, 55% relative humidity). Data collection was

performed daily for quality related parameters which included color change, wilting index and cumulative weight loss. Results show that there was a progressive deterioration in quality of the collard and black nightshade with storage time regardless of harvest stage and nitrogen level. Harvesting at 8 weeks after transplanting resulted in longer shelf life in collard (three days) and black nightshade (two days) when compared to harvesting at 4 weeks or 6 weeks after transplanting. Collard and black nightshade showed reduced hue angles over storage time at different harvest stages. Black nightshade subjected to 90 kg N/ha and harvested at 4 weeks after transplanting had the highest wilting index of 33%. The highest cumulative weight loss of 29% was recorded in collard that were harvested at 8 weeks after transplanting. Black nightshade subjected to 90 kg N/ha and harvested at 6 weeks after transplanting showed the best color at a hue angle of 145°. Overall, harvesting at 8 weeks after transplanting resulted in the longest shelf life of both black nightshade and collard. These results show that low application of nitrogen fertilizer in black nightshade (30 kg N/ha) and in collard (55.5 kg N/ha) had minimal effects on weight loss and wilting and resulted in good keeping quality.

Key Words: Black nightshade, Collard, Harvest Stage, Nitrogen nutrition, Shelf life

iCB 2022-94

Maturity Indices of Specific Mango Varieties Produced at Medium Altitude Agro-Ecological Zone in Kenya.

Muiruri, J., Ambuko, J., Nyankanga, R. & Owino, W. O. (2022). *African Journal of Food, Agriculture, Nutrition & Development*, *22*(6): 20752-20774

Abstract

The high postharvest losses (40 – 50%) reported in the mango value chain are partly attributed to lack of reliable maturity indices. Harvest maturity is dictated by the intended use and the target market for the fruits. The aim of this study was to establish maturity indices of three commercial mango varieties namely 'Van dyke,' 'Kent' and 'Tommy Atkins' in Embu County of Kenya. At least eighteen mango trees (six per variety) were randomly tagged at 50% flowering in each of the three selected smallscale farms in Embu County. Number of days from flowering to different maturity stages were recorded (computational method). For each variety and maturity stage, five fruits were randomly sampled from the pool and analysed for physical (size, density, firmness, colour), physiological (ethylene evolution and respiration rate) and biochemical (o brix/Total Soluble Solids (TSS), total titratable acidity (TTA) and their ratio) indices of maturity. The results showed that although size increased as the fruits developed, it was not a reliable index of maturity since some small-sized fruits attained advanced maturity earlier than others that were large-sized. The weight of the fruits fluctuated as the fruits developed and similar trend was observed on the specific gravity. Flesh firmness decreased gradually with maturity from a mean firmness of 40.54 N to 6.84 N. Tommy Atkins exhibited the lowest firmness levels at stage 4. Kent variety had the lowest ethylene at all stages while Tommy Atkins variety had the highest respiration rate of 21.40 ml/kg/hr at stage 1, which increased gradually to 32.10 ml/kg/hr at stage 4. The highest TSS: TTA values were reported in Kent variety. The results revealed significant differences in maturity indices of the three mango varieties despite similar physical indices. This study confirms the unreliability of physical maturity indices such as size and shape in establishing the right harvest

stage of mango fruits. Computational, physiological and biochemical maturity indices should be incorporated in determination of accurate harvest maturity for mango.

Key Words: Ethylene, Harvest maturity, 'Kent', Maturity indices, Respiration, 'Tommy Atkins', 'Van dyke'

iCB 2022-95

Effect of Coolbot™ Cold Storage and Modified Atmosphere Packaging on the Shelf Life and Postharvest Quality of Collards

Kathambi, J., Ambuko, J., Hutchinson, M. & Owino, W. (2022). *African Journal of Food, Agriculture, Nutrition & Development, 22*(6): 20668-20686

Abstract

Collard (*Brassica oleracea var.acephala* L.) is a nutritious leafy vegetable that is widely cultivated and consumed in Kenya. However, collard is highly perishable with a shelf life of one to two days at ambient conditions, which limits its consumption. Exploring storage options and packaging methods that can extend the shelf life of collards, can avert quantity and quality losses of the vegetable. This will ensure sustained income to producers and continued vegetable supply to consumers. The study aimed to evaluate the effectiveness of CoolBotTM Technology and Modified Atmosphere Packaging (MAP) as options to preserve quality and extend the shelf life of collards. Two experiments were conducted at Kabete and Juja sub-counties using freshly harvested collards from the University of Nairobi Kabete farm. In each experiment, homogenous batch of freshly harvested collards were first divided into four batches. The vegetable batches were then subjected to two storage options (CoolBotTM cold room; 5±2 °C, 75±20% RH, and ambient conditions; 25±10 °C, 50±15% RH), which were further split into two packaging treatments (packaged using Xtend® MAP, and unpackaged). The experimental layout was a 2 by 2 factorial arranged in a completely randomized design with three replications. Measurements were performed daily to determine cumulative weight loss, yellowing, wilting and color changes. Biochemical assay was also performed to determine the changes in vitamin C and betacarotene content. Results show that CoolBotTM cold storage extended the shelf life of collards by 6 days without MAP and 13 days with MAP, in comparison to collards stored at ambient conditions. The slow rate of deterioration under CoolBotTM storage (with or without MAP) was evidenced by delayed yellowing, wilting, and reduced weight loss compared to ambient conditions, in the two experimental sites. The loss in vitamin C content was significantly higher ($p \leq 0.05$) in collards under ambient conditions than those under CoolBotTM storage. In ambient conditions, unpackaged collards lost 77.7% of their vitamin C content while the packaged collards lost 57.7% by end of shelf life (day four). In CoolBotTM storage, packaged collards lost 18.4% whereas the unpackaged lost 26.3% of their initial vitamin C content. In CoolBotTM storage, packaged collards lost 26.2% while the unpackaged lost 44.1% of their initial Vitamin C by day seven. These results demonstrate a synergistic effect of CoolBotTM cold storage and MAP in preserving quality and extending the shelf life of collards.

Key Words: CoolBotTM Technology, Xtend, Collards, Postharvest Quality, Shelf life

iCB 2022-96

Surface Moisture Induces Microcracks and Increases Water Vapor Permeance of Fruit Skins of Mango cv. Apple

Athoo, T. O., Winkler, A., Owino, W. O., & Knoche, M. (2022).
Horticulturae, *8*(6), 545. https://doi.org/10.3390/ horticulturae8060545

Abstract

Exposure to surface moisture triggers cuticular microcracking of the fruit skin. In mango fruit cv. apple, microcracking compromises postharvest performance by increasing moisture loss and infections with pathogens. This study reports the effects of exposing the fruit's skin to surface moisture on the incidence of microcracking and on water vapor permeance. Microcracking was quantified microscopically following infiltration with a fluorescent tracer. Water mass loss was determined gravimetrically. Moisture exposure increased cuticular microcracking and permeance. During moisture exposure, permeance increased over the first 4 d, remained constant up to approximately 8 d, then decreased for longer exposure times. Fruit development followed a sigmoid growth pattern. The growth rate peaked approximately 103 days after full bloom. This coincided with the peak in moisture-induced microcracking. There were no increases in water vapor permeance or in microcracking in control fruit that remained dry. When experimental moisture exposure was terminated, microcracking and water vapor permeance decreased. This suggests a repair process restoring the barrier properties of the fruit skin. Histological analyses reveal a periderm forms in the hypodermis beneath a microcrack. Our study demonstrates that surface moisture induces microcracking in mango cv. apple that increases the skin's water vapor permeance and induces russeting.

Key Words: Russeting; Cuticle; Microcracks; Permeance; Skin; Periderm; Wax

iCB 2022-97

Efficacy of Hexanal Field Spray on the Postharvest Life and Quality of Papaya Fruit (*Carica papaya* L.) in Kenya

Hutchinson, M. J., Ouko, J. R., Yumbya, P. M., Ambuko, J. L., Owino, W. O., & Subramanian, J. (2022). *Advances in Agriculture, 2022*.

Abstract

Papaya is a thin-skinned fruit that ripens and softens over a very short time, usually in 3 days, predisposing the fruit to physical damage and phyto-pathogen invasion even with careful handling further shortening postharvest shelf life. The objective of this study was to determine the efficacy of Hexanal, naturally occurring compound, on-farm spray, in managing the postharvest shelf life of papaya in two agro-ecological zones in Kenya. A formulation of Hexanal containing Tween 20 and ethanol was made by volume basis (v/v) and spray treatment at 1 and 2% in "Solo sunrise" and "Mountain" papaya cultivars. The experiment was a randomized block design with ninety-six plants per farm randomly selected. Spraying was applied at 30 days, 30 + 15 days, and 15 days to harvest time on mature green papaya. Control papaya fruits were sprayed with clean tap water as control. Data were collected on color changes and fruit retention on tree. The fruits were harvested when two to three yellow stripes were visible from the lower end of the fruits for postharvest analysis. Hexanal sprayed papaya fruits were retained for at least 13 days longer compared to the control fruits on tree. Hexanal treatment at 2% revealed an improved effect on managing papaya

postharvest shelf life. All fruits treated with Hexanal significantly showed reduced rate of color break, softening, and enhanced extension of fruit shelf life by at least 6 days. Hexanal treatment also delayed ethylene and respiratory peaks by three days and showed no significant ($P \leq 0.05$) difference in the levels of total titratable acidity and total soluble solids. The results of this study indicate that Hexanal applied as a preharvest spray on mature green "Solo sunrise" and "Mountain" papaya cultivars grown in Kenya, is effective in prolonging shelf life and postharvest quality.

iCB 2022-98

Microbial Contamination and Occurrence of Aflatoxins in Processed Baobab Products in Kenya.

James, M., Owino, W., & Imathiu, **S.** (2022).

International Journal of Food Science, 2022. Article ID 2577222,

Abstract

Baobab fruit demand has been on the rise in the recent past, and in an attempt to match the demand, farmers and middlemen are forced to harvest immature fruits which are not fully dried. To ensure an acceptable moisture content, baobab fruits are subjected to solar drying, which is a slow process and often carried out in open and unhygienic conditions raising safety concerns. This study was conducted to investigate the microbial and aflatoxin contamination levels in ready-to-eat baobab products from selected formal and informal processors in specific counties of Kenya. Selected processed baobab products were sampled randomly from formal and informal processors and analyzed for the total aerobic count, Enterobacteriaceae, yeast and molds, ergosterol, aflatoxins, moisture, and water activity. The moisture and water activity of baobab pulp and candies from formal processors ranged between 7.73% and 15.06% and 0.532 and 0.740 compared to those from informal processors which ranged from 10.50% to 23.47% and 0.532 to 0.751, respectively. In this study, baobab pulp from formal processors had significantly (p = 0:0008, 0.0006) lower Enterobacteriaceae and yeast and molds loads (0:7±0:29 and 3:1±0:38 log 10 CFU/g, respectively) than pulp from informal processors (3:1±0:70 and 5:3±0:11 log 10 CFU/g, respectively). Similarly, the Enterobacteriaceae counts of candies from formal processors (nondetectable) were considerably lower (p = 0:015) than those from informal processors (1:8±0:56 log 10 CFU/g). The ergosterol content in these baobab product samples ranged between 0.46 and 1.92 mg/100 g while the aflatoxin content ranged between 3.93 and 11:09 × 103 μg/kg, respectively. Fungal and aflatoxin contamination was detected in 25% and 5% of pulp from formal and informal processors, respectively, and in 5% of candies from informal processors. Microbial contamination in processed baobab products shows an unhygienic processing environment while the fungal and aflatoxin contamination may indicate poor postharvest handling, transport, and storage conditions of baobab fruits along the baobab value chain.

iCB 2022-99

Probiotic Properties of Lactic Acid Bacteria Isolated from "Tchoukou" Traditional Milk Cheeses Produced in Selected Region of Niger

Doumbouya, I., Willis, O., & Omolo, K. (2022).

International Journal of Food Sciences, 5(1), 1-15.

Abstract
Purpose: The current study's aim is to evaluate the probiotic potential of lactic acid bacteria strains isolated from traditional "Tchoukou" milk cheeses produced in a selected region of Niger.
Methodology: Nine Samples were collected in selected regions of Niger (Tahoua, Maradi, and Zinder).Probiotic properties of isolated LAB were identified based on their acid tolerance, bile salt tolerance, auto-aggregation ability, simulated stomach and duodenum passage, simulated gastric juice survivability and their antimicrobial activities.
Findings: A total of eighteen strains were analysed *in vitro* for acid tolerance, bile tolerance, survival under simulated gastro-intestinal tract conditions and antimicrobial activity against index organisms. The results indicated that all seventeen strains exhibited a high viability after twenty-four hours of incubation at pH 2.5 and pH 3, but a decreased viability at pH 2.0 in which only eight strains were able to survive, strain C13 failed to grow at the three different pH. In this study, the isolates generally survived better after exposure to 0.3% bile salt. Also were able to survive exposure to simulated stomach and duodenum passage (SSDP) for three hours ranging from (89%-100%).All strains were able to survive under simulated gastric juice at different pH (2, 2.5 and 3). for auto-aggregation Only fifteen isolates showed the best auto-aggregation abilities ranging from (15-83%) and the other two had less autoaggregation ability (2-11%). The isolates showed diverse antimicrobial activity against the index organisms. Among the isolates, only three (C1, C2 and C9) could not inhibit any of the selected pathogens.
Unique contribution to theory, practice and policy: This study was conducted to characterize the probiotic properties of LAB isolate which could serve as a potential source for industries and commercial applications.

Key Words: Tchoukou, Probiotics, Lactic acid bacteria, Antimicrobial

iCB 2022-100

Concomitant Production of α-amylase and Protease by *Bacillus Aerius* strain FPWSHA isolated from food wastes

Niyomukiza, S., Owino, W., Maina, J. M., Maina, N., & Issifu, M. (2022).
Biointerface Research in Applied Chemistry, 13(4) 1-15.

Abstract
Amylase and protease are enzymes that have potential applications in the food industry, detergent formulation, pharmaceuticals, waste degradation, and the dehairing process in the leathermaking industry. In the current study, fifty-six bacteria were isolated from food wastes and screened for amylase and protease production. Biochemical tests and 16S rRNA gene sequencing were used to characterize and identify bacterial strains. Ten potential isolates with high extracellular enzyme secretion were selected. Among ten isolates, strain FPWSHA was ideal for α-amylase and protease production based on its larger hydrolytic zone of clearance under casein and starch agar than other isolates. This strain was identified as *Bacillus aerius* FPWSHA (Accession number in GenBank: OM258619) and utilized to produce protease and α-amylase enzymes using potato peels powder (PPP) waste as a cheap substrate under submerged fermentation. Under culture conditions optimization, 16.9 U/mL amylase and 12.3 U/mL proteases were achieved within 48 h of fermentation. *Bacillus aerius* was isolated from food wastes for the first time to produce α-amylase

and protease enzymes. In the future, the bacterial strain described here should be improved for hydrolytic enzyme production in commercial and biotechnological applications.

Key Words: amylase; protease; food waste; bacteria isolation; 16S rRNA; Bacillus aerius FPWSHA; potato peels powder; submerged fermentation; culture conditions optimization

iCB 2022-101

Chemical Composition and Digestibility of Preferred Forage Species by Lactating Somali Camels in Kenya

Ikanya, L. W., Maina, J. G., Gachuiri, C. K., Owino, W. O., & Dubeux Jr, J. C. B. (2022). *Rangeland Ecology & Management*, *80*, 61-67.

Abstract

Climate change has increased the frequency and severity of frequent drought in the Kenya arid and semiarid lands with resultant fodder and water shortages. In order to adapt to these longer and less predictable droughts, keeping of camels has been adopted as a coping strategy in grappling with the vagaries of climate change. Camels are both grazers and browsers of a broad spectrum of preferred forages whose nutrient composition is not well documented. The objective of this study was to identify and determine the chemical composition of forage species mostly preferred by lactating Somali camels in Laikipia County, Kenya. Lactating Somali camels and their calves were monitored while browsing and grazing in the rangelands during the wet and dry seasons from August to November 2019. The forage species were ranked on the basis of bite count. The most browsed forages identified through observation were sampled, identified by the local and scientific names, and analyzed for proximate composition, detergent fiber fractions, and in vitro dry matter digestibility. The most browsed forage species were *Acacia nubica* (22.6%), *Acacia seyal* (47.3%), Cucumis *aculeatus* (7.2%), *Euclea divinorum* (11.1%), *Hibiscus parrifolia* (11.9%) during the wet season and Barleria *acanthoides* (22.9%), Balanites *aegyptiaca* (15.5%), *Cynodon dactylon* (11.7%), *Lycium europaeum* (32%), and *Pollichia campestris* (17.8%) during the dry season. Shrubs constituted 60%, trees 30%, and grasses 10% of the most preferred forage species. The preferred browsed and grazed species had a range of 7.1% ± 0.4% to 25.7% ± 1.2% crude protein on a dry matter basis, 29.1% ± 2.7% to 74.0% ± 7% for neutral detergent fiber concentrations, and 43.4% ± 0.2% to 81.6% ± 0.3% for in vitro dry matter digestibility. The study indicates that trees and shrubs with high crude protein and low neutral detergent fiber concentrations were more preferred, indicating that forage nutritive value affected the forage preference by the camels.

iCB 2022-102

Effect of Dietary Supplementation with Seaweed on Growth and Nutritional Quality of Nile Tilapia

Kubai, R., Wawire, M., & Kahenya, P. (2023).
Journal of Agriculture, Science and Technology, *22*(2), 100-116.

Abstract

Feed is a major component of production costs in aquaculture, accounting for about 80% of the production costs. High-quality aquafeeds are a prerequisite to healthy and nutritious fish. Aquafeeds are expensive owing to the fact that fish oil and fish meals are the main sources of lipid

and protein components, respectively. Having alternative, cheap sources of lipids in the feeds is therefore important. The brown seaweed (*Sargassum portieranum*) that is locally available on the Kenyan coast is known to be rich in omega-3 fatty acids. The objective of this study was therefore to determine the suitability of brown seaweed dietary supplementation and its effect on the nutritional quality and growth performance of Nile tilapia (*Oreochromis niloticus*). A total of 180 male Nile tilapia fingerlings were divided into three experimental groups in triplicate. The fish were assigned to one of the three treatment diets: 0% (control diet), 5%, or 10% inclusion of the brown seaweed, and fed for 12 weeks. The weight and length (from head to tail) of the fish were measured every two weeks to determine the growth performance. At the end of the experiment, the fish muscle protein, lipid, and mineral content were determined using AOAC methods. Seaweed supplementation significantly ($P < 0.05$) improved the body weight, length, survival, and specific growth rate of the fish, with the 10% inclusion showing higher performance than the 5%. The protein, mineral, and lipid contents of the fish muscles were also significantly affected by the seaweed supplementation. Fish fed on the 10% diet had the highest total lipid content in the muscle, at 0.93%, compared to 0.78% in the fish fed on the control diet. The protein content in the fish muscle was not significantly affected ($P < 0.05$) by the inclusion of seaweed in the feed. Overall, the results showed that supplementing the feed with 5% or 10% brown seaweed improved the growth performance and nutritional quality of tilapia fish. Thus, including brown seaweed meal in the diet of tilapia fish could offer an effective means to boost production in aquaculture.

Key Words: seaweeds, Nile tilapia, aquaculture, nutritional, polyunsaturated fatty acid, growth performance

iCB 2022-103

Perceived Facilitators and Barriers to Healthy Dietary Behaviour in Adults with Type 2 Diabetes Mellitus in Kenya: A Qualitative Study

Mokaya, M., Saruni, E., Kyallo, F., Vangoitsenhoven, R., & Matthys, C. (2022).
Public Health Nutrition, *25*(12), 3335-3343.

Abstract

Objective: This study aimed to explore the facilitators and barriers to healthy dietary behaviour in adults with type 2 diabetes mellitus (T2DM) in Kenya. Design: A qualitative descriptive design using telephone interviews was applied. An interview guide was developed through a modified theoretical framework. Setting: This study was conducted in selected hospitals in Nakuru County, located in west-central Kenya. Participants: A two-step sampling strategy was used to select hospitals and study participants. Adult participants aged 30 to 85 years, with T2DM from six hospitals were selected based on their ability to openly elaborate on the theme of dietary behaviour. Results: Thirty respondents were interviewed (mean age 62 years; 43·3 % females). The average duration of the interviews was 32:02 min (SD 17·07). The highest-ranking internal facilitators of healthy dietary behaviour were knowledge of healthy food choices, gardening, self-efficacy, food preparation skills and eating at home. External facilitators included inaccurate beliefs and information on food and diet, education by healthcare workers, food availability, proximity to food selling points and family support. Internal barriers included tastes and preferences, health conditions barring intake of certain foods, and random eating of unhealthy foods. External barriers included socio-economic factors, seasonal unavailability of fruits and food safety concerns.

Conclusions: Facilitators and barriers to healthy dietary behaviour among Kenyan adults with T2DM are related to food literacy and include selection, preparation and eating. Interventions to enhance healthy dietary behaviour should target context-specific knowledge, skills and self-efficacy.

Key Words: Dietary behavior, Health, Low- and middle-income country, Type 2 diabetes mellitus

iCB 2022-104

Clinical and Patient-Centered Implementation Outcomes of mHealth Interventions for Type 2 Diabetes in Low-and-Middle Income Countries: A Systematic Review

Mokaya, M., Kyallo, F., Vangoitsenhoven, R., & Matthys, C. (2022).
International Journal of Behavioral Nutrition and Physical Activity, *19*(1), 1.

Abstract

Background: The prevalence of Type 2 Diabetes is rising in Low- and Middle-Income Countries (LMICs), affecting all age categories and resulting in huge socioeconomic implications. Mobile health (mHealth) is a potential high-impact approach to improve clinical and patient-centered outcomes despite the barriers of cost, language, literacy, and internet connectivity. Therefore, it is valuable to examine the clinical and implementation outcomes of mHealth interventions for Type 2 Diabetes in LMICs. Methods: The Preferred Reporting Items for Systematic review and Meta-Analysis (PRISMA) guidelines were applied in framing and reporting the review criteria. A systematic search of Cochrane Library, Web of Science, PubMed, Scopus, and Ovid databases was performed through a combination of search terms. Randomized Controlled Trials (RCTs) and cohort studies published in English between January 2010 and August 2021 were included. Risk of bias for missing results in the included studies was assessed using the Cochrane risk-of-bias tool for randomized trials (RoB 2). Quantitative and qualitative methods were used to synthesize the results. Results: The search identified a total of 1161 articles. Thirty studies from 14 LMICs met the eligibility criteria. On clinical outcomes, 12 and 9 studies reported on glycated hemoglobin (HbA1c) and fasting blood glucose (FBG) respectively. Text messages was the most commonly applied mHealth approach, used in 19 out of the 30 studies. Ten out of the 12 studies (83.3%) that reported on HbA1c had a percentage difference of <0.3% between the mHealth intervention and the comparison group. Additionally, studies with longer intervention periods had higher effect size and percentage difference on HbA1c (1.52 to 2.92%). Patient-centred implementation outcomes were reported variedly, where feasibility was reported in all studies. Acceptability was reported in nine studies, appropriateness in six studies and cost in four studies. mHealth evidence reporting and assessment (mERA) guidelines were not applied in all the studies in this review. Conclusion: mHealth interventions in LMICs are associated with clinically significant effectiveness on HbA1 but have low effectiveness on FBG. The application of mERA guidelines may standardize reporting of patient-centered implementation outcomes in LMICs. Trial registration: PROSPERO: Registration ID 154209.

Key Words: Clinical outcomes, mHealth, Patient-centered implementation outcomes, Type 2 diabetes mellitus

iCB 2022-105

Bioequivalence of Micronutrient Powders to Corn-soy Blend on Serum Zinc Concentration of Children (6–36 months) with Moderate Acute Malnutrition in Thika Urban Slums, Kenya: A Cluster-Randomized Controlled Trial

Kiio, J., Ochola, S., Nduati, R., Kuria, E., Mathenge, S., & Okoth, J. (2022).
PLoS ONE, *17*(9), e0274870.

Abstract

Zinc deficiency is common among children with Moderate Acute Malnutrition (MAM) and contributes to growth failure, increased morbidity and mortality. Diarrhoea and poor dietary practices are the main causes of zinc deficiency. Corn-soy Blend (CSB), the standard product in management of children with MAM has a limitation of poor micronutrient bioavailability. Micronutrient powders (MNPs) which are added at the point of consumption have a potential in improving micronutrient status however, scientific evidence on efficacy on improving the zinc status is scarce. A cluster-randomized clinical trial was designed to establish bioequivalence of MNPs to CSB on serum zinc status among children (6–36 months) with MAM in Thika informal settlements, Kenya. Sample size was calculated to show bioequivalence within ±20% limit. Twelve villages were randomized to four study groups. Three experimental groups received different formulations of MNPs added to unfortified CSB porridge as; multiple micronutrients containing zinc (CSB-MNP-A n = 84), multiple micronutrients without zinc (CSB-MNP-B n = 88) and zinc only (CSB-MNP-C n = 94). Control group (n = 80) received standard CSB fortified with multiple micronutrients. Standard amount of CSB was consumed in feeding centres for six months. Serum zinc concentration was assessed pre- and post-intervention. Data was analyzed based on treatment assignment regardless of adherence and drop-out status. Mixed effects linear regression was used to model pre-post change in serum zinc concentration, adjusting for clustering effect and baseline differences. Bioequivalence was assessed using two one-sided t-tests. At baseline, 84.4% were zinc deficient (serum zinc <65μg/dL) and zinc intake was sub-optimal (<3 mg/day) for 95.7% of children. Mean change in serum zinc concentration was significantly higher (p = 0.024) in CSB-MNP-A (18.7 ± 2.1) μg/dL compared to control group (11.8 ± 2.6 μg/dL). MNPs are not bioequivalent to CSB within the ±20% bioequivalence limit. MNPs are more effective in improving serum zinc status compared to CSB. Trials with larger sample sizes are recommended to validate the current findings.

iCB 2022-106

Supplementary Feeding and Nutritional Status of Pre-School Children 4-5 Years Old from Busia County Kenya

Susan, M., Wakhu-Wamunga, F., & Okoth, J. (2022).
Journal of Food and Nutrition Sciences, *10*(3), 53-61. doi: 10.11648/j.jfns.20221003.11

Abstract

Poor quality diet is the most immediate factor responsible for malnutrition and ill health among school going children in many developing countries, including Kenya. The aim of the study was to evaluate effect of soybean fortified porridge on nutritional status of pre-school children at Igero Primary School, Busia County. The flour blends developed and used in making supplement porridges were; maize:soybean 70:30, sorghum:soybean 70:30, sorghum: maize:soybean 45:25:30 and 100% maize flour (control). A longitudinal survey and Complete Randomized Design

experiment were employed. The 235 childeren enrolled in pre-school at the beginning of the study were randomized into four groups and the four types of porridge randomly allocated to the groups. Pre-school children were fed for a period of six months with approximately 350ml of porridge daily, Monday to Friday while in school. Anthropometric measurements were taken at baseline, every month for 6 months and at 9th month. From the study results, there was significant ($p < 0.05$) reduction in prevalence of underweight and wasting, from 33.6% to 15.5% and from 28.5% to 10.8% respectively, among children fed on soybean fortified porridges by the end of intervention. However change in underweight and wasting among children fed on unfortified 100% maize flour porridge was not significant ($p>0.05$). The group fed on maize:soybean, sorghum:soybean and sorghum:maize:soybean blends gained mean weight of 2.83kg, 1.88kg and 2.19kg respectively by the end of study. Results on nutritional status assessment 3 months later when porridge was withdrawn showed that, 31.5% and 28.3% of children became underweight and wasted respectively. In conclusion, soybean fortified porridges improved the nutritional status of children. It is recommended that maize-soybean or sorghum-soybean blends be used in preparing 10 o'clock porridge in schools to enhance nutritional status of pre-school children.

Key Words: Nutritional Status, Evaluate Effect, Soybean Fortified, Pre-school Children

iCB 2022-107

Screening for Yield-Related Agronomic Traits in a Panel of Locally Conserved Common Bean (*Phaseolus vulgaris* L.) Accessions

Wahome, W., Githiri, M., Kinyanjui, P. K., Toili, M. E. M., & Angenon, G. (2023). *Journal of Plant Breeding and Crop Science*, *15*(1), 14-31.

Abstract

Characterization and conservation of germplasm is a critical step toward the genetic improvement of the crop. This study assessed variation in 257 common bean genotypes which included 207 accessions obtained the National Gene Bank of Kenya, 33 accessions from Kenya Agricultural and Livestock Research Organization (KALRO), 13 landraces collected from farmers' fields and four commercial varieties for various agronomic traits. The experiments were laid out in a randomized complete block design with three replicates at Jomo Kenyatta University of Agriculture and Technology (Kenya) for four seasons between 2019 and 2020. Significant differences ($P\leq0.05$) existed among the common bean accessions for all traits studied. Seed yield ranged from 220.6 to 4641.9 kg/ha (KNB0106) among the accessions with a mean of 1267.0 kg/ha. Significant ($P \leq0.05$) positive correlation was recorded for days to flowering and days to maturity (0.73), while 100-seed weight had a significantly negative correlation with the number of pods per plant (-0.66) and the number of seeds per pod (-0.65). High (>20%) broad-sense heritability was recorded for 100-seed weight (89.0%), days to flowering (76.8%), and grain yield (60.5%). Nineteen accessions that combined early maturity and high-yielding traits were identified. On average, higher seed yields were recorded for large-seeded and climbing genotypes compared to small-seeded and bush types. Common bean accessions characterized can be exploited in breeding programs.

Key Words: Common bean, Agronomic traits, *Phaseolus vulgaris*, Variability, Broad sense heritability.

iCB 2022-108

Genome-Wide Association Study of Variation in Cooking Time among Common Bean (*Phaseolus vulgaris* L.) Accessions Using Diversity Arrays Technology Markers

Wahome, S. W., Githiri, M. S., Kinyanjui, P. K., Toili, M. E. M., & Angenon, G. (2023). *Legume Science*, e184.

Abstract

Stored grains of common bean (*Phaseolus vulgaris* L.) develop the hard-to-cook trait (HTC), which is manifested in a prolonged cooking time, thereby imposing time and energy constraints. The objective of this study was to determine variation in cooking time among common bean genotypes and to identify single nucleotide polymorphism (SNP) markers associated with cooking time. Seeds of 222 common bean accessions sourced from Kenyan institutions were multiplied in the Jomo Kenyatta University of Agriculture and Technology (JKUAT) field in 2019. The freshly harvested seeds and those stored at 35^{o}C and 50% red haricot (RH) for 4 months for accelerated aging were soaked in distilled water for 16 h and evaluated for cooking time using the finger-pressing method. The accessions were also genotyped to determine variation in SNP markers using Diversity Arrays Technology Sequencing (DArTseq). Genome-wide association study (GWAS) analysis was conducted to identify SNPs significantly associated with cooking time. The study revealed significant differences ($p \leq 0.05$) within and between fresh and aged bean accessions. Fresh seeds had a lower cooking time with a mean of 40.8 min and ranged from 28.1 to 72.2 min, whereas aged seeds had a higher average cooking time of 54.1 min and ranged from 32.1 to 96.3 min. GWAS identified a region in Chromosome 10 to be significantly ($p \leq 0.05$) associated with the cooking time of aged seeds. Consequently, two potential candidate genes Phvul.010G038000 and Phvul.010G038100 were revealed. The characterized common bean accessions and the identified SNP markers can be utilized in breeding programs to improve the cooking quality of the common bean.

Key Words: Common bean, Cooking time, GWAS, *Phaseolus vulgaris*, SNP markers, Variability

iCB 2022-109

Antinutrient to Mineral Molar Ratios of Raw Common Beans and their Rapid Prediction Using Near-Infrared Spectroscopy

Wafula, E. N., Onduso, M., Wainaina, I. N., Buvé, C., Kinyanjui, P. K., Githiri, S. M., Saeys, W., Sila, D. N. & Hendrickx, M. (2022). *Food Chemistry*, *368*, 130773.

Abstract

The presence of antinutrients in common beans negatively affects mineral bioavailability. Therefore, this study aimed to predict the antinutrient to mineral molar ratios (proxy-indicators of *in vitro* mineral bioavailability) of a wide range of raw bean types, using near-infrared (NIR) spectroscopy. Iron, zinc, phytate and tannin concentrations and, antinutrient to mineral molar ratios were determined. Next, model calibration using NIR spectra from milled beans was performed. This entailed wavelength selection, pre-processing and partial least squares regression. Bean type had a significant effect on tannin content. The average values of phytate to iron (Phy:Fe), phytate to zinc (Phy:Zn), tannins to iron (Tan:Fe) and phytate and tannins to iron (Phy+Tan:Fe) MRs were 27.6, 61.7, 16.0 and 43.6, respectively. With determination coefficients for test set prediction

above 75%, the PLS-R models for Phy:Zn, Tan:Fe and Phy+Tan:Fe molar ratios are useful for screening purposes.

Key Words: Common beans, Near-infrared spectroscopy, Antinutrients, Minerals, Molar ratios

iCB 2022-110

Nutraceutical Potential of Mushroom Bioactive Metabolites and their Food Functionality

Ishara, J., Buzera, A., Mushagalusa, G. N., Hammam, A. R., Munga, J., Karanja, P., & Kinyuru, J. (2022). *Journal of Food Biochemistry, 46*(1), e14025.

Abstract

Numerous mushroom bioactive metabolites, including polysaccharides, eritadenine, lignin, chitosan, mevinolin, and astrakurkurone have been studied in life-threatening conditions and diseases such as diabetes, cardiovascular, hypertension, cancer, DNA damage, hypercholesterolemia, and obesity attempting to identify natural therapies. These bioactive metabolites have shown potential as antiviral and immune system strengthener natural agents through diverse cellular and physiological pathways modulation with no toxicity evidence, widely available, and inexpensive. In light of the emerging literature, this paper compiles the most recent information describing the molecular mechanisms that underlie the nutraceutical potentials of these mushroom metabolites suggesting their effectiveness if combined with existing drug therapies while discussing the food functionality of mushrooms. The findings raise hope that these mushroom bioactive metabolites may be utilized as natural therapies considering their therapeutic potential while anticipating further research designing clinical trials and developing new drug therapies while encouraging their consumption as a natural adjuvant in preventing and controlling life-threatening conditions and diseases.

Practical applications: Diabetes, cardiovascular, hypertension, cancer, DNA damage, hypercholesterolemia, and obesity are among the world's largest life-threatening conditions and diseases. Several mushroom bioactive compounds, including polysaccharides, eritadenine, lignin, chitosan, mevinolin, and astrakurkurone have been found potential in tackling these diseases through diverse cellular and physiological pathways modulation with no toxicity evidence, suggesting their use as nutraceutical foods in preventing and controlling these life-threatening conditions and diseases.

Key Words: Bioactive metabolites, Food functionality, Health threatening conditions, Mushrooms, Nutraceutical

iCB 2022-111

Formulation, Processing and Characterization of Fermented Probiotic Mango Juice Using Selected Starter Cultures

Mwanzia, M., Kiio, J., & Okoth, E**.** (2022).
European Journal of Agriculture and Food Sciences, 4(1), 86-91.

Abstract

Probiotics are live microorganisms added to food products to confer health benefits such as gut health, cancer protection and improved immunity when consumed. Fruits juices are considered as potential channels for delivering probiotics as they contain essential nutrients and low pH suitable

for the growth of probiotics. The study was undertaken to formulate, process and characterize fermented probiotic mango fruit juice using three different mixed lactic acid bacteria cultures: Abt-5® culture (S*treptococcus thermophillus, Bifidobacterium* and *Lactobacillus acidophilus*); Fiti® culture (*Lactobacillus rhamnosus* GR-1) and Yo-mix® culture (*Streptoc.occus thermophillus* and *Lactobacillus delbruikii ssp bulgaricus*). The viability of the cultures was also assessed. The mango juice was formulated using mango pulp to water ratios of 100:0, 25:75, 50:50 and 75:25 (v/v) and adjusted to 17° brix by adding cane sugar. The formulated mango juices were pasteurized at 90 °C for 1 minute and cooled to 10 °C. Sensory evaluation was carried out to determine the most preferred formulation of the fruit juice before fermentation. The preferred mango juice samples were cooled to 402 °C and incubated with the three different mixed bacteria cultures (1 g/l) for 0, 12, 16, 24, 36, 48 and 72 hours. The final product stored at 4 °C. Analysis for sensory evaluation, culture viability, pH, total soluble solids (TSS) and total titratable acidity (TTA) was done. The 50:50 ([mango pulp: water) mango fruit juice formulation was significantly different ($p<0.05$) from the other samples in consistency and was rated the best in overall acceptability. There was general increase in cell count in all cultures with mango juice fermented with *Lactobacillus rhamnosus* GR-1 for 48 hours recording the highest viable cell count of log10 9.14 CFU/ml. Highest pH decrease was observed in 50:50 formulation with significant ($p<0.05$) increase in TTA from 0.15% to 0.69% using *Lactobacillus rhamnosus* GR-1 within 72 hours. Subsequently, the TSS decreased from 17° brix to 14.47° brix. The study showed that the three mixed were able to utilize nutrients present in the formulated mango juice during fermentation as demonstrated by decrease in pH and TSS. The study therefore recommends that further research should be done on the probiotic fermented mango juice to determine the change in physco-chemical characteristics and culture viability during storage.

Key Words: Fermentation, Formulation, Incubation, Pasteurization, Probiotics, Viability

iCB 2022-112

Color, pH, Microbiological, and Sensory Quality of Crickets (*Gryllus bimaculatus*) Flour Preserved with Ginger and Garlic Extracts

Akullo, J. O., Kiage-Mokua, B. N., Nakimbugwe, D., Ng'ang'a, J., & Kinyuru, J. (2023). *Food Science & Nutrition*: 2023; 00:1–14. DOI: 10.1002/fsn3.3262

Abstract

Although spices have been used in food for centuries, little is known about their use to preserve insect-based foods. This study assessed the flour produced from blanched crickets treated with extracts of either ginger, garlic or both at a ratio of 1:4 (v/w) for color, pH, microbiological profile, sensory quality, and acceptability. Sodium benzoate treated and untreated cricket flour was used as positive and negative controls, respectively. The flour was stored at ambient conditions and analyzed on 0, 30, and 60 days of storage. The pH, moisture content and color change increased during storage but remained within acceptable limits. The total microbial count, yeast and molds significantly decreased with storage duration ($p < .05$), while fecal coliforms and *Escherichia coli* were not detected in any of the samples. At the end of the 60- day storage period, cricket flour treated with sodium benzoate and garlic extracts both had a significantly lowest population of yeast and molds (1.91 log cfu/g). On five point hedonic scale (1. Dislike extremely and 5. Like extremely), color (3.84 ± 0.86– 2.55 ± 0.99), aroma (3.59 ± 1.09–2.40 ± 1.01), texture (4.11 ±

0.97– 3.11 ± 0.97) and overall acceptability (3.77 ± 0.64–2.83 ± 1.01) sensory scores were all significantly high on day 0 and low on day 60 of storage, respectively. The study concluded that preserving crickets with garlic extracts significantly reduced the population of yeast and molds. Cricket flours were microbiologically safe and acceptable to consumers. Therefore, storage of cricket flour preserved with garlic and ginger extracts for longer periods is recommended. In addition, utilization of the preserved flour as an ingredient in different food applications is recommended to determine its suitability and sensory acceptability.

Key Words: Acceptability, Cricket flour, Insect-based foods, Spice extracts, Storage

iCB 2022-113

Growth Performance, Biochemical and Haematological Parameters of BALB/c Mice Fed on Staple Grains and Bee Larvae (Apis Mellifera) Blended Complementary Foods

Mekuria, S. A., Kinyuru, J. N., Mokua, B. K., & Tenagashaw, M. W. (2022). *Heliyon*, *8*(2), e09003. https://doi.org/10.1016/j.heliyon.2022.e09003

Abstract

In Sub-Saharan Africa, inadequate complementary feeding practices and being nutritionally inadequate are primary factors in infant and young child malnutrition, growth failure, and high morbidity and mortality. Therefore, novel complementary foods need to be developed to alleviate malnutrition problems in IYC. Therefore, this experimental study aimed to assess the effects of newly developed grain-bee larvae blended complementary foods on the growth performance, haematological, and biochemical parameters of BALB/c mice. A complete randomized design was used and a total of 75 BALB/c mice were assigned to each of the five treatments. The treatments were: T1 = Casein diet; T2 = 57 % Maize, 29 % Teff, 14 % Soybean; T3 = 58 % Maize, 29 % Teff, 13 % Bee larvae; T4 = Commercial wean mix; and T5 = Basal diet alone. The *in vivo* experiment trial was done for 28 days along with seven days of adaptation. Dietary intake was not significantly different (P = 0.96) between treatments, but it was noted that T3 had gained the highest final body weight (38.52 g). The examined biochemical parameters showed T4 had the lowest serum protein (6.27 mg/dl) and globulin (3.61 mg/dl). Compared to others, T3 significantly ($P < 0.001$) increased WBC (4×10^6 mm^3), RBC (11.37×10^3 mm^3), Haemoglobin (16.42 g/dl), and Hematocrit (63.04 %). The highest serum levels of zinc (0.55 mg/dl) and iron (2.08 mg/dl) were reported on T2, while the highest serum calcium content (10.64 mg/dl) was reported on T1. The results indicated that T3 can aid body growth, health, and prevent malnutrition in infants and young children.

Key Words: Biochemical, Complementary foods, Growth, Haematological, Mice, Treatments

iCB 2022-114

Valorization of African Indigenous Leafy Vegetables: The Role of Phyllosphere Microbiota

Misci, C., Taskin, E., Vaccari, F., Dall'Asta, M., Imathiu, S., Cocconcelli, P. S., & Puglisi, E. (2022). *Food Research International, 162* (A), 111944.

Abstract

In sub-Saharan Africa, malnutrition occurs in various forms going from micronutrient deficiency (MND) to severe malnutrition. In this scenario, African indigenous leafy vegetables (AILVs) could

help in alleviating hunger and food insecurity. Principally used by smallholder farmers as subsistence crops thanks to the ease of growing, AILVs have been reported to have valuable nutrient content. Nevertheless, rough handling coupled with microbial activities could lead to phyllosphere deterioration, hence leading to spoilage events that make the sustainable supply and consumption of AILVs difficult. Reviewing the literature regarding AILVs' phyllosphere microbiota, some bacteria such as *Pseudomonadaceae*, *Enterobacteriaceae*, and lactic acid bacteria (LAB) were commonly found. Their ability to deteriorate vegetables is known, thus stressing the necessity to valorize these commodities.
In this review, fermentation was deepened as an inexpensive form of food processing to valorize AILVs, modulating the phyllosphere microbiota in favor of fermenting microorganisms. The literature review revealed that traditional methods implying alkaline fermentation lower the levels of toxigenic compounds in AILVs such as cyanhydric acid. Methods involving lactic acid bacteria (LAB) fermentation with beneficial LAB were able to control the fermentation, hindering the proliferation of spoilage (i.e. *Pseudomonadaceae*) and potentially pathogenic bacteria (i.e. *Enterobacteriaceae*). Aside, the improvement of nutritional content is achieved, obtaining increased levels of B-group vitamins, carotenoids, and the reduction of antinutrient and toxic compounds for certain AILVs. Furthermore, the AILVs' shelf life is also prolonged, thus further confirming that the final products are valorized by the fermentation processes. Howbeit, this review also points out some weaknesses in the methods. Indeed, alkaline fermentation can allow the growth of toxin-producing *Bacillus* spp. that can jeopardize the consumers' health. While the unpredictability of spontaneous LAB fermentation caused in some cases the resilience of certain pathogens such as *Enterobacteriaceae*. More studies involving alternative ways to inoculate LAB starters such as back slopping might be useful to perfect the fermentation methods and finally valorize AILVs.

Key Words: African indigenous leafy vegetables, Sub-Saharan Africa, Malnutrition, Phyllosphere, Spoilage, Fermentation, Post-harvest losses

iCB 2022-115

Determination of Nutritional Composition and Selected Phytochemical and Anti-nutrient Content of Vitex payoffs (Chocolate Berry), a Neglected and Underutilized Fruit from Two Kenyan Counties

Karanja, C., Imathiu, S., Ojijo Nelson, K. O., & Thari, W. (2022).
Journal of Food Security, *10*(2), 44-52.

Abstract

Indigenous fruits, which are usually underutilized, play an important role in food and nutrition security especially in developing countries. *Vitex payos* fruit (chocolate berry) is one such example which is currently gaining popularity in arid and semi-arid parts of Kenya. Fruits of *V. payos* were collected from three wards in each of the two Counties (Kitui and Tharaka-Nithi). A composite sample from each County was obtained by mixing the three ward samples in a ratio of 1:1:1. Standard analytical methods were used in the determination of the physicochemical composition of the fruit samples. Apart from crude fat and protein, significant differences ($P<0.05$) were observed in other fruit sample parameters between the two Counties. Potassium and calcium contents were significantly higher ($P<0.05$) in Kitui compared to Tharaka-Nithi County samples,

while phosphorous was significantly lower (P<0.05) in the latter than in the former County samples. Niacin, pyridoxine and ascorbic acid were significantly higher (P<0.05) in Kitui than in Tharaka-Nithi County samples while thiamin was not detected in both County samples. All phytochemicals and anti-nutrients determined were significantly higher (P<0.05) in Kitui than in Tharaka-Nithi County samples. The results from this study indicate that *V. payos* is a good source of nutrients whose concentration may be region-dependent. Nutrient concentration of *V. payos* is comparable to most fruits. Its potassium, dietary fiber and total flavonoid content are particularly higher than in most of the common fruits.

Key Words: Anti-nutrients, Chocolate berry, Indigenous fruits, Nutritional content, Phytochemicals, *Vitex payos*

iCB 2022-116

Caregiver Factors Influencing Nutritional Status of Preschool Children in Mwingi West, Kitui County Kenya

Mbijiwe, J., Ndung'u, Z., & Kinyuru, J. (2022).
Journal of Agriculture, Science and Technology, *21*(4), 22-34.

Abstract

Children are at an increased risk of malnutrition, with many undernourished children being highly susceptible to preventable premature death and morbidity. Insufficient dietary intake, infections, food insecurity, and inadequate care are the main causes of child malnutrition. These factors are sequentially influenced by caregivers' characteristics. Despite this, the effect of a caregiver's characteristics on a child's nutrition status has not been exhaustively studied in rural areas of Kenya. It is important to continuously examine the trends in the prevalence of malnutrition for effective interventions. Regular updates on the prevalence of malnutrition are crucial for appropriate interventions. In this study, the nutritional status of children was evaluated alongside their association with caregivers' characteristics. The study was based in Migwani ward, Mwingi West Sub-County in Kitui County. The study was conducted between October and December 2020 and involved 106 caregivers with their 106 children aged 36–42 months. The characteristics of the caregivers were determined by the use of a pretested study questionnaire. To evaluate the nutritional status of children, the height and weight measures, age, and sex of the child were taken and transferred into the WHO Anthro software, and z-scores were derived. The Statistical Package for the Social Sciences (SPSS) was used to carry out additional data analysis. Children's nutritional status and caregivers' characteristics were bivariate tested to determine the association. In the present study, the prevalence of stunting was 33.0%, wasting was 15.1%, and underweight was 20.8%. In this study, the caregivers that had lower income had more children that were underweight ($\chi2 = 9.2$ $p = 0.02$), stunted ($\chi2 = 10.4$ $p = 0.015$) and wasted ($\chi2 = 16.9$, $p<0.001$) compared to those with higher incomes. More so, the caregivers that were younger had more children that were wasted ($\chi2 = 20.04$, $p<0.001$), stunted ($\chi2 = 9.65$, $p = 0.032$) and underweight ($\chi2 = 8.26$, $p = 0.041$). Households that were headed by women had more children that were stunted ($p = 0.022$), wasted ($p = 0.041$) and underweight ($p = 0.003$). Similarly, respondents with lower education levels had more children that were stunted ($\chi2 = 14.02$, $p = 0.003$), wasted ($\chi2 = 4.85$, $p = 0.037$) and underweight ($\chi2 = 4.76$, $p = 0.045$). In this study, the caregiver's occupation was significantly associated with children's stunting ($\chi2 = 12.23$, $p = 0.007$) and underweight levels ($\chi2$

= 6.12, p = 0.034). The caregiver's occupation had no influence on the children's wasting levels. The present study found that the marital status of a caregiver did not influence a child's nutritional status. These study results affirm that nutritional problems of stunting, wasting, and underweight among preschool children in Kitui County require public health actions. That caregivers' characteristics play a role in the nutritional status of preschool children in Kitui County. Based on these study findings, priority should be given to children's nutrition programs that incorporate the dynamics of caregivers' characteristics. By doing this, such programs will be more effective.

Key Words: Nutritional Status, Caregivers Factors, Children, Rural Areas.

iCB 2022-117

Insight into Pectin-Cation-Phytate Theory of Hardening in Common Bean Varieties with Different Sensitivities to Hard-to-Cook

Wainaina, I., Lugumira, R., Wafula, E., Kyomugasho, C., Sila, D., & Hendrickx, M. (2022). *Food Research International*, *151*, 110862.

Abstract

In this study, a detailed quantitative analysis of the mechanisms linked with pectin-cation-phytate hypothesis of hard-to-cook development (HTC) was evaluated to assess the plausibility of this hypothesis. Several common bean varieties with varying sensitivities to HTC were characterized for pectin, cell wall bound calcium and inositol hexaphosphate ($InsP_6$) content before and after ageing. Ageing resulted in a significant decrease in $InsP_6$ content (resulting in calcium release) in all varieties. Despite not significantly changing during ageing, the cell wall bound calcium content significantly increased in most aged bean varieties upon short cooking indicating enhanced internal cation migration during the early phase of cooking in contrast to during ageing and soaking. Among the parameters evaluated in this study, the relative changes in $InsP_6$ content significantly correlated with the change in cooking times as well as changes in cell wall bound calcium content. Results obtained in this study suggest that in some bean varieties, pectin-cation-phytate hypothesis is the predominant mechanism by which hardening occurs during storage while in other varieties, the role of other factors such as phenolic crosslinking as suggested in literature cannot be ruled out.

Key Words: Cation, Cell wall-bound, Pectin, Inositol phosphate, Cooking time, Aged.

iCB 2022-118

Associations between Stunting, Wasting and Body Composition: A Longitudinal Study in 6- to 15-Month-Old Kenyan Children

Konyole, S. O., Omollo, S. A., Kinyuru, J. N., Owuor, B. O., Estambale, B. B., Ritz, C., Michaelsen, K. F., Filteau, S. M., Wells, J. C., Roos, N., Friis, H., Owino, V. O. & Grenov, B. (2023). *The Journal of Nutrition*. https://doi.org/10.1016/j.tjnut.2023.02.014

Abstract

Background: Early growth and body composition may influence the risk of obesity and health in adulthood. Few studies have examined how undernutrition is associated with body composition in early life.

Objectives: We assessed stunting and wasting as correlates of body composition in young Kenyan children.
Methods: Nested in a randomized controlled nutrition trial, this longitudinal study assessed fat and fat-free mass (FM, FFM) using deuterium dilution technique among children at age 6 and 15 months. This trial was registered at http://controlled-trials.com/ (ISRCTN30012997). Cross-sectional and longitudinal associations between *z*-score categories of length-for-age (LAZ) or weight-for-length (WLZ) and FM, FFM, fat mass index (FMI), fat-free mass index (FFMI), triceps, and subscapular skinfolds were analyzed by linear mixed models.
Results: Among the 499 children enrolled, breastfeeding declined from 99% to 87%, stunting increased from 13% to 32%, and wasting remained at 2% to 3% between 6 and 15 mo. Compared with LAZ >0, stunted children had a 1.12 kg (95% CI: 0.88, 1.36; $P < 0.001$) lower FFM at 6 mo and increased to 1.59 kg (95% CI: 1.25, 1.94; $P < 0.001$) at 15 mo, corresponding to differences of 18% and 17%, respectively. When analyzing FFMI, the deficit in FFM tended to be less than proportional to children's height at 6 mo ($P \leq 0.060$) but not at 15 mo ($P > 0.40$). Stunting was associated with 0.28 kg (95% CI: 0.09, 0.47; $P = 0.004$) lower FM at 6 mo. However, this association was not significant at 15 mo, and stunting was not associated with FMI at any time point. A lower WLZ was generally associated with lower FM, FFM, FMI, and FFMI at 6 and 15 mo. Differences in FFM, but not FM, increased with time, whereas FFMI differences did not change, and FMI differences generally decreased with time.
Conclusions: Overall, low LAZ and WLZ among young Kenyan children were associated with reduced lean tissue, which may have long-term health consequences.

Key Words: Body composition, Malnutrition, Infancy and childhood, Fat-free mass, Fat mass, Infant growth, Child growth

iCB 2022-119

Edible Insect Biodiversity and Anthropo-Entomophagy Practices in Kalehe and Idjwi Territories, D.R. Congo

Ishara, J., Cokola, M. C., Buzera, A., Mmari, M., Bugeme, D., Niassy, S., Katcho, K. & Kinyuru, J. (2023). *Journal of Ethnobiology and Ethnomedicine*, *19*(1), 1-17.

Abstract

Background: Located in the Eastern Democratic Republic of Congo (South-Kivu), Kalehe and Idjwi are two relatively unexplored territories with little to no research on edible insects even though anthropo-entomophagy practice is widespread. This study therefore aimed at exploring the biodiversity, perception, consumption, availability, host plants, harvesting techniques, and processing techniques of edible insects.
Methods: Data were collected through a field survey using three techniques, namely structured interviews, direct observations, and insect collection and taxonomy. A total of 260 respondents, 130 in each territory, were interviewed. The field survey focused on inventorying commonly edible insects as well as recording consumer preferences, preference factors, seasonal availability, host plants, harvesting techniques, and processing and preservation methods. Samples for taxonomic characterization were preserved in 70% alcohol.
Results: Nine edible insects, namely *Ruspolia differens* Serville 1838, *Gryllotalpa Africana* Palisot de Beauvois 1805, *Locusta migratoria* Linnaeus 1758, *Macrotermes subhyalinus* Rambur 1842,

Gnathocera trivittata Swederus 1787, *Rhynchophorus phoenicis* Fabricius 1801, *Vespula spp*. Linnaeus 1758, *Apis mellifera* Linnaeus 1758, and *Imbrasia oyemensis* Rougeot 1955, were recorded as being consumed either as larvae, pupae, and adults. *Ruspolia differens* and *M. subhyalinus* were reported as the most preferred by consumers in the studied territories. A scatter plot of matrices and Pearson's correlations showed a negative correlation between preference based on taste, size, and shape, as well as perceived nutritional value. Their seasonal availability differs from one species to another and correlated with host plants availability. Harvesting techniques and processing and preservation methods depend on species, local knowledge, and practices.
Conclusion: The huge edible insect diversity observed in Kalehe and Idjwi is evidence of anthropo-entomophagy practices in the area. In addition to being an important delicacy and traditional foods, edible insects can contribute to food, environmental, and financial security through local business opportunities. Households can rely on edible insects to meet their nutritional needs instead of conventional livestock. Indigenous practices and technologies used for harvesting, processing, and preserving edible insects must be improved to meet international standards to increase the market and capitalize on the economic potential of edible insects.

Key Words: Edible insects, Biodiversity, Anthropo-entomophagy, Seasonal availability, Host plants, Harvesting techniques, Processing methods

iCB 2022-120

Edible Insects Regulatory National Standards in Kenya: An Incentive or a Deterrent?

Kinyuru, J., & Ndung'u, N. (2022). *Journal of Agriculture, Science and Technology*, *21*(4), 1-3.

Abstract

Different wild collections of edible insects have been reported variously in the last decade. An overview of the global scene indicates that there is an unqualified and virtually untapped opportunity. Therefore, there is a need to focus not just on increased production but also on increased utilization as an ingredient in food and feed. This may enhance the supply of highvalue nutrients for humans and livestock as the insects supply a balance of energy, protein, fats, vitamins, and minerals. Improvements in technologies and practices in farming have been shown to improve productivity and enhance the nutritional value of insects, which means that high-value food products can be developed, therefore. Post-harvest loss for edible insects in the East Africa region is generally low due to high consumer demand. However, on rare occasions of glut, a 20–30% loss may be witnessed, mainly due to a lack of adequate storage infrastructures such as refrigeration, storage capacity, and shelf-stable products. The most common value-added edible insect products in the markets are minimally processed insects, mainly deep fried, although some variations, such as smoked fried grasshoppers, can also be found. Ultra-processed insect-based products are rare and most have been reported as the work of research by scientists. The demand for minimally processed insects is high enough to reduce the chances for highly processed, value-added products. However, with increased farming techniques being studied and promoted, opportunities for developing highly and ultra-processed products will unfold.

iCB 2022-121

Potential Sources of Natural Antioxidants and Antimicrobials: Comparative Analysis of Turmeric (Curcuma longa) Extracts from Different Solvent Extraction Systems

Akullo, J. O., Kiage-Mokua, B., Nakimbugwe, D., Ng'ang'a, J. & Kinyuru, J. (2022). *Journal of Food Chemistry & Nanotechnology 8(4): 138-146.*

Abstract

Phytochemical content and activity of organic and aqueous extracts of turmeric (*Curcuma longa*) was studied to determine their potential for use as natural antioxidants and antimicrobials for therapeutic and food applications. Turmeric rhizomes were extracted with acetone, ethanol, methanol, water and analysed using standard procedures. Organic extracts exhibited significantly higher total phenolic and flavonoid content compared to aqueous extract; 1379.94, 515.60, 561.16, 307.45 mg /100g Gallic acid equivalence and 382.66, 411.88, 339.01, 158.11mg /100g quercetin equivalent in acetone, ethanol, methanol and water aqueous respectively ($p<0.05$). Tannins were highest in acetone and lowest in ethanol extracts (175.86 and 20.45 mg /100g Catechin equivalent respectively); while vitamin C levels varied significantly, being highest in water and lowest in acetone extract; 62.78 and 11.77 mg /100g ascorbic acid equivalent respectively ($p<0.05$). Free radical scavenging activity of the extracts was in decreasing order of acetone, ethanol, water, and methanol. Antioxidant activity of acetone extracts compared favourably with vitamin C (standard). Antimicrobial activity (Diameter of growth inhibition zones) varied significantly among the extracts. Antifungal activity of aqueous extracts (29.33 millimeters) was significantly higher than organic solvent (19-25.33 millimeters) extract ($p<0.05$). Ethanolic extract was the most effective against *Escherichia coli* (18.33 millimeters); while the efficacy against *Staphylococcus aureus* was not significantly different among the extracts ($p>0.05$) and *Candida albicans* was the most susceptible microorganism to all extracts. The study concluded that both organic and aqueous turmeric extracts exhibited varied antioxidant and antimicrobial activities owing to the level of major phytochemical groups in the extracts.

Key Words: Turmeric extracts, Phenolic content, Free radical scavenging, Antifungal activity

iCB 2022-122

Effect of Aqueous and Organic Solvent Extraction on in-vitro Antimicrobial Activity of Two Varieties of Fresh Ginger (*Zingiber officinale*) and Garlic (*Allium sativum*)

Akullo, J. O., Kiage, B., Nakimbugwe, D., & Kinyuru, J. (2022). *Heliyon*, *8*(9), e10457.

Abstract

The current state of antimicrobial resistance to synthetic antimicrobial drugs has led to renewed interest in natural antimicrobial compounds. Antimicrobial activity of extracts of (local and hybrid) ginger and garlic was investigated using the agar well diffusion method against *Staphylococcus aureus, Escherichia coli* and *Candida albicans.* Aqueous and organic solvent extracts of both varieties of ginger and garlic exhibited varied and concentration-dependant antimicrobial activity. Inhibition zones at 25 mg/mL varied significantly against the microorganisms, being highest on *C. albicans*; 18.00 ± 2.00 to 30.67 ± 1.16 mm for acetone extracts and raw juice of hybrid ginger and 19.67 ± 1.16 to 30.33 ± 1.53 mm for methanol and raw extracts of local garlic respectively. Minimum Inhibitory Concentration ranged from 2.5 to 10 mg/mL in garlic extracts. The study

concluded that both varieties of ginger and garlic possess antimicrobial substances, though ginger is more potent as antifungal agent.

Key Words: Antimicrobial activity, Minimum inhibitory concentration, Agar well diffusion method, Pathogens

iCB 2022-123

Physico-Chemical Characterization, Acceptability and Shelf Stability of Extruded Composite Flour Enriched with Long-Horned Grasshopper (*Ruspolia differens*)

Pius, E. S., Owaga, E., & Kinyuru, J. (2022).
Journal of Agriculture, Science and Technology, 21(2), 4-32.

Abstract

In Tanzania, chronic malnutrition rates remain high, with 32 percent of children under the age of 5 being stunted. The high cost of dietary protein sources is a contributing factor to the deterioration of the nutritional status of most children. Edible insects are suggested to provide an alternative source of protein in enriching the nutritional composition of foods. However, there is limited knowledge on the potential use of long-horned grasshopper (Ruspolia differens) to enhance the nutritional properties of extruded composite flour. This study intended to develop an extruded composite flour enriched with the long-horned grasshopper and further evaluate its proximate composition, mineral properties, antinutritional composition, functional properties, sensory acceptability, and shelf-life stability. Four samples of composite flour were formulated and processed using a twin-screw extruder to produce extruded composite flour (ECF) with a mixing (%wt.) ratios of 100:0 (ECF 0), 95:5 (ECF 5), 85:15 (ECF 15), 75:25 (ECF 25) for composite flour (cassava, millet, sorghum) and edible long-horned grasshopper pellets, respectively. Feed moisture content and barrel temperature were adjusted from 15 to 16% and 128 to 142 0C for Zone I, and 105 to 114 0C for Zone II, respectively. The findings show that the inclusion of long-horned grasshopper meal in the extruded composite flour significantly increased the moisture, crude fibre, crude ash, crude protein, and crude fat and mineral contents of Fe and Zn while significantly decreasing the carbohydrate contents at ($p<0.001$), and Mg contents at ($p=0.0089$). The phytate contents between ECF 0 and extruded composite flour treatments enriched with long-horned grasshopper did not differ significantly ($p<0.141$). All treatments showed a significant higher tannin content ECF 5 (0.007 mg CE/g), ECF 15 (0.012 mg CE/g) and ECF 25 (0.011 mg CE/g) when compared to values in control (0.004 mg CE/g). There was a significant difference at a 5% confidence level on the sensory properties between ECF 0 and ECF 15 and ECF 25; the latter two treatments had higher scores for colour and a lower score for aroma and taste attributes, respectively ECF 0. In addition, treatments (ECF 5, ECF 15, ECF 25) showed significantly higher peroxide values (3.52 to 5.32 mEq/Kg) than those in the control sample (2.80 to 3.33 mEq/Kg). In conclusion, the inclusion of edible long-horned grasshopper in the composite flour, significantly improved the quantity of crude protein, crude fat, and energy with an adequately appropriate amount of Zn and Fe to meet the needs of fast-growing infants and young children. Moreover, the functional properties of the resulted product were positively affected and its consumption is expected not to cause any harm to the human body. However, the product needs modification to improve aroma and taste attributes to increase product acceptability.

Key Words: Extruded composite flour, Edible insect, *Ruspolia differens*, Physicochemical propperties, Shelf-life stability, Sensory acceptability, Food enrichment

iCB 2022-124

Growth and Reproductive Performance of Edible Grasshopper (*Ruspolia differens*) on Different Artificial Diets

Malinga, G. M., Acur, A., Ocen, P., Holm, S., Rutaro, K., Ochaya, S., S., Kinyuru, J. N., Eilenberg, J., Roos, N., Valtonen, A., Nyeko, P. & Roininen, H. (2022).
Journal of Economic Entomology, *115*(3), 724-730.

Abstract

Ruspolia differens (Serville) (Orthoptera: Tettigoniidae), also known as the 'edible grasshopper', 'African edible bush-cricket', and 'nsenene', is regarded as one of the most promising edible insect species that can be used for food, particularly in Sub-Saharan Africa. However, there is insufficient information on suitable diets and their effects on survival, adult weight, fecundity, and developmental time of this species, which are preconditions for large-scale production. In this study, we experimentally evaluated the effects of 12 diets (wheat bran, rice seed head, finger millet seed head, soya bran, maize bran, fresh maize comb, millet flour, chicken feed egg booster, simsim cake, sorghum seed head, powdered groundnut, and germinated finger millet), that are known to be accepted by *R. differens*, on their growth and reproductive parameters. The survival rate, developmental time, and adult weight varied considerably on the various diets. The highest nymphal survival rates, shortest development times, and highest adult weights were recorded for both sexes when fed fresh maize comb and germinated finger millet diet. Lifetime fecundity of females fed on germinated finger millet also was, on average, more than twice higher compared to other diets. The present study demonstrated that relatively inexpensive and locally available germinated finger millet, fresh maize seed (at the silking stage on the comb), sorghum seedhead, and finger millet seedhead could be successfully used to rear and sustain populations of *R. differens*. Our findings contribute to the future design of an effective mass-rearing system for this economically important edible insect.

Key Words: Edible bush-cricket, Feeding, Growth, Insect farming, *Ruspolia* rearing

iCB 2022-125

Extraction, Phytochemical Analysis, Monosaccharide Composition and Functional Properties of *X. americana* Seed Mucilage

Bazezew, A. M., Emire, S. A., Sisay, M. T., & Kinyuru, J**.** (2022).
Bioactive Carbohydrates and Dietary Fibre, *27*, 100302.

Abstract

The ability of mucilage to improve the functional and rheological properties of foods has initiated interest in exploiting different plant sources. *Ximenia americana* seed, disposed after consuming of the fruit pulp, has not been exploited for its mucilage potential to be used in food industry. *X. americana* seed mucilage was extracted and precipitated with water and ethanol, respectively. This study investigates the phytochemical constituents, antioxidant activities, monosaccharide composition, and morphological features of *X.americana* seed mucilage. The yield of mucilage obtained from the seed was 17.15%. The amount of total phenol, flavonoid, alkaloid, and tannin

extracted with methanol was higher than that of acetone. Saponin was not detected in this mucilage extract. Xylose (50.18%) was the dominant sugar, while sucrose (2.83%) was the least in quantity among monosaccharides. The FTIR result revealed the presence of (OH) group which indicated the hydrophilic nature of the mucilage. The SEM micrograph also showed the amorphous and uneven shapes with cracks. The mucilage had remarkable functional properties in terms of foaming capacity, foam stability, emulsion capacity, emulsion stability, water and oil holding capacity and viscosity. The result indicated that the mucilage from *X. americana* seed could be a potential ingredient in food industry.

Key Words: Mucilage, Xylose, X. Americana, Seed, Monosaccharide, Extract

iCB 2022-126

Allergens Associated with Edible Insects Unlikely to Cause Adverse Health Effects to Consumers

Kinyuru, J. and Ng'ang'a, J. (2022). *Journal of Agriculture, Science and Technology*, *21*(1), 1-3.

Abstract

Insects represent a significant part of the diet for many communities and are delicacy in several countries in Africa, South America, Asia and Oceania. However, in western countries, the consumption of insects (entomophagy) is yet to be culturally and socially accepted. Currently, more than 2,000 documented arthropods are being eaten worldwide. From a nutritional point of view, insects have an interesting nutritional profile, offering important sources of vitamins, minerals and animal-derived proteins. They also require less feed for each kg of food produced, and have higher relative growth and lower emission of greenhouse gases compared to livestock. Thus, considering their efficiency, edible insects could play an important role to meet the increasing demand for food, in particular as an important source of animal protein. Little is known on the food safety aspects of edible insects and this could be of critical importance to meet the society's approval, especially if people are not accustomed to eating insects. Food allergy is an adverse immune response to food, which is caused by substances called allergens (type of antigens), which can result to a serious illness and sometimes death. Globally, food allergy is an emerging public health problem whose management along the food value chain continues to pose great challenge to the industry and professional health care practitioners. A wide range of foods containing protein can cause allergic reactions to sensitive people.

iCB 2022-127

Inventory Reveals Wide Biodiversity of Edible Insects in the Eastern Democratic Republic of Congo

Ishara, J., Ayagirwe, R., Karume, K., Mushagalusa, G. N., Bugeme, D., Niassy, S., Udomkun, P. & Kinyuru, J. (2022).
Scientific Reports, *12*(1), 1576.

Abstract

In response to growing food demand, edible insects are perceived as an opportunity to alleviate food insecurity. With its wide edible insects' biodiversity, the Democratic Republic of Congo is one of Africa's most critical entomophagous. This study aimed at giving a first insight on inventory showing diversity, perception, consumption, availability, host plants, harvesting techniques and

processing techniques of edible insects in South-Kivu, DRC. It recorded twenty-three edible insects belonging to nine families and five orders, some of which are consumed in the larval, adult, egg and pupa stages. *Rhyncophorus phoenicis*, *Alphitobius diaperinus*, *Macrotermes subhyalinus* and *Acheta domesticus* were the most preferred edible insects in Fizi Territory, *Ruspolia differens* and *Apis mellifera* larvae in Kabare Territory, *Imbrasia oyemensis*, *Imbrasia epimethea*, *Rhynchophorus ferrugineus* and *Rhyncophorus phoenicis* in Mwenga Territory, *Ruspolia differens*, *Macrotermes subhyalinus*, *Gryllotalpa africana*, Nsike, *Nomadacris septemfasciata* and *A. mellifera* larvae in Walungu Territory. *Ruspolia differens*, *I. oyemensis*, *A. mellifera* larvae, *G. africana* and Nsike, were preferred for their taste. *Acheta domesticus*, *A. diaperinus* and *A. mellifera* larvae were abundant throughout the year, while others were only available for 9 months or less per year. Numerous plants have been recorded as their hosts, including plants used for food and income. Harvesting strategies and period, processing methods and preservation techniques depend on insect species, local knowledge and practices. These findings suggest similar and thorough studies on entomophagy across the country while encouraging the rearing of edible insects to address their existing high demand and environmental concerns.

iCB 2022-128

Safety, Regulatory and Environmental Issues Related to Breeding and International Trade of Edible Insects in Africa

Niassy, S., Omuse, E. R., Roos, N., Halloran, A., Eilenberg, J., Egonyu, J. P., Tanga, C., Meutchieye, F., Mwangi, R., Subramanian, S. and Musundire, R., Nkunika, P. O. Y.; Anankware, J. P.; Kinyuru, J.; Yusuf, A. & Ekesi, S. (2022). *Scientific and Technical Review 41*(1), 117-131, https://doi.org/10.20506/rst.41.1.3309

Abstract

Insect breeding or farming for food and feed is an emerging enterprise that can address the ever-growing demand for protein and curb high unemployment rates in Africa and beyond. However, for the sector to prosper, its value chain needs to be regulated to ensure sustainability and safety for consumers and the environment. Although a few African countries, such as Kenya, Uganda and Rwanda, have promulgated standards on the use of insects as food and feed, greater efforts are needed in other countries, and relevant policies governing the sector need to be formulated. All over the globe, attention to the regulation of the edible insect sector is increasing, and more investment in the in- dustry is foreseen. Safety issues such as identifying which species should be reared, substrate quality and traceability imposed by importing countries will be critical for expansion of the sector. This paper analyses safety, regulatory and environmental issues related to breeding and international trade of edible insects in Africa and provides case studies and recommendations for sustainable use of insects for food and feed.

Key Words: Animal feed, Enterprises, Global food and nutrition security, Healthy diets, Legislation, Protein, Standards, Sustainable Development Goals.

iCB 2022-129

Comparison of Healthfulness of Conventional Meats and Edible Insects in Sub-Saharan Africa Using Three Nutrient Profiling Models

Weru, J., Chege, P., Wanjoya, A., & Kinyuru, J. (2022).
Bulletin of the National Research Centre, *46*(43), 1-14.

Abstract
Background: Meat and meat products have been blamed for a myriad of problems facing human kind like lifestyle illnesses, environmental degradation, and climate change. Edible insects have been suggested as the suitable alternatives to conventional meats in order to ameliorate these drawbacks. Healthfulness is the ability for a given food to impart health benefits to the consumer. Evidence is however scanty on the healthfulness of both the meats and edible insects in order to have grounds for replacing meats with insects in the diet. This study aimed to comparatively evaluate the healthfulness of meats and edible insects in Sub-Saharan Africa using modern nutrient profiling models.
Materials and methods: Nutritional data for meats and edible insects were obtained from Food Composition Tables (FCTs) and a systematic review, respectively. The data was applied to three nutrient profiling models: the WXYfm (Ofcom) model that was designed to regulate advertising of foods to children, the RRR (Ratio of Recommended to Restricted) model that assesses the ratio of positive to negative nutrients in foods, and the GDA (Guideline Daily Amounts) model which has been used to regulate health claims on foods. Tukey's Studentized Range (HSD) Test (The SAS System) was used to check for significance in differences of healthfulness using mean scores.
Results: The WXYfm model classified all foods as healthful, and *Nasutitermes spp*. was significantly more healthful than duck ($P = 0.05$). The RRR classified all foods as healthful, and *Nasutitermes spp*. was significantly more healthful than all other foods except *Macrotermes bellicosus* and tilapia ($P = 0.05$). Duck (for women and men) and pork (for women), were classified as unhealthful by the GDA scoring system, and duck was significantly less healthful than all other foods ($P < 0.0001$), except for pork and mutton.
Conclusion: Edible insects are promising alternatives to conventional meats, but the choice should be on a species-to-species basis. This would be significant in broadening the choice of protein sources to cater for an ever-increasing world population.

Key Words: Meat, Edible insects, Healthfulness, Nutrient profling, Scores

iCB 2022-130
Effects of Seed Treatments and Storage Duration on *Myzus persicae* (Hemiptera: Aphididae) and Amaranth Fresh Leaf Yield
Nampeera, E. L., O'Neal, M. E., Nonnecke, G. R., Murungi, L. K., Abukutsa-Onyango, M. O., & Wesonga, J. M. (2023). *Environmental Entomology*, XX(XX), 1–11.

Abstract
The green peach aphid, *Myzus persicae* (Sulzer) (Hemiptera: Aphididae), is a key insect pest of amaranth in East Africa. Pest management has been restricted to indiscriminate application of insecticides to foliage. Applying systemic insecticides to seeds has been shown to manage aphid infestations in other crop systems. We evaluated two commercially available seed treatments in East Africa, Apron Star (thiamethoxam 20 g/kg + metalaxyl-M 20 g/kg + difenoconazole 2 g/kg) and Menceron (imidacloprid 233 g/L + pencycuron 50 g/L + thiram 107 g/L) for their efficacy against *M. persicae* and impact on fresh leaf yield with two *Amaranthus* species, *Amaranthus blitum* (2 selections), *Amaranthus hybridus* (4 selections) and untreated control. Two storage periods (24 h and 3 months) with seed treatments were used. Each amaranth selection was treated individually with Apron and Monceren or untreated, and seeds were planted either 24 h or 3

months after treatment. Significant reduction in live aphids was observed with *A. blitum* and *A. hybridus* selections grown with seed treatment, at 6, 8 and 10 d after infestation (DAI) when compared with seeds grown without seed treatment. Untreated seeds of *A. hybridus* (selection 5) had significantly higher number of live aphids up to 243, greater percentage of damaged leaves and leaf damage score up to 84% and 64% respectively when compared with treated seeds of specific amaranth at 10 DAI. No significant difference was noted between seed treatment and storage time. Amaranth seeds treated with Monceren offered more protection against infestations of *Myzus persicae* than amaranth seeds treated with Apron under high tunnel experiments.

Key Words: Amaranth, Insecticide, Neonicotinoids, Pest management

iCB 2022-131

The World Vegetable Center Amaranthus Germplasm Collection: Core Collection Development and Evaluation of Agronomic and Nutritional Traits

Schafleitner, R., Lin, Y. P., Dinssa, F. F., N'Danikou, S., Finkers, R., Minja, R., **Abukutsa-**Onyango, M., Nyonje, W. A., Lin, C. Y., Wu, T. H., Sigalla, J. P., Van Zonneveld, M. Hsiao, Y. Y., Kumar, S., Wu, W. J., Wang, H. I., Lin, S. & Yang, R. Y. (2022).
Crop Science, *62*(3), 1173-1187. https://doi.org/10.1002/csc2.20715

Abstract

Amaranth (*Amaranthus* spp.) is an underutilized crop increasing in popularity as a grain and as a leafy vegetable. It is rich in protein, minerals, and vitamins, and adapts well to a range of production systems. Currently, the lack of improved cultivars limits the use of the crop. Breeding-improved cultivars requires access to large collections of amaranth biodiversity stored in genebanks. The task of searching such vast collections for traits of interest can be eased by generating core collections, which display the diversity of large collections in a much smaller germplasm set. The World Vegetable Center amaranth collection contains around 1,000 accessions of 13 species; among them, there are 281 accessions of four species important for use as vegetable amaranth in Africa (*A. cruentus*, *A. hypochondriacus*, *A. caudatus*, and *A. dubius*). Based on single nucleotide polymorphism (SNP) marker genotype diversity, a core collection (CC) of 76 accessions, cultivars, and selections was assembled. To a large extent, it represents the diversity of the whole collection. The CC was evaluated for yield and nutritional parameters during the cool and warm seasons in Tanzania and Taiwan and a pretest for variation of drought tolerance in the CC has been performed. Cultivar Madiira 2, an improved cultivar developed for vegetable production in Africa, outperformed all other tested cultivars in terms of yield stability, but several CC accessions had higher yield, lower wilting score, and higher nutrient content than Madiira 2. This indicates the core collection can be used for further improvement of amaranth cultivars.

iCB 2022-132

Effect of Storage Temperature on Fruit Firmness and Weight Loss of Nine Tomato Lines

Kathimba, F. K., Kimani, P. M., Narla, R. D., & Kiirika, L. M. (2022).
African Journal of Plant Science, *16*(10), 276-284.

Abstract
This study aimed to determine effect of three temperature levels on fruit firmness and weight in nine tomato lines in Kenya. Fruit firmness and weight loss were evaluated in a split plot design, temperature levels as main plots and tomato lines as sub-plots at the University of Nairobi, Pilot Seed Processing Plant. Fruits stored at 16°C showed the lowest average decrease in fruit firmness (58.19%) followed by 4°C (61.11%) while the highest loss of 73.34% was at 25°C. An average firmness loss of <47.59% was recorded in tomato lines after three weeks storage at 4°C and <50.62% after four weeks at 16°C. More than 50.31% loss was recorded after two weeks at 25°C. Tomato lines stored at 4°C recorded a weight loss of <38.76% throughout the storage period. More than 50.00% weight loss at 16°C was recorded after three weeks while at 25°C, the same loss was recorded after one week of storage. At 4°C, loss in fruit weight varied from 0.98% (AVTO1424) to 3.11% (Roma VF x AVTO1314) in week one and from 22.85% (AVTO1424) to 38.76% (AVTO1314) in week five. AVTO1424 had the lowest loss in fruit firmness and weight while Valoria selects had the highest.

Key Words: Shelf-life, Quality attributes, Genotypes, Fruit mass, Storage conditions.

iCB 2022-133
Appraisal of Determinants of Orange-Fleshed Sweet Potato Production and Utilization in Isiolo County, Kenya
Kavoo, A. M., Mwajita, R. M., Kariuki, L. W., & Kiirika, L. M. (2022). *African Journal of Food, Agriculture, Nutrition and Development, 22*(3), 19886-19909. DOI:10.18697/ajfand.108.21210

Abstract
Micronutrient deficiency remains a leading challenge among children and pregnant women in arid and semi-arid areas (ASALs) of Kenya. An important strategy for supplementing dietary intake of micronutrients, especially vitamin A, is through food fortification. Vitamin A deficiency (VAD) affects 190 million pre-school children and 19 million pregnant women globally. Orange-fleshed sweet potato (OSP) is a rich plant-based source of beta-carotene which is converted into Vitamin A upon consumption and has the potential to alleviate this deficiency among ASALs communities. In this study, household surveys were conducted to profile Orangefleshed sweet potato (OSP) farmers' knowledge, production practices, constraints, acceptance and willingness to grow OSP in Isiolo County, Kenya. The overall aim of the study was to enhance adoption and improve food and nutrition security. Farmers were purposively sampled depending on their involvement in sweet potato farming for at least one year. A total of 150 farmers representing three wards namely: Burat, Ngaremara, and Bulla Pesa were interviewed. Data were collected using structured questionnaires via face-to-face interviews as well as focused group discussions (FGDs). Collected data was analysed using Statistical Package for Social Sciences (SPSS) software Version 16.0. A total of six sweet potato varieties were grown in the study area. The yellow fleshed variety cultivated by 40% of the respondents was cited as the most palatable variety (60%). Only 52.4% of the farmers were aware of OSP and its benefits with 100% of the farmers willing to grow the OSP varieties. Several constraints were reported to influence production of OSP which included pests and diseases, lack of improved varieties, short shelf life, and lack of market (76.2%, 81%, 71.4% and 61.9%, respectively). The most common forms of OSP utilization were whole cooked products and dual purpose, that is, food and feed (81% and 52% of respondents, respectively). The dual

nature of sweet potato utilization suggests a huge potential for up-scaling production to satisfy a demand for dietary diversification, value addition and product diversification and eventual increase in household incomes and reduced resource related conflicts among pastoralist communities.

Key Words: Orange-fleshed Sweet Potato, Adoption, Malnutrition, Dietary diversification, Food security

iCB 2022-134

Analysis of Tomato Agronomic Traits Using Generation Mean

Kathimba, F. K., Kimani, P. M., Narla, R. D., & Kiriika, L. M. (2022). *African Crop Science Journal*, *30*(4), 441-453. DOI:10.4314/acsj.v30i4.4

Abstract

Information on inheritance of agronomic traits and lack of tomato *(Solanum lycopersicum* L.) a robust breeding programme in Kenya, has led to dependency on imported tomato varieties. The objective of this study was to assess the inheritance of growth attributes of tomato lines in Kenya and identify cross family with great potential for further breeding. Six generations; namely P1, P2, F1, F2, BC1P1 and BC1P2, were developed from five parental lines. A split-plot design with crosses as main plots and generations as subplots was used in two sites (Kabete Field Station and Mwea Research Station), located in Kenya. Cross Roma VF x AVTO1424 and Roma VF x AVTO1314 were the earliest (33 days) to reach 50% flowering; while BC1P2, of Roma VF (38 days) was the latest to flower. Mwea Station had plants with the tallest plants, with a mean height of 62 cm at 50% flowering, compared to Kabete Station with a mean height of 48 cm. A significant increase (>10%) in plant height was registered in F1 generations compared to parental lines. Plant height at maturity across the environments ranged from 82 cm for shorter parent, Roma VF, to 120 cm for taller offspring BC1P1. Significant genotype x environment interactions were observed in Roma VF x AVTO1314 and Roma VF x AVTO1429 for days to 50% flowering, plant height, and number of trusses per plant. The importance of gene effects for agronomic trait inheritance was in additive and dominance-additive portions, which implied that traits were inherited.

Key Words: Additive, Dominance, *Solanum lycopersicum*

iCB 2022-135

Generation Mean Analysis for Yield and Yield Related Traits in Five Tomato Genotypes in Kenya

Kathimba, F. K., Kimani, P. M. Narla, R.D. & Kiriika, L. M. (2022).
International Journal of Plant Breeding and Genetics, *9*(7), 001-011

Abstract

The study aimed to determine inheritance of tomato yield and yield related traits in Kenya. Six generations were developed. Experiment was conducted in a split-plot design with crosses as main plots and generations as subplot at two sites. The six generations in all crosses performed better at Kabete compared to Mwea site. Significant yield increase of ≥18.11% per plant was registered in F_1 and F_2 generationsin comparison to parental genotypes. Cross Roma VF x AVTO1429 had the

highest yield of 5.59 and 5.39 kg plant^{-1} in F_2 and F_1 generations, respectively. Highly significant additive, dominance, additive x additive, dominance x dominance and additive x dominance effects were noted in total soluble sugars and number of fruits per plant while significant dominant and additive x additive interaction effects were noted in fruit firmness and fruit width traits. BC_1P_2 of cross Roma VF x Valoria select had the highest TSS Brix of 4.00%. P2, F1 and F2 hybrids and BC_1P2 of cross Roma VF x Valoria select had the highest number of fruits. The importance of gene effects for inheritance was in additive and dominance-additive portions of genetic traits expressions which implied that the traits were inherited.

Key Words: Generation mean, Inheritance, Tomato, Yield traits, Additive, Dominance.

iCB 2022-136

Heterosis and Combining Ability for Related Traits in Tomato

Kathimba, F. K., Kimani, P. K., Narla, R. D., & Kiriika, L. M. (2022).
African Crop Science Journal, *30*(s1), 109-125.

Abstract

Tomato (*Solanum lycopersicum* L.) yields have continued to plummet in Kenya due to biotic stresses and reliance on low yielding varieties. This study aimed at determining heterosis and combining ability for fruit yield and yield components among tomato genotypes and select F1 hybrids combining high fruit yield and other market demanded traits under Kenyan conditions. Ten parental genotypes and their 45 F1 hybrids were studied using 10×10 half diallel mating design, excluding the reciprocals and the self's. The experiment was set up in Kiambu and Kirinyaga Counties in Kenya. Out of 45 F1 hybrids evaluated, 89% had reduced (negative heterosis) days to 50% flowering and 11% days to maturity, compared to their better parents. Higher heterosis (-9%) was recorded on days to flowering in AVTO1429 x Cal J VF) and -5% for maturity in Roma VF x AVTO1314. All the F1 hybrids had positive heterosis for number of trusses per plant and fruit yield. F1 hybrid AVTO1429 x AVTO1314 had the highest positive heterosis of 114.39% for fruit weight per plant yield. The results showed high significant difference among the ten genotypes for general and specific combining ability effects (male x female) for all the traits evaluated. There was additive and non-additive gene action for the traits, which are important aspects in developing a tomato breeding programme.

Key Words: Gene action, Heterosis, *Solanum lycopersicum*, Trusses

iCB 2022-137

Shelf-Life and Processing Quality of Five Parental Lines and Four F1 Hybrids Developed in Kenya

Kathimba, F. K., Kimani, P. M., Narla, R., & Kiirika, L. M. *Available at SSRN 4164482*. Available at SSRN: https://ssrn.com/abstract=4164482 or http://dx.doi.org/10.2139/ssrn.4164482

Abstract

This study aimed to determine the shelf-life and processing quality of five parental lines and four F 1 hybrids grown during 2019 long rain season. Fruits harvested at breaker stage were washed with chlorinated water and stored at 4, 16 and 25 o C. Fruit firmness and weight loss traits were

evaluated in a split plot design, temperature levels as main plots and genotypes as sub-plots. Storage at 4°C had the highest fruit firmness mean of 50.39 N/cm^2 while 25°C had the lowest (35.57 N/cm^2) over the storage duration. Fruit firmness mean reduced significantly from 66.02 to 30.65 N/cm 2 recorded in week five. Genotype AVTO1424 had the highest fruit firmness mean of 50.18Ncm^{-2} while Roma VF x Valoria select had the lowest (41.02 Ncm^{-2}). Similarly, storage at 4°C had the highest fruit weight of 212.61g while 25°C had the lowest (98.95g). Fruit weight mean reduced significantly from 171.69 to 114.42g recorded after five weeks. Genotype AVTO1424 had the highest fruit weight mean of 168.01g while AVTO1314 had the lowest (133.36g). Results revealed that, as the storage duration increased from one to five weeks, fruit firmness and weight reduced significantly in the nine tomato genotypes evaluated.

Key Words: Shelf-life, Firmness, Weight, Genotypes, F1 hybrids, Proccessing quality

iCB 2022-138

Transcriptome-Guided Identification of Pectin Methyl-Esterase-Related Enzymes and Novel Molecular Processes Effectuating the Hard-to-Cook Defect in Common Bean (*Phaseolus vulgaris* L.)

Toili, M. E. M., de Koning, R., Kiekens, R., Ndumba, N., Wahome, S., Anami, S., Githiri, S. M. & Angenon, G. (2022). *Foods*, *11*(12), 1692. https://doi.org/10.3390/foods11121692

Abstract

The hard-to-cook defect in common beans is dictated by the ability to achieve cell separation during cooking. Hydrolysis of pectin methyl-esters by the pectin methyl-esterase (PME) enzyme influences cell separation. However, the contributions of the PME enzyme and the cell wall to the hard-to-cook defect have not been studied using molecular tools. We compared relevant molecular processes in fast- and slow-cooking bean varieties to understand the mechanisms underpinning the hard-to-cook defect. A PME spectrophotometric assay showed minor differences in enzyme activity between varieties. Meanwhile, a PME *HMMER* search in the *P. vulgaris* genome unveiled 113 genes encoding PMEs and PME inhibitors (PMEIs). Through RNA sequencing, we compared the gene expression of the PME-related genes in both varieties during seed development. A PME (*Phvul010g080300*) and PMEI gene (*Phvul005g007600*) showed the highest expression in the fast- and slow-cooking beans, respectively. We further identified 2132 differentially expressed genes (DEGs). Genes encoding cell-wall-related enzymes, mainly glycosylphosphatidylinositol mannosyltransferase, xyloglucan O-acetyltransferase, pectinesterase, and callose synthase, ranked among the top DEGs, indicating novel relations to the hard-to-cook defect. Gene ontology mapping revealed hydrolase activity and protein phosphorylation as functional categories with the most abundant upregulated DEGs in the slow-cooking bean. Additionally, the cell periphery contained 8% of the DEGs upregulated in the slow-cooking bean. This study provides new insights into the role of pectin methyl-esterase-related genes and novel cell wall processes in the occurrence of the hard-to-cook defect.

Key Words: Pectin methyl-esterase (PME); Pectin methyl-esterase inhibitor (PMEI); *Phaseolus vulgaris*; Hard-to-cook defect; RNA sequencing

iCB 2022-139

Abundance and Diversity of Arbuscular Mycorrhizal Fungal (AMF) Spores Isolated from the Rhizosphere of Papaya and other Different Cropping Systems in Central Kenya

Muiruri, J., Rimberia, F. K., Mwashasha, M. R., & Kavoo, A. (2022).
Journal of Agriculture, Science and Technology, *21*(1), 18-36.

Abstract

Arbuscular mycorrhiza fungi (AMF), obligate symbionts, are important in the majority of cultivated plant species in colonizing roots and supporting plant growth in adverse climatic conditions. However, the abundance and quality of mycorrhizal colonization is affected by land-use types, cropping systems and climate change. On the other hand, rhizospheric mycorrhizae present in rhizospheric soils can be isolated for enhancing plant performance. One such opportunity arises in the acclimatization of seedlings for adaptation to depleted field conditions. Isolation and characterization of rhizospheric AMF species is important in evaluating the efficiency of colonization especially in plants that have not been previously evaluated such as papaya, which is well known for its high nutritive value. In this study, soils were sampled from grass, banana and papaya plants'rhizosphere, from three different papaya growing regions in Kenya; Mwea, Mitunguu and Juja. Spores were isolated using the sucrose method. Spore abundance was done using a gridded Petri dish and morphologically characterized using the International Culture Collection of Vesicular Arbuscular Mycorrhizal Fungi (INVAM) database. At least 4 families, 10 genera and 41 species of glomeromycota phylum were isolated from the 3 sampling sites. The families of glomeraceae (16 species) and acaulosporaceae (14 species) dominated in Juja and Mwea Sub Counties. Glomus spp. isolated from the rhizosphere of banana and grass plants were the most abundant, at $p \leq 0.05$, in Juja while *Diversispora spp* (diversisporaceae) was the least abundant, at $p \leq 0.05$. Mwea Sub County had the most spore abundance, at $p \leq 0.05$, compared to Mitunguu and Juja. Mycorrhizal spores isolated from the grass family were the most abundant, at $p \leq 0.05$, (Mwea, 41; Juja, 37; Mitunguu, 35.2) as opposed to banana and papaya plants. The results showed that AMF spore abundance and diversity varies with different locations and the associating plants.

Key Words: Arbuscular mycorrhiza fungi, rhizospheric, spores, sucrose.

iCB 2022-140

Occurrence of a Novel Strain of Moroccan Watermelon Mosaic Virus Infecting Pumpkins in Kenya

Mumo, N. N., Ateka, E. M., Mamati, E. G., Rimberia, F. K., Asudi, G. O., Machuka, E., Njuguna, J. N., Stomeo, F. & Pelle, R. (2022).
Plant Disease, *106*(1), 39-45.

Abstract

The *Potyvirus* Moroccan watermelon mosaic virus (MWMV) naturally infects and severely threatens production of cucurbits and papaya. In this study, we identified and characterized MWMV isolated from pumpkin (*Cucurbita moschata*) intercropped with MWMV-infected papaya plants through next-generation sequencing (NGS) and Sanger sequencing approaches. Complete MWMV genome sequences were obtained from two pumpkin samples through NGS and validated

using Sanger sequencing. The isolates shared 83.4 to 83.7% nucleotide (nt) and 92.3 to 95.1% amino acid (aa) sequence identities in the coat protein and 79.5 to 79.9% nt and 89.2 to 89.7% aa identities in the polyprotein with papaya isolates of MWMV. Phylogenetic analysis using complete polyprotein nt sequences revealed the clustering of both pumpkin isolates of MWMV with corresponding sequences of cucurbit isolates of the virus from other parts of Africa and the Mediterranean regions, distinct from a clade formed by papaya isolates. Through sap inoculation, a pumpkin isolate of MWMV was pathogenic on zucchini (*Cucurbita pepo*), watermelon (*Citrullus lanatus*), and cucumber (*Cucumis sativus*) but not on papaya. Conversely, the papaya isolate of MWMV was nonpathogenic on pumpkin, watermelon, and cucumber, but it infected zucchini. The results suggest the occurrence of two strains of MWMV in Kenya having different biological characteristics associated with the host specificity.

Key Words: Disease management, Tree fruits, Viruses and viroids

iCB 2022-141

Thymol and Eugenol Nanoparticles Elicit Expression of *Ralstonia solanacearum* Virulence and Potato Defense Genes and are Potential Bactericides against Potato Bacterial Wilt

Oluoch, G., Nyongesa, M., Mamati, E. G., & Matiru, V. (2022).
Archives of Phytopathology and Plant Protection, *55*(9), 1136-1157.

Abstract

Bacterial wilt disease caused by *Ralstonia solanacearum* impacts negatively on potato production. This study evaluated the effects of thymol and eugenol encapsulated in chitosan nanoparticles (TCNP and ECNP) on the virulence genes (*PhcA, XpsR* and *HrpG*) of *R. solanacearum* and their *in vivo* efficacy against bacterial wilt. Gene expression levels of virulence genes in the presence of TCNP (5.6 and 11.3 µg mL−1) and ECNP (11.3 and 22.5 µg mL^{-1}) together with those of plant defense genes (chitinase and β-l,3-glucanase) were determined through RT-qPCR. All the virulence genes were downregulated when exposed to both TCNP and ECNP while glucanase and chitinase genes increased and peaked after 18 hours post inoculation. The lowest disease severity index (10.3%) was recorded with plants treated with 90 µg mL^{-1} ECNP. The results of this study show that both TCNP and ECNP have a potential to be used as bacterial wilt bactericides.

Key Words: Bacterial wilt, RT-qPCR, Virulence genes, Plant defense genes, Disease severity index

iCB 2022-142

In-vitro Antibacterial Activity of Thymol and Eugenol against *Ralstonia solanacearum* Isolated from Potato

Oluoch, G., Mamati, E. G., Matiru, V., & Nyongesa, M. (2022).
Innovations in Microbiology and Biotechnology, 5, 26-37.

Abstract

Ralstonia solanacearum-caused bacterial wilt is a serious limitation to potato output (*Solanum tuberosum* L.). *R. solanacearum* is mainly spread through infected seed stocks but can also spread from infested to healthy fields by farm equipment, irrigation water and plant-to-plant through the

rhizosphere. There are no known conventional bactericides that can effectively control this soil-borne pathogen at this time. This study aimed to investigate the antibacterial activity of eugenol and thymol which are the major components of thyme and clove essential oils respectively against *R. solanacearum*. The pathogen was isolated from potato tubers exhibiting bacterial wilt symptoms. Disc diffusion and minimum inhibition concentration (MIC) techniques were used to test the inhibitory impact of these substances. Chequerboard assay was used to conduct a combinational test. Thymol and eugenol had 27 mm and 17 mm inhibition zones, respectively, at a dosage of 100 mg mL-1. Both eugenol and thymol displayed bactericidal effects against R. solanacearum, and their MICs were determined to be 275 and 175 g mL-1, respectively. An additive effect was found in a combinational test, demonstrating that their use together did not considerably improve inhibition. Both chemicals have the potential to be used as antibiotics to treat bacterial wilt disease, albeit thymol has a lower concentration than the other. However, in vivo use of these volatile chemicals encounters difficulties that can be overcome by encapsulating them in a suitable nanocarrier.

Key Words: Essential oils, Inhibitory effect, Combinational test, Chequerboard assay, Bactericidal effect

iCB 2022-143

The Outstanding Rooting1 Mutation Gene Maintains Shoot Growth and Grain Yield through Promoting Root Development in Rice under Water Deficit Field Environments

Hasegawa, T., Wainaina, C. M., Shibata, A., Lucob-Agustin, N., Makihara, D., Kikuta, M., M., Menge, D. M., Gichuhi, E. W., Samejima, H., Kano-Nakata, M., Kimani, J. M., Musila, R: N., Yamauchi, A. & Inukai, Y. (2022). *Journal of Agronomy and Crop Science*, *208*(6), 815-829.

Abstract

Drought is one of the most serious constraints to rice cultivation, even under alternate wetting and drying (AWD), which is a water-saving management practice. In rice, enhanced root development is essential for stable shoot growth, adaptability and productivity under water deficit environments. We identified and characterized outstanding rooting1 (*our1*) rice mutant using hydroponics. The present study sought to examine morphological root traits of the *our1* mutant and the role of the mutation gene in shoot growth and yield under AWD. Thus, we evaluated the growth performance of the *our1* rice mutant in pot experiments and under field AWD conditions in Kenya. The experiments were conducted with our1 mutant, its wild type and their progenies under both AWD and continuously waterlogged (CWL) conditions. The our1 mutant possessed a well-developed root system and exhibited particularly enhanced thin root development, which was maintained from the early vegetative stage through the reproductive stage under both pot and field AWD management. This enhanced root development promoted shoot growth through increased water uptake during rewatered conditions between drought periods in AWD. In addition, the *our1* mutant showed enhanced shoot growth during the reproductive stage, resulting in the maintenance of yield under AWD fields. Genotypes harbouring *our1* mutation gene showed higher yields compared to wild-type genotypes which was attributed to their higher photosynthetic ability as a result of enhanced root activity. These results suggest the important role of a well-developed root system architecture and enhanced root function in stabilizing rice yields under water-limited

environments. Our findings indicate that the *our1* mutation gene can serve as a novel breeding material to mitigate the impact of transient drought stress on yield under AWD.

Key Words: Drought stress, Mutation gene, Rice, Root development, Water saving technique, Yield

iCB 2022-144

Transcript Expression Level Analysis of Phytoene Synthase and Phytoene Desaturase Associated with β-carotene Content in Selected Kenyan Bitter Melon

Naitchede, L. H., Nyende, A. B., & Runo, S. (2022).
Molecular Biology Reports, 49:12029–12037.

Abstract

Background: Bitter melon (*Momordica charantia* L.) is a widely cultivated food and medicinal plant native to the world's subtropics and tropics. Constraints affecting cultivation of Bitter melon affect productivity of β-carotene. Knowing the mechanism that controls the transcription of the β-carotene biosynthesis genes in Bitter melon will be of great value in improving the yield of this important metabolite.

Methods and Results: The expressions of β-carotene biosynthetic genes such as Phytoene Desaturase (PDS) and Phytoene Synthase (PSY) were evaluated in Bitter melon accessions 'GBK027049', 'NS1026', 'Mahy-ventura', '453B' and 'Sibuka532'. Transcript expression level analysis of PSY and PDS, and amount of β-carotene in leaf, stem, and fruit, were determined using quantitative polymerase chain reaction and high-performance liquid chromatography (HPLC). Root transcript expression was used as a negative control for determining relative fold change in other tissues. Expression of PSY in fruit (6 to 27-fold compared to the control) was higher than in the other organs for all accessions. This was also the case of PDS expression (10 to 29-fold compared to the control). Leaves had the highest β-carotene concentration (17.92–45.35 μg·g−1); there was no difference between stems (5.67–12.75 μg·g−1) and fruit (6.18–12.53 μg·g−1). The highest β-carotene content was in accessions 'GBK027049' (12.53–45.35 μg·g−1) and '453B' (6.18–32.09 μg·g−1). The PSY and PDS expressions were positively correlated with amount of β-carotene in leaves, stems, and fruits.

Conclusion: Bitter melon leaves, especially those of 'GBK027049' and '453B' accessions, are an alternative to alleviate the β-carotene deficiencies in the world and especially in Africa.

Key Words: Biosynthetic genes, Gene expression, HPLC, *Momordica charantia*, PDS, PSY

iCB 2022-145

Coffee Production Enhancement through Direct Somatic Embryogenesis

Mayoli, R. N., Isutsa, D. K., Nyende, A. B., & Mweu, C. M. (2022). *List of Editors*, 87.

Abstract

Regeneration of plantlets via somatic embryogenesis (SE) is considered pivotal for application of cell culture methods. This research evaluated the response of 'Ruiru 11' Sibs to plantlet regeneration protocol. Experiments were set up at Coffee Research Institute (CRI), Kenya in 2016 and 2017. Explants from field-grown mother plants were harvested, sterilized, cultured, germinated and rooted in culture media containing MS basal salts. Results showed that explants

were effectively sterilized using 30% sodium hypochlorite for 20 minutes. Sib 71 best responded to SE and should be used in future for mass propagation of 'Ruiru 11'.

Key Words: Coffee, Ruiru 11 sibs, Somatic embryos, Regeneration

iCB 2022-146

Field Deployable Reverse Transcriptase–Recombinase Polymerase Amplification (RT-RPA) for Detection of Maize Chlorotic Mottle Virus (MCMV)

Mwatuni, F. M., Redinbaugh, M. G., Miller, S., Ma, X., Aggrey, B. N., & Suresh, L. M. (2022). *Journal of General and Molecular Virology, 11*(1), 1-13. DOI: 10.5897/JGMV2022.0082

Abstract

Diagnosis of maize lethal necrosis (MLN)-causing viruses is key in MLN surveillance programs and in testing seed for zero tolerance of Maize chlorotic mottle virus (MCMV) in seed lots. This is crucial for MLN management in farmers' fields and in commercial seed fields. A customized MCMV detection assay that is specific, sensitive, affordable, and portable is therefore important for this task. Reverse Transcriptase–Recombinase Polymerase Amplification (RT-RPA) meets those conditions earlier described. RPA is a rapid isothermal nucleic acid amplification and detection platform that is based on patented Recombinase Polymerase Amplification (RPA) technology. In this study, a real time endpoint analysis and field deployable RT-RPA diagnostic method for the detection of MCMV was developed. RPA primer sets with their complementary probes were designed, synthesized and tested through a series of primer set evaluations to determine the most efficient primer sets. The primer sets targeted the MCMV genome at position 2765-2948 bp (MCMV_gp2 replicase gene). The parameters evaluated were sensitivity, specificity and reproducibility for the assay with remarkable results. The assay discriminated against other maize infecting viruses hence specific to MCMV. The assay takes only 20 min and its detection limit of 10-4 is well comparable to RT-PCR and other molecular based detection assays. MCMV was also detected directly from leaf saps without the nucleic acid extraction step hence suitable for on-farm testing. RPA is a relatively inexpensive technique that requires minimal instrumentation. This assay is therefore suitable for the detection of MCMV in field surveys, routine MCMV testing for phytosanitary measures and in the seed certification procedures.

Key Words: Maize lethal necrosis, maize chlorotic mottle virus, diagnostics, recombinase polymerase amplification

iCB 2022-147

Thickness-Dependent Release of Microplastics and Phthalic Acid Esters from Polythene and Biodegradable Residual Films in Agricultural Soils and its Related Productivity Effects

Uzamurera, A. G., Wang, P. Y., Zhao, Z. Y., Tao, X. P., Zhou, R., Wang, W. Y., Xiong, X. B., Wang, S., Wesly, K., Tao, H. Y. & Xiong, Y. C. (2023).
Journal of Hazardous Materials, 448, 130897.

Abstract

It is crucial to elucidate the release rate of microplastics (MPs) and phthalic acid esters (PAEs) in agricultural soil and their effects on crop productivity regarding film types and thicknesses. To address this issue, two-year landfill test was performed using 0.016 mm-thick polyethylene (PEt1)

& biodegradable (BIOt1), and 0.01 mm-thin polyethylene (PEt2) & biodegradable (BIOt2) residual films as materials with no landfill as CK. Scanning electron microscopy (SEM) and infrared analyses revealed that two-year landfill caused considerable changes in physical forms and spectral peaks in BIO film, which was more pronounced in thin BIO (36.90 % weight loss). Yet, less changes were presented in the above analyzes in polyethylene (PE) films, and thick films damaged relatively less. MPs number was 86,829.11 n/kg in BIOt1 and 134,912.27 n/kg in BIOt2, equivalent to 2.55 and 3.72 times higher than in PEt1 and PEt2, respectively. This was closely associated with PAEs release, as soil PAEs concentration was substantially lower in PEt1 (17.60 g/kg) and PEt2 (21.43 g/kg) than in BIOt1 and BIOt2 (37.12 g/kg and 49.20 g/kg), respectively. Furthermore, maize productivity parameters were negatively correlated with the amount of MPs and PAEs. BIOt2 and PEt1 had the lowest and highest grain yield, respectively. BIO exhibited greater environmental risk and adverse effects on soil and crop productivity than PE film due to physical degradation and release of PAEs. Thickness-wise comparison exhibited that thin film residues had more adverse effect relative to thick film ones.

Key Words: Plastic film residues; Biodegradable plastic film; Polyethylene film; Degradability; Environmental pollution

iCB 2022-148

Reduced Plastic Film Mulching under Zero Tillage Boosts Water Use Efficiency and Soil Health in Semiarid Rainfed Maize Field

Ren, A. T., Li, J. Y., Zhao, L., Zhou, R., Ye, J. S., Wang, Y. B., Zhang, X. C., Wesly, K., Ma, M. S. & Xiong, Y. C. (2023). *Resources, Conservation and Recycling*, *190*, 106851.

Abstract

Reducing the amount of plastic film while maintaining high water use efficiency & soil health is a huge challenge globally. A two-year field investigation showed that full and half plastic film mulching harvested greater in-season rainfall infiltration into soils, and significantly greater grain yield and water use efficiency under the no-tillage conditions than under the tillage conditions. Among the no-tillage treatments, half plastic film mulching resulted in significantly greater soil light fraction organic carbon by 42.7% and particulate organic carbon by 41.2% than full plastic film mulching respectively, due to its enhanced extramatrical hyphal length, glomalin production and root biomass input. Owing to higher water availability, soil nutrient uptake was accordingly enhanced under no-tillage. This phenomenon was tightly correlated with the improved abundance of arbuscular mycorrhizal fungi. Therefore, it might be feasible and efficient to massively reduce plastic mulching but improve water use efficiency and soil health in semiarid environment.

Key Words: Reduced plastic mulching; No-tillage; Water use efficiency; Soil fertility; Semiarid areas

iCB 2022-149

In Situ Degradation of Low-Density Polyethylene Film in Irrigation Maize Field: Thickness-Dependent Effect

Xiong, X. B., Zhao, Z. Y., Wang, P. Y., Zhou, R., Cao, J., Wang, J., Wesly, K., Wang, W. L., Wang, N., Hao, M., Wang, Y. B., Tao, H. Y & Xiong, Y. C. (2023). *Science of The Total Environment*, *858*, 159999.

Abstract

Thickness of low-density polyethylene (LDPE) film might determine its mechanical strength, clean production and soil health. Yet, this issue is little understood. In situ aging effects were evaluated in LDPE films with the thickness of 0.006 mm, 0.008 mm, 0.010 mm and 0.015 mm in maize field. The data showed that maximum tensile force (TFmax), maximum tensile strength (TSmax) and elongation at break (EAB) were massively lowered with increasing thickness after aging. The greatest and lowest reduction magnitude of EAB was 27.6 % and 11.2 % in 0.006 mm and 0.015 mm films respectively. Also, the melting point (Tm) and crystallinity (Xc) under Differential Scanning Calorimeter (DSC) tended to decline with the increasing thickness. Moreover, the peak intensity of crystalline regions tended to transfer and concentrate on the amorphous regions, and such tendency became more pronounced in the thin films. Interestingly, there existed a pronounced distinct thickness-dependent effects on soil bulk density (SBD) and soil water-stable aggregate proportion. Thick plastic film mulching increased SBD but reduced the proportion of macroaggregates (mainly referred to 0.015 mm and 0.010 mm). In addition, thick film mulching slightly reduced the levels of soil organic carbon (SOC) and total nitrogen (TN), but significantly promoted the contents of soil labile C and N. Particularly, it significantly promoted above- & under-ground biomass of maize across two growing seasons ($p < 0.05$). To sum up, thickening LDPE film may act as a promising solution to improve LDPE film residue recycling, while benefiting for higher productivity. However, thick film mulching may cause a certain adverse impact on soil structure, and further investigations would be needed in the future.

Key Words: LDPE film thickness; Mechanical properties; Crystallinity and crystalline regions; Biomass; Soil physicochemical properties

iCB 2022-150

The Impact of Wetland Utilisation on Provisioning Ecosystem Services in Nyando Wetland, Kenya

Maithya, J. K., Ming'ate, F. L., & Letema, S. C. (2022). *Journal of Environmental Assessment Policy and Management*, *24*(01), 2250023. https://doi.org/10.1142/S1464333222500235

Abstract

People's livelihoods in developing countries are often directly dependent on wetlands and watersheds for the provision of food, water, fuel, wood, fibre, and genetic resources. The high rural population density within the Lake Victoria basin is facilitating the rapid conversion of land to settlement and agriculture. These activities have resulted in the depletion of wetland resources to the extent that they cannot replenish naturally, thus threatening the Nyando wetland ecosystem, potential recreational opportunities, and the livelihoods of local communities. This paper, therefore, examines the implication of Nyando wetland utilisation in provisioning ecosystem services. A case study survey design approach was employed for data collection. Both quantitative and qualitative data were collected to answer the study objectives. Stratified random sampling was conducted to collect data from 391 households using a structured questionnaire. An interview guide was also used to collect data from stakeholder representatives at the national and county governmental level, non-governmental organisations, and members of the local community. Descriptive statistics were used to analyse the quantitative data, while qualitative data were

analysed through content analysis by ordering distinct themes into similar categories. A land-use change analysis was performed using an unsupervised classification technique. The results show that the local community depends on the wetland for farming, firewood, settlement, roofing and mat-making materials, and fishing for domestic and commercial use. The local community's increased demand and utilisation of Nyando wetland resources has contributed to a reduction in the size of the wetland and consequently affected the availability of ecosystem services. Thus, sustainable utilisation of the wetland is needed.

Key Words: Wetland utilisation, Ecosystem services, Livelihoods, Local communities

iCB 2022-151

Harnessing the Strigolactone Biosynthesis Mutant lgs1 to Combat Food Insecurity in Africa.

Mutinda, S., Jamil, M., Wang, J. Y., Berqdar, L., Ateka, E., Bellis, E. S., Al-Babili, S. & Runo, S. (2023).

Abstract

Sorghum is a food staple for millions of people in sub-Saharan Africa, but parasitic weeds of the Striga genus greatly diminish its production. An efficient and cost-effective way of managing *Striga* in smallholder farms in Africa is to deploy resistant varieties. Here, we leverage genomics and the vast genetic diversity of sorghum – evolutionarily adapted to cope with Striga parasitism in Africa – to identify new *Striga*-resistant sorghum genotypes. We exploit a Striga resistance mechanism that hinges on essential communication molecules – strigolactones exuded by hosts to trigger parasite seed germination. We used the Sorghum Association Panel (SAP) to search for sorghum genotypes with a mutation on the LOW GERMINATION STIMULANT 1 (*LGS1*) locus that makes them ineffective in inducing *Striga* germination. Our analysis led us to identify new lgs1 sorghum genotypes which we named SAP lgs1. SAP *lgs1* had the SL exudation profile of known *lgs1* sorghum whose hallmark is the production of the low inducer of germination, orobanchol. Laboratory and field resistance screens showed that the SAP *lgs1* genotypes also exhibited remarkable resistance against Striga. Our findings have far-reaching implications for improving food security in Africa by potentially reducing crop losses due to Striga parasitism.

iCB 2022-152

Stability and Hopf Bifurcation Analysis of a Delayed Eco-Epidemiological Model of IYSV Disease Dynamics in Onion Plants with Nonlinear Saturated Incidence and Logistic Growth

Kawe, P. C., Abonyo, O. J., Malonza, D., & Ateka, E. M. (2022).

Communications in Mathematical Biology and Neuroscience, 2022, Article-ID 80.

Abstract

Iris Yellow Spot Disease (IYSD), caused by Iris Yellow Spot Virus (IYSV) is a destructive and fastspreading virus disease of onion plants worldwide. It is mainly transmitted by an insect vector called thrips tabaci in a persistent and propagative manner and as such, there is a significant latent time after acquisition of the virus by the vector and an incubation time is needed for the appearance of disease symptoms on plants. In this paper, we formulate and analyze a non-linear mathematical model to explore the dynamics of IYSV disease in onion plants using system of delay differential equations by incorporating incubation and latent periods as time delays factors. The delays are

introduced by adding an exposed population for onion plants representing the plants that are infected but not yet infective and by taking into account that there is fraction of the newly exposed onion plants that do not die during incubation period before becoming infective. It is assumed that the onion plant grows logistically in the farm so that the total onion plant population is taken as variable. The local stability of the disease-free equilibrium in the presence of delays is investigated using Descartes's rule of signs. We establish the sufficient conditions for the stability of the endemic equilibrium in presence of delays and we investigate the occurrence of Hopf bifurcation when certain conditions are satisfied by considering the two delays as bifurcation parameters. We compute the critical values of the delays which preserve the local asymptotic stability of the endemic equilibrium and the model shows an oscillatory behavior beyond these critical values. Finally, numerical simulations are performed and displayed graphically to support the analytical results, and the eco-epidemiological implications of the key outcomes are briefly discussed.

Key Words: IYSV; time delays; Holling type II; Hopf bifurcation; stability analysis; logistic growth

iCB 2022-153

Regulation of the bE and bW Genes in *Sporisorium scitamineum* using Silver Nanoparticles Synthesized with *Carissa spinarum* Eextract

Nkhabindze, B. Z., Ateka, E., Earnshaw, D., & Wanyika, H. N. (2022).
Research Square. DOI: https://doi.org/10.21203/rs.3.rs-1697276/v2

Abstract

Background: Sugarcane smut is a disease that is caused by the fungus *Sporisorium scitamineum*. This is a disease of economic importance in the sugarcane industry because it can cause losses of up to 50%. Current management practices have shown to be ineffective in controlling the fungal disease and hence there is a need for the development of antifungal agents that are biocompatible, non-toxic, environmentally friendly and easy to develop. Biosynthesized silver nanoparticles have been found to possess antimicrobial properties, and have not been explored in *S. scitamineum*.

Results: The synthesis of silver nanoparticles using *Carissa spinarum* yielded particles that were spherical, smooth and had a size range from 3nm to 33nm in size. Optimization of the mixtures using ultraviolet-visual spectroscopy (UV-Vis) showed peaks in the range of 340nm to 450nm. The Fourier transform infrared spectroscopy analysis identified proteins to be essential capping agents and reducing sugars were responsible for the reduction of the silver nitrate to nanoparticles and stabilizing the nanoparticles. The biosynthesized silver nanoparticles had the highest antifungal activity at 5mg/ml, while the minimum inhibitory concentration and minimum fungal concentration were 78µg/ml. The *in-vivo* assays showed a significant (at P=0.05) reduction of the pathogen biomass concentration on the plants that were treated with the nanoparticles when compared to the control plants. The application of 58.5µg/ml of the b-AgNPs to the *S. scitamineum* resulted in a significant (P=0.05) increase in expression of the *bE* and *bW* genes, while the treatment with 39 µg/ml significantly (P=0.05) increased the expression of the bE gene, but had no significant (P=0.05) change in the expression of the bW gene.

Conclusion: Silver nanoparticles that were synthesized successfully using *C. spinarum* crude extract inhibited the growth of *S. scitamineum* both *in-vitro* and *in-vivo*. The silver nanoparticles had a regulatory effect on the expression of the *bE* and *bW* genes in the fungus.

Key Words: *Sporisorium scitamineum*, Sugarcane smut, *Carissa spinarum*, biosynthesized silver nanoparticles, antifungal activity, gene regulation, Fungi

iCB 2022-154

The Morphological and Molecular Variability of *Sporisorium Scitamineum* Isolates in Eswatini

Nkhabindze, B. Z., Earnshaw, D., Wanyika, H., & Ateka, E. (2022).
Research Square. DOI: https://doi.org/10.21203/rs.3.rs-1389981/v1

Abstract

Background: Sugarcane smut, caused by *Sporisorium scitamineum*, is a disease of economic importance in the sugarcane industry, occasioning losses of up to 50%. Current management practices have been shown to be ineffective in controlling the fungal disease and hence the understanding of the local pathogen and development of appropriate control measures is required. This study investigates the morphology, development patterns and molecular variability of *Sporisorium scitamineum* isolates in Eswatini to understand its pathogenicity for effective control.
Results: Fungal isolates were collected along the Sugarbelt in Lowveld of Eswatini. The isolates were verified by polymerase chain reaction (PCR) using the bE 4 and bE 8 specific primers with an amplification of a 420bp fragment; this was further verified by the sequencing results. The teliospores from the isolates were uniform for the brown colour, spiny texture and circular shape. The teliospore sizes were significantly (P=0.05) different among the isolates. The isolate from Big-Bend had a mean diameter of 5.55µm, while Simunye, Nsoko and Mhlume had average diameters of 4.69µm, 4.98µm and 4.87µm, respectively. The documentation of the developmental stages revealed that the samples were of variable virulence with significantly (P=0.05) different rates of promycelium development. Genetic distance matrix analysis and the cluster analysis showed a high homology (99-100%) among the local isolates.
Conclusion: There is very low variability in the strains that are found in the selected sugarcane growing areas in Eswatini. Local isolates may possess varying virulence levels, but may not require variable management strategies.

Key Words: *Sporisorium scitamineum*, Molecular Analysis, Sugarcane smut, teliospore, Morphology Analysis

iCB 2022-155

Resolving Intergenotypic Striga Resistance in Sorghum

Mutinda, S., Maati, F. M., Hale, B., Dayou, O., Ateka, E., Wijeratne, A., Wicke, S., Bellis, E. S. & Runo, S. (2022). *bioRxiv*, 2022-12. doi: https://doi.org/10.1101/2022.12.08.519579

Abstract

Genetic underpinnings of host-pathogen interactions in the parasitic plant *Striga hermonthica*, a root parasitic plant that ravages cereals in sub-Saharan Africa, are unclear. We performed a comparative transcriptome study on five genotypes of sorghum exhibiting diverse resistance responses to *S. hermonthica* using weighted gene co-expression network analysis (WGCNA). We found that *S. hermonthica* elicits both basal and effector-triggered immunity – like a bona fide

pathogen. Resistance response was genotype-specific. Some resistance responses followed the salicylic acid-dependent signaling pathway for systemic acquired resistance characterized by cell wall reinforcements, lignification and callose deposition while in others the WRKY-dependent signaling pathway was activated leading to a hypersensitive response (HR). In some genotypes, both modes of resistance were activated while in others, either mode dominated the resistance response. Cell-wall-based resistance was common to all sorghum genotypes but strongest in IS2814, while HR-based response was specific to N13, IS9830 and IS41724. WGCNA further allowed for pinpointing of *S. hermonthica* resistance causative genes in sorghum. Some highlights include a Glucan synthase-like 10, a pathogenesis-related thaumatin-like family, and a phosphoinositide phosphatase gene. Such candidate genes will form a good basis for subsequent functional validation and possibly future resistance breeding.

Key Words: Cell wall-based resistance, Comparative transcriptomics, Lignin-based resistance, Parasitic plants pathogen associated molecular patterns, Programmed cell death, Weighted gene co-expression networks

iCB 2022-156

Synthesis of Silver Nanoparticles using Crude Leaf Extracts of *Acacia nilotica, Azadirachta indica, Carissa spinarum, Melia azedarach, Senna didymobotrya* and *Warburgia ugandensis*, and their Antifungal Activity against *Sporisorium scitamineum*

Nkhabindze, B. Z., Wanyika, H. N., Earnshaw, D. M., & Ateka, E. M. (2022).
African Journal of Biotechnology, 21(7), 305-313. DOI: 10.5897/AJB2022.17478

Abstract

Bio-synthesised silver nanoparticles are effective in controlling several micro-organisms. They are correspondingly environmentally friendly, affordable, and easy to synthesise when compared with chemically synthesised silver nanoparticles. This study investigated the efficacy of biosynthesized silver nanoparticles against the fungus *Sporisorium scitamineum*, the causal agent of sugarcane smut. The reduction of silver nitrate upon mixing with the plants' crude extracts was evidenced by the change in colour of the mixture to dark brown. Optimization of the mixtures using ultraviolet-visual spectroscopy showed peaks in the range of 340 to 450 nm. The Fourier transform infrared spectroscopy analysis identified proteins to be essential capping agents, and reducing sugars were responsible for the reduction of silver nitrate to nanoparticles and stabilizing the nanoparticles. The transmission electron microscope analysis showed the sizes of the nanoparticles to vary between 3 and 70 nm. *Carissa spinarum* and *Melia azedarach* had the most antifungal activity against *S. scitamineum* as observed from the inhibition-zone assay. Silver nanoparticles were successfully synthesized using the selected botanicals. All the synthesized nanoparticles showed varying antifungal effects against the *S. scitamineum*. *C. spinarum* and *M. azedarach* exhibited the highest antifungal activity, while *Azadirachta indica* showed the least.

Key Words: *Sporisorium scitamineum*, *Acacia nilotica*, *Carissa spinarum*, *Senna didymobotrya*, *Warburgia ugandensis*, *Melia azedarach*, *Azadirachta indica*, Bio-synthesised silver nanoparticles, Antifungal activity.

iCB 2022-157

Modeling and Stability Analysis of an Eco-Epidemiological Model of IYSV Disease Dynamics in Onion Plants with Nonlinear Saturated Incidence Rate and Logistic Growth

Kawe, P. C., Abonyo, O. J., Malonza, D. M., & Ateka, E. M. (2022).

Global Journal of Pure and Applied Mathematics, 18(1), 171-204.

Abstract

Iris Yellow Spot Disease (IYSD), caused by Iris Yellow Spot Virus (IYSV) and transmitted by Thrips tabaci vectors is a destructive and fast-spreading virus disease of onion crops worldwide. In this paper, we propose and analyze an eco-epidemiological model to explore the dynamics of Iris Yellow Spot Virus (IYSV) disease in onion plants with a nonlinear saturated incidence of the Holling type II form, and logistic growth. We computed the threshold quantity R_0 using the next-generation matrix method and carried out the stability analysis of the model equilibria. We applied the center manifold theory to investigate the local stability of the endemic equilibrium and we found that the model exhibits a forward bifurcation at $R_0 = 1$. Further, the global stability of the endemic equilibrium is obtained under a certain condition using Lyapunov's method and LaSalle's invariance principle. Moreover, we performed the global sensitivity analysis of the model using the Latin Hypercube sampling and the partial rank correlation coefficient techniques. We found from sensitivity analysis that R_0 is most sensitive to the death rate of thrips vectors. Finally, we performed numerical simulations and displayed them graphically to validate our analytical results, and the epidemiological implications of the key outcomes were briefly discussed.

Key Words: Modeling, IYSV, *Thrips tabaci*, Basic reproduction number, Stability analysis, Sensitivity analysis, Bifurcation analysis.

1.2. Compilation of Abstracts from iCMoB Subtaskforce

iCMoB 2023-01

Oral acute, sub-acute toxicity and phytochemical profile of Brassica carinata A. Braun microgreens ethanolic extract in Wistar rats

Lilian Nakakaawa, Ifeoluwa D. Gbala, Xavier Cheseto, Joel L. Bargul, John M. Wesonga (2023), *Journal of Ethnopharmacology, Volume 305, 2023,*

Abstract

Ethnopharmacological relevance

Currently, there is a remarkable increase in the consumption of microgreens, (young edible vegetables or herbs), as potential nutraceuticals for the management of diseases. *Brassica carinata* A. Braun is one of the traditional leafy vegetables cultivated in various parts of Sub- Saharan Africa. The plant is revered for its efficacy in the treatment of wounds and gastrointestinal disorders among other medicinal benefits. It is therefore crucial to characterize *Brassica carinata* microgreens for their phytoconstituents and ascertain their safety for use.

Aim of the study: The study evaluated the oral acute and subacute toxicity of *Brassica carinata* microgreens ethanol extract (BMEE) in Wistar rats and identification of its chemical composition and profile.

Materials and methods: For acute toxicity (14 days), rats were grouped into four and received a single oral dose, the control group received distilled water, while others received 500 mg/kg, 1000 mg/kg, and 2000 mg/kg of BMEE. For the subacute toxicity (28 days), rats in four groups received daily doses of 250 mg/kg, 500 mg/kg or 1000 mg/kg and distilled water. Daily clinical observations like lethargy and mortality were conducted. Hematological, biochemical, and histopathological evaluations were performed at the end of each experiment. Phytochemical profile was determined using a UV-VIS spectrophotometer and Gas Chromatography coupled to Mass Spectrometry (GC-MS) analysis determined the potential bioactive components in the microgreens extract.
Results: In both acute and sub-acute toxicity studies, no mortalities, indications of abnormality, or any treatment related adverse effects were observed at doses of 2000 mg/kg, 1000 mg/kg, 500 mg/kg, and 250 mg/kg. The LD_{50} of BMEE was above 2000 mg/kg. No significant ($p > 0.05$) changes in the hematological and biochemical parameters of the treated groups compared to the control groups in both studies. Histopathological examination of the liver, kidney, lungs, and heart revealed a normal architecture of the tissues in all the treated animals. Phytochemical analyses revealed the presence of flavonoids (most abundant), phenols and alkaloids. Phytol, linoleic acid, and 9,12,15-octadecatrienoic acid, among other compounds, were identified by GC-MS analysis.
Conclusion: The results showed that *B. carinata* microgreens ethanol extract is nontoxic and found to have several compounds with reported pharmacological significance suggesting safety for use.

iCMoB 2023-02

The soil microbiomes of forest ecosystems in Kenya: their diversity and environmental drivers

Lorine Akinyi Onyango, Florence Atieno Ngonga, Edward Nderitu Karanja Josiah Kuja Ochieng, Hamadi Iddi Boga, Don A Cowan, Kennedy Wanjau Mwangi, Marianne Wughanga Maghenda, Pedro Bixirao Neto Marinho Lebre, Anne Kelly Kambura (2023).

Abstract

Soil microbiomes in forest ecosystems act as both nutrient sources and sink through a range of processes including organic matter decomposition, nutrient cycling, and humic compound incorporationinto the soil. Most forest soil microbial diversity studies have been performed in the northern hemisphere, and very little has been done in forests within African continent. This study examined the composition, diversity and distribution of prokaryotes in Kenyan forests top soils using amplicon sequencing of V4-V5 hypervariable region of the 16S rRNA gene. Additionally, soil physicochemical characteristics were measured to identify abiotic drivers of prokaryotic distribution. Different forest soils were found to have statistically distinct microbiome compositions, with Proteobacteria and Crenarchaeota taxa being the most differentially abundant across regions within bacterial and archaeal phyla, respectively. Key bacterial community drivers included pH, Ca, K, Fe, and total N while archaeal diversity was shaped by Na, pH, Ca, total P and total N. To contextualize the prokaryote diversity of Kenyan forest soils on a global scale, the sample set was compared to amplicon data obtained from forest biomes across the globe; displaying them to harbor distinct microbiomes with an over-representation of uncultured taxa such as TK-10 and Ellin6067 genera.

iCMoB 2022-01

Growth performance of Nile Tilapia *(Oreochromis niloticus)* fingerlings fed with water spinach *(Ipomoea aquatica)* diets.

Chepkirui M, Orina P.S, Opiyo M, Muendo P, Mbogo K and Omondi R. (2022*).*
Ann Mar Sci 6(1): 001-006. DOI: https://dx.doi.org/10.17352/ams.000026

Abstract

Nile tilapia (*Oreochromis niloticus*) are herbivores with longer coiled intestines compared to carnivores; mouth characteristics necessary for plant shredding. Hence, several studies have been conducted to replace feed ingredients in the diet of Nile tilapia considering the increasing cost. In this study, Water spinach (Ipomoea aquatica) was evaluated as a potential feed ingredient for Nile tilapia. A six months feeding trial was conducted to assess the effects of water spinach fish feed composition on the performance of Nile tilapia fingerlings. Five diets were formulated containing 0% (control diet), 5%, 10%, 15% and 20% water spinach composition. Each treatment was carried out in triplicate using 30 Nile tilapia juveniles per replicate with an initial mean weight of 2±1g. The fish were fed at 5% body weight twice per day. Water quality monitoring was done every morning before feeding. There was no significant ($p > 0.05$) variation in water quality parameters between all the treatments. The best growth performance was recorded from a fish-fed 5% diet (180.49±0.83 g), while fish fed with a 20% diet had poor growth performance (128.98± 0.80g). The highest SGR was obtained in fish fed with a 5% diet (1.34±0.05) while the lowest was obtained in fish fed with a 20% diet (1.09±0.05). Except for SGR, WG, FL, and FW, there was no significant difference ($P>0.05$) in other growth parameters of all the treatments. Final weight had a signi ficant difference as determined by One-Way ANOVA ($F(4,316) =6.363$, $P=0.00$) between 15% and 20% water spinach composition compared to 5% water spinach composition. Therefore, 5% water spinach composition had the best growth performance.

iCMoB 2022-02

Genome Sequence of Escherichia coli Isolated from an Adult in Kibera, an Urban Informal Settlement in Nairobi, Kenya.

Gilbert K. Kikwai, Bonventure Juma, Fredrick Nindo, Caroline Ochieng, Newton Wamola**,** Kevin Mbogo, Douglas R & Elizabeth Hunsperger (2022). *DOI: https://doi.org/10.1128/mra.01241-21*

Abstract

An Escherichia coli strain (sequence type 636) was isolated from an adult residing in an urban informal settlement in Nairobi, Kenya, and was sequenced using the Illumina MiSeq platform. The draft genome was 5,075,726 bp, with a Col (BS512) plasmid plus *aph(6)-Id*, $bla_{\text{TEM-1B}}$, and *dfrA7* genes, which encode kanamycin, ampicillin, and trimethoprim resistance proteins, respectively. Escherichia coli is a facultative anaerobic bacterium that is able to exist within a mammalian tract as a harmless commensal or as a pathogen. The bacterial genome can acquire or lose genetic information, which can offer competitive advantages for individual strains).

We report the genome sequence of an Escherichia coli sequence type 636 (ST636) strain that was isolated from an adult residing in Kibera, an urban informal settlement in Nairobi, Kenya. This community is characterized by poor sanitation, unregulated antibiotic use, outdoor food vending, and poor water supplies. Sample collection was performed using protocol SSC 2998 of the Scientific and Ethical Review Unit of the Kenya Medical Research Institute and protocol 14413

of the Washington State University institutional review board. The strain was isolated by spread-plating a stool sample on a MacConkey plate. After 12 to 18 h of incubation at 37°C, a single pink/rose colony was transferred to Luria-Bertani broth and stored at −20°C.

The selected E. coli isolate was revived on Trypticase soy agar for 24 h at 37°C, and genomic DNA was then extracted by using a Qiagen DNeasy blood and tissue kit. The concentration was determined by using a Qubit double-stranded DNA (dsDNA) assay kit (Invitrogen, Carlsbad, CA, USA) according to the manufacturer's instructions. Genomic DNA libraries were prepared with a Nextera XT library preparation kit (Illumina, USA), and paired-end sequencing was completed by using a MiSeq sequencer (Illumina, Inc., San Diego, CA, USA) with 2 × 250 cycles. Raw reads was quality filtered and subsequently trimmed with Trimmomatic v0.38 using the settings sliding window: 4:15, leading: 3, and minlen: 50. *De novo* assembly was performed with SPAdes v3.13.0 using default assembly parameters). The contigs obtained were filtered using in-house scripts (https://doi.org/10.6084/m9.figshare.17126777) to retain those that met minimum length and coverage criteria of 500 bp and 1.5× coverage, respectively, and the quality of the assembly was assessed using QUAST v5.0.2.

iCMoB 2022-03

Marketing of Dairy Goat Products in Kenya: A survey of the Dairy Products in Selected Supermarkets in Nyeri, Meru and Kiambu Counties.

Eucabeth Majiwa, Geoffrey Otieno1 and Caroline Ngugi (2022). *DOI: 10.5897/JAERD2022.1311*

Abstract

Dairy goat farming is a significant source of income, particularly for low-income families. However, 75% of the dairy goat products business is still unorganized in Kenya, making its marketing difficult. This study surveyed dairy products in selected supermarkets in Nyeri, Meru and Kiambu counties. The purpose was to identify the types of dairy products sold in supermarkets, the sales preferences, reasons for stocking and not stocking the dairy goat products and perceptions about the dairy goat products. The study targeted all the supermarkets that sold dairy products, excluding those that did not sell dairy products or were not willing to be surveyed. A sample of 40 supermarkets and 5 milk dealers in the three counties was obtained through purposeful sampling. Close-ended questionnaires were administered to managers or appointees of the outlets. According to the findings, 10 types of dairy products were stocked by the outlets as follows: Raw cow milk (11%), pasteurized cow milk (87%), long life cow milk (82%), cow milk yoghurt (93%), ghee (24%), cow mil ice cream (67%), cow milk butter (31%), cow milk cheese (36%), cow sour milk (76%) and pasteurized goat milk. Out of the 45 supermarkets/milk vendors surveyed only 5 outlets sold the dairy goat products (pasteurized milk) which thus indicate the gap in the marketing of dairy goat milk and its products in the study counties. The dairy goat products were not stocked because the products were not available (63%), lack of customers' awareness (40%), they were not preferred by customers (18%) and high price (10%). The dairy goat milk was stocked due to customers' preferences (100%). The general perception of the supermarkets was that dairy goat milk was moderately preferred (36%), highly (4%) and not preferred (60%) mainly due to lack of customers' awareness. Thus, measures should be put in place to promote dairy goat milk as an alternative to dairy cow milk due to its high nutritive value and potential

iCMoB 2022-04

Development and Characterization of *Anti-Naja ashei Three-Finger Toxins (3FTxs)-Specific* Monoclonal Antibodies and Evaluation of Their In Vitro Inhibition Activity.

Manson EZ, Kyama MC, Kimani J, Bocian A, Hus KK, Petrilla V, Legáth J, Kimotho JH (2022). Toxins *2022; 14(4):285.* https://doi.org/10.3390/toxins14040285

Abstract

Antivenom immunotherapy is the mainstay of treatment for snakebite envenoming. Most parts of the world affected by snakebite envenoming depend on broad-spectrum polyspecific antivenoms that are known to contain a low content of case-specific efficacious immunoglobulins. Thus, advances in toxin-specific antibodies production hold much promise in future therapeutic strategies of snakebite envenoming. We report anti-3FTxs monoclonal antibodies developed against N. ashei venom in mice. All the three test mAbs (P4G6a, P6D9a, and P6D9b) were found to be IgG antibodies, isotyped as IgG1. SDS-PAGE analysis of the test mAbs showed two major bands at approximately 55 and 29 kDa, suggestive of immunoglobulin heavy and light chain composition, respectively. The immunoaffinity-purified test mAbs demonstrated higher binding efficacy to the target antigen compared to negative control. Similarly, a cocktail of the test mAbs was found to induce a significantly higher inhibition (p-value < 0.0001) compared to two leading commercial brands of antivenoms on the Kenyan market, implying a higher specificity for the target antigen. Both the test mAbs and 3FTxs polyclonal antibodies induced comparable inhibition (p-value = 0.9029). The inhibition induced by the 3FTxs polyclonal antibodies was significantly different from the two antivenoms (p-value < 0.0001). Our results demonstrate the prospects of developing toxin-specific monoclonal-based antivenoms for snakebite immunotherapy.

iCMoB 2022-05

Valuation of lethality and cytotoxic effects induced by *Naja ashei* (*large brown spitting cobra*) venom and the envenomation-neutralizing efficacy of selected commercial antivenoms in Kenya

Ernest Z.Manson Mutinda C.Kyama , Joseph .Gikunju James H.Kimotho(2022).

Abstract

Neutralization of lethality in mice model at the preclinical level has been established by the World Health Organization as the gold standard for the evaluation of antivenom efficacy. The assessment of the neutralization profiles of antivenoms helps to discern the efficacy or otherwise of these antivenoms at neutralizing the toxic effects induced by medically significant snake venoms. However, for many antivenoms, information on their preclinical efficacy remains limited. Therefore, to strengthen global efforts at reducing the impact of snakebite envenoming, the provision of information on the preclinical efficacy of antivenoms, especially in parts of the world where antivenom availability and accessibility is problematic, including sub-Saharan Africa is crucial. This study presents the lethal and toxic activities of *N. ashei* venom and the neutralizing capacity of two commonly used commercial antivenoms in Kenya; VINS™ and Inoserp™. Median lethal dose (LD_{50}), minimum necrotizing dose (MND) and minimum edema-forming dose (MED) of *N. ashei* venom as well as the neutralization of these effects were evaluated in mice. The LD_{50} of *N. ashei* venom was found to be 4.67 (3.34–6.54) mg/kg while MND and MED were 11.00 µg and 0.80 µg respectively. Both VINS™ and Inoserp™ antivenoms demonstrated capacity to neutralize the lethal and toxic effects induced by *Naja ashei* venom albeit at varying efficacies.

Our results thus confirm the toxic effects of *N. ashei* venom as previously observed with other *Naja* sp. venoms and also underscore the relevance of para-specific neutralizing capacity of antivenoms in the design of antivenoms.

iCMoB 2022-06

Building community and public engagement in research – the experience of early career researchers in East Africa

Joel L. Bargul, Denna M. Mkwashapi, Imelda Namagembe Immaculate Nakityo, Annettee Nakimuli, Josaphat Byamugisha5, Daniel Semakula, Janet Seeley, Nelson K. Sewankambo (2022).. *https://doi.org/10.12688/aasopenres.13349.1*

Abstract

Background: In this paper, we explain how three early career researchers actively engaged community members in health research in Kenya, Tanzania and Uganda in their research projects, and what was learnt from the experience. The research project in Kenya was on camel trypanosomiasis and the role of camel biting keds (or louse flies) in disease transmission. The project in Tanzania looked at the effect of human immunodeficiency virus (HIV) and antiretroviral therapy on fertility and ascertained the trends in the use of family planning services amongst women of reproductive age. The focus of the project in Uganda was the implementation of maternal death surveillance and the response policy to determine the cause of maternal deaths and how they might be prevented.

Methods: In the three different settings, efforts to ensure local community engagement provided a focus for the researchers to hone their skills in explaining research concepts and working in partnership with community members to co-develop ideas, their research methods and outputs.

Results: Involvement of communities in scientific research, which entailed a two-way mutual engagement process, led to (i) generation of new research ideas that shaped the work, (ii) strengthened mutual trust, and (iii) promoted uptake of research findings.

Conclusions: Our key findings strongly support the need for considering community engagement as one of the key components in research studies.

iCMoB 2022-07

The developmentally dynamic microRNA transcriptome of *Glossina pallidipes* tsetse flies, vectors of animal trypanosomiasis

Careen Naitore, Jandouwe Villinger, Caleb K Kibet, Shewit Kalayou, **Joel L Bargul**, Alan Christoffels, Daniel K Masiga (2022).

Bioinformatics Advances, Volume 2, Issue 1, 2022, vbab047, https://doi.org/10.1093

Abstract

MicroRNAs (miRNAs) are single stranded gene regulators of 18–25 bp in length. They play a crucial role in regulating several biological processes in insects. However, the functions of miRNA in *Glossina pallidipes*, one of the biological vectors of African animal trypanosomosis in sub-Saharan Africa, remain poorly characterized. We used a combination of both molecular biology and bioinformatics techniques to identify miRNA genes at different developmental stages (larvae, pupae, teneral and reproductive unmated adults, gravid females) and sexes of *G. pallidipes*. We identified 157 mature miRNA genes, including 12 novel miRNAs unique to *G. pallidipes*.

Moreover, we identified 93 miRNA genes that were differentially expressed by sex and/or in specific developmental stages. By combining both miRanda and RNAhybrid algorithms, we identified 5550 of their target genes. Further analyses with the Gene Ontology term and KEGG pathways for these predicted target genes suggested that the miRNAs may be involved in key developmental biological processes. Our results provide the first repository of *G. pallidipes* miRNAs across developmental stages, some of which appear to play crucial roles in tsetse fly development. Hence, our findings provide a better understanding of tsetse biology and a baseline for exploring miRNA genes in tsetse flies.

iCMoB 2022-08

Spatial Distribution of Tsetse Flies and trypanosome Infection Status in a Vector Genetic Transition Zone in Northern Uganda.

Robert Opiro, Okello Allele Moses, Robert Opoke, Francis A. Oloya, Esther Nakafu, Teresa Iwiru,[2] Richard Echodu, Geoffrey M. Malinga,[1] Joel L. Bargul,[5] and Elizabeth A. Opiyo (2022).
Volume 2022 |Article ID 9142551 | https://doi.org/10.1155/2022/9142551

Abstract

Background. Tsetse flies are vectors of the genus Trypanosoma that cause African trypanosomiasis, a serious parasitic disease of people and animals. Reliable data on the vector distribution and the trypanosome species they carry is pertinent for planning sustainable control strategies. This study was carried out to estimate the spatial distribution, apparent density, and trypanosome infection rates of tsetse flies in two districts that fall within a vector genetic transition zone in northern Uganda. Materials and Methods. Capturing of tsetse flies was done using biconical traps deployed in eight villages in Oyam and Otuke, two districts that fall within the vector genetic transition zone in northern Uganda. Trapped tsetse flies were sexed and morphologically identified to species level and subsequently analyzed for detection of trypanosome DNA. Trypanosome DNA was detected using a nested PCR protocol based on primers amplifying the internal transcribed spacer (ITS) region of ribosomal DNA. Results. A total of 717 flies (406 females; 311 males) were caught, all belonging to the Glossina fuscipes fuscipes species. The overall average flies/trap/day (FTD) was (). Out of the 477 (201 male; 276 females) flies analyzed, 7.13% (34/477) were positive for one or more trypanosome species. Three species of bovine trypanosomes were detected, namely, Trypanosoma vivax, 61.76% (21/34), T. congolense, 26.47% (9/34), and T. brucei brucei, 5.88% (2/34), and two cases of mixed infection of T. congolense and T. brucei brucei, 5.88% (2/34). The infection rate was not significantly associated with the sex of the fly (generalized linear model (GLM), , ,) and district of origin (, , ,). However, trypanosome infection was highly significantly associated with the fly's age based on wing fray category (, , ,), being higher among the very old than the young. Conclusion. The relatively high tsetse density and trypanosome infection rate indicate that the transition zone is a high-risk area for perpetuating animal trypanosomiasis. Therefore, appropriate mitigation measures should be instituted targeting tsetse and other biting flies that may play a role as disease vectors, given the predominance of T. vivax in the tsetse samples.

iCMoB 2022-09

Isolation of Cellulose Nanofibers from Oryzasativa Residues via TEMPO Mediated Oxidation.

Edwin S. Madivoli, Patrick G. Kareru, Anthony N. Gachanja, Samuel M. Mugo, David M. Sujee & Katharina M. Fromm (2022).

Journal of Natural Fibers, 19:4, 1310-1322, DOI:10.1080/15440478.2020.1764454

Abstract

Cellulose nanocrystals (CNCs) or cellulose nanofibers (CNFs) with different morphologies, chemical, mechanical and physical properties can be obtained when microcrystalline cellulose is subjected to enzymatic, chemical or mechanical treatment. With the aim of utilizing cellulose nanofibrils (CNFs) from *Oryza sativa*, we isolated microcrystalline cellulose using the Kraft process, followed by successive fiber fibrillation using mechanical grinding, then (2,2,6,6-Tetramethylpiperidin-1-yl)oxyl (TEMPO) mediated oxidation. Analysis of pulp fibers obtained after each treatment step revealed that fiber properties such as length, crystallinity and crystal size changed when the pulp was subjected to mechanical grinding, ultrasonication and TEMPO mediated oxidation. The degree of crystallinity of the fibers increased while crystal size and fiber length decreased after each treatment. TEMPO mediated oxidation led to a decrease in fiber length and an increase in degree of crystallinity of the fibers as compared to mechanical treatment and ultrasonication. It further introduced carboxyl functional groups (COOH) on the surface of the fibrils, which implies that the nanofibers obtained in this study could be further functionalized. Hence, TEMPO mediated oxidation offers the possibility of further chemical functionalization of cellulose nanofibers isolated from agricultural residues.

iCMoB 2022-10

Probiotic Properties of Lactic Acid Bacteria Isolated from "Tchoukou" Traditional Milk Cheeses Produced in Selected Region of Niger.

Ibrahima Doumbouya, Kevin Mbogo Omolo, Willis Owino (2022).

International Journal of Food Sciences 2789-7680 (online) Vol. 5, Issue 1, No. 1, pp 1 – 15

Abstract

Purpose: The current study's aim is to evaluate the probiotic potential of lactic acid bacteria strains isolated from traditional "Tchoukou" milk cheeses produced in a selected region of Niger. Methodology: Nine Samples were collected in selected regions of Niger (Tahoua, Maradi, and Zinder).Probiotic properties of isolated LAB were identified based on their acid tolerance, bile salt tolerance, auto-aggregation ability, simulated stomach and duodenum passage, simulated gastric juice survivability and their antimicrobial activities.

Findings: A total of eighteen strains were analysed in vitro for acid tolerance, bile tolerance,survival under simulated gastro-intestinal tract conditions and antimicrobial activity against index organisms. The results indicated that all seventeen strains exhibited a high viabilityafter twenty-four hours of incubation at pH 2.5 and pH 3, but a decreased viability at pH 2.0 in which only eight strains were able to survive, strain C13 failed to grow at the three different pH. In this study, the isolates generally survived better after exposure to 0.3% bile salt. Also were able to survive exposure to simulated stomach and duodenum passage (SSDP) for three hours ranging from (89%-100%).All strains were able to survive under simulated gastric juice at

different pH (2, 2.5 and 3). for auto-aggregation Only fifteen isolates showed the best auto-aggregation abilities ranging from (15-83%) and the other two had less auto-aggregation ability (2-11%). The isolates showed diverse antimicrobial activity against the index organisms. Among the isolates, only three (C1, C2 and C9) could not inhibit any of the selected pathogens. Unique contribution to theory, practice and policy: This study was conducted to characterize the probiotic properties of LAB isolate which could serve as a potential source for industries and commercial applications.

Keywords: Tchoukou, Probiotics, Lactic acid bacteria, Antimicrobial

iCMoB 2022-11

The Africa Phage Forum: A New Collaborative Network for Bacteriophage Research in Africa

Noutin Michodigni,, Ritah Nakayinga, Angela Makumi, Josephine Kimani, Ivy Mutai, Christy Dapuliga, Belayneh Getachew, Jerrold Agbankpè, Jesca Nakavuma, Atunga Nyachieo, Nnaemeka Emmanuel Nnadi (2022).

Abstract

The problem of antimicrobial resistance has created a new need for alternative/ complementary treatments. To this end, bacteriophages offer an exciting prospect, as they can infect and kill specific bacteria without harming the host. This survey aimed to evaluate the state of applied phage research in Africa, among the members of the Africa phage Forum (APF). This was a cross-sectional survey whereby a google form was created for the members of the Africa Phage forum to fill so as to access the stage of phage research in Africa. Data was collected between June and July 2021 using a structured questionnaire form. A total of 65 out of a total of 101 forum members completed the questionnaire. The survey indicated that a majority 68% of phage researchers in Africa were at the training stages of their career. Some available participants were limited (8%). Most of the members identified funding, lack of skill set, near absence of adequate laboratory infrastructure as major hurdles for phage research. Despite these challenges, 73.3% of APF members work with the ESKAPE group with the majority of its members carrying out research in Phage in Biocontrol (80%), whereas others perform research related to human phage therapy (60%). However, it appeared this research has not yet reached the stage of commercialization. Overall, Phage research is in its infancy in Africa. Key challenges included poor laboratory infrastructure, lack of capacity building in the phage field, and lack of local awareness on the significance of phages for policymakers and governments. APF could, therefore, play a role in creating phage awareness in Africa; mobilizing resources; enhancing networks and collaborations amongst APF members and beyond, especially with more experienced phage mentors in the Western countries, to greatly reduce the gap in knowledge and enhance phage research in Africa.

1.3. Compilation of Abstracts from from iPIC Subtaskforce

iPIC 2022-01

Simulation of design variables effect on performance of a common beans (*Phaseolus vulgaris L*) portable thresher

Patrick W. Wamalwa, Christopher L. Kanali, Erick K. Ronoh, Gareth M. Kituu

Abstract
In Kenya, threshing of common beans is mainly made by traditional method using sticks and animal tramping, which are slow, inefficient and tedious. Consequently, there is a need to develop portable threshers locally available on the market for small and medium-scale farmers. The objective of this study was to simulate design variables effect on the performance of a common beans portable thresher. Sizing of design variables and parameters was the key in the development of the bean thresher. This could be achieved by costly experiments or use of prediction mathematical model equation. The later method was used by developing mathematical models from combination of Buckingham Pi theorem and reference to other similar works in literature. The predicting equation for power requirement, grain losses, grain damages, efficiency and throughput capacity were developed and validated using experimental thresher from the same study. The results showed that there was a positive correlation with R2 of 0.9. Based on actual data and 10% absolute residual error interval, the prediction performance of the developed models was above 77%. The results noted that increase in cylinder peripheral speed of the pegs resulted in the increase in power requirement, bean grains damage, threshing efficiency and throughput capacity. Also increase in effective cylinder diameter caused increase in threshing efficiency and grain damage.

Keywords: Common beans, portable thresher, modelling, simulation, grain damage, efficiency

iPIC 2022- 02

Performance of flexible PV-film technology as an auxiliary energy source in a solar-electric hybrid greenhouse dryer

Samuel N. Ndirangu, Christopher L. Kanali, Erick K. Ronoh, Victor K. Langat, Anthony P. Roskilly, Mohammad Royapoor, Paul Laidler

Journal of Sustainable Research in Engineering Vol. 7 (1) 2022, 1-10

Abstract
Solar drying is an economical way to preserve agricultural produce. The intermittent nature of solar radiation necessitates use of supplementary energy for improved airflow rates and to supply heat during periods of low solar radiation. This study evaluated the performance of low-cost, flexible and lightweight solar PV film developed by Power Roll Limited (UK) for food drying application. Two tests were conducted (Trial 1: with fans only on; Trial 2: with fans and electric heater on) using a forced convection solar-electric hybrid greenhouse dryer at no load (empty drying beds). Test results shows that for Trial 1 the PV was able to run throughout the day, while Trial 2 the system run for 6 hours. Further, about 95% of the PV load power was used to run the fans, with the two fans using 144.1 ± 3.0 W and the maximum fan cumulative power was 961 Wh for Trial 1. For Trial 2, the PV load (1510-1524 W) was higher than the PV charge rate (304-694 W), hence the PV power declined to 30%. Further analysis showed that dryer temperatures increased by 5.05oC at a radiation of 800 W/m2 due to the heater. The results on drying of African nightshade (*Solanum scabrum*) indicated this 5.05oC temperature increase realized through the auxiliary energy from the PV system improves drying substantially. The cost benefit analysis shows that usage of the PV system led to energy saving of about US$ 1.6 from 8.5 kWh of energy used within the 6 hours of PV system deployment.

Keywords: Auxiliary energy, greenhouse dryer, performance, PV film, solar radiation

iPIC 2022-03

Mesophilic process and kinetics studies of selected biomolecules as potential enhancers of biomethanization of cow dung in an anaerobic tubular batch reactor

Paul Njogu, Francis Xavier Ochieng, Benard Ogembo, Stephen Ondimu, Christopher Kanali, Erick Ronoh, Daniel Omondi, Hiram Ndiritu;

Energy and Power Engineering, 2022, 14, 147-155

Abstract

Mesophilic biogas production and substrate decomposition is one of the significant limiting steps in biogas generation. The rate of generation and quality often affect the viability of biogas systems. This study assessed the potential for biogas process catalysis using powdered Sorghum bicolor L., Zea mays, and Pennisetum glaucum. The kinetics and biogas generation processes were studied. Experiments were conducted in 1 m3 tubular batch reactors, where batches were dosed with various organic biomolecules. Results show that the use of P. glaucum L. and S. bicolor L. reduced the biogas retention times significantly. Biogas generation commenced after the first day for digesters fed with S. bicolor L. and P. glaucum L. while one with Z. mays and control occurred on day two. The rate of biomethanation and methane content were enhanced. S. bicolor L. led to the highest methane content. Findings reveal that locally available organic biomolecules improved biogas quality and quantity

Keywords; Mesophilic, Kinetics, Biomolecules, Biomethanation, Reaction Rates, Anaerobic

iPIC 2022-04

Assessment of physical and mechanical properties of particleboard from millet husk-recycled expanded polystyrene composite

Vinny Nyembo, Christopher Kanali, Doko Kouandété Valery, Walter Odhiambo Oyawa

International Journal of Advanced Research in Science, Engineering and Technology, Vol. 9,

Abstract

In this study, physical and mechanical properties of particle boards made from a mixture of millet husks (MH) and resinous materials obtained from polystyrene waste were evaluated and discussed. Particle boards were prepared by mixing polystyrene-based resin (PBR) and millet husks followed by a flat press process at different ratios (v/v). Mix ratios of 2.1:1, 2.3:1, and 2.5:1 of polystyrene-based resin (PBR) by weight of the millet husks were produced. Mechanical (modulus of rupture and modulus of elasticity) and physical properties (density, moisture content, thickness swelling and water absorption) were carried out following ASTM D1037-93 procedures. The results showed that density, moisture content (MC), water absorption (WA), thickness swelling (TS), and mechanical properties such as modulus of elasticity (MOE) and modulus of rupture (MOR) of 2.3:1 and 2.5:1 were better than that of 2:1 particleboard and met the minimum value prescribed by the American National Standards Institute (ANSI A208.1).

Key words: Millet husks, recycled polystyrene, polystyrene based resin, particleboard, composite materials

iPIC 2022- 05

Characterisation and quantification of bioprocessing effluents from coffee, dairy and tannery plants

Jared Ombaye Ondiba, Christopher L. Kanali, Benson B. Gathitu, Stephen N. Ondimu

International Journal of Agriculture and Environmental Research; ISSN: 2455-6939; Vol: 08.

Abstract

There is an increasing rate of environmental pollution resulting from high emission rates from bioprocessing industries in Kenya. This study provides information on the characterization of bioprocessing effluents from 3 industries in Kenya. To achieve this, samples of effluents were collected from the 3 industries and then transported using plastic containers to JKUAT chemistry laboratories within 24 hours for analysis. Each sample was divided into 3 different 500 ml bottles, and the experiment was replicated 3 times. Physico-chemical parameters such as total dissolved solids (TDS), biological oxygen demand in 5 days at 20°C (BOD 5), pH, total solids (TS), total suspended solids (TSS), chemical oxygen demand (COD) and electrical conductivity (EC) of collected samples were analysed. The mean concentration levels were found to be (118±5, 176±10, and 128±3) for COD and (1200±2,800±1 and 700±6) for BOD 5 for dairy, coffee, and tannery effluents, respectively. These values were found to be slightly higher than the standard removal levels. The pollutant levels noticed at the different industries were notably high in tannery with 286 mg/l and least in the dairy effluents with 28mg/l. Based on the results obtained, there is need to treat effluents before discharging to water bodies.

Key words: Bioprocessing effluents, Characterisation, Cations, and Physico-chemical parameters

iPIC 2022-06

Performance evaluation of an evaporative charcoal cooler utilizing thin-film photovoltaic system for preservation of avocado

Victor K. Langat, Christopher L. Kanali, Erick K. Ronoh, Stephen N. Ondimu, Samuel N. Ndirangu, Tony Roskilly, Mohammad Royapoor, Paul Laidler.

International Journal of Agriculture and Environmental Research; ISSN: 2455-6939

Abstract

Fruits are high moisture agricultural produce rendering them highly perishable hence the danger of postharvest losses is also lurking when there are inadequate storage facilities. The losses result from physical, chemical, and physiological changes that are triggered by the loss in moisture content. Preservation of fruits using available and affordable technologies (such as charcoal coolers) can benefit small-scale farmers in minimizing postharvest losses. An evaporative charcoal cooler 4 m long, 4 m wide, and 2.5 m high providing a 40 m3 storage capacity was utilized in the study. The cooler with a 150 mm wide cavity filled with charcoal had a perforated pipe connected to a 1000-litrecistern raised at 2.5 m above the ground and connected to a water pump (Pedrollo PKm 60, Italy) that kept the charcoal wet by a drip system. The pump and the three axial fans (REC-21725 A2 W, USA) rated 180 cubic feet per minute (CFM) and 2600 revolutions per minute (RPM) were powered by fast fold thin-film PV (FFMAT-10, Renovagen, UK) system connected to a 10-kWh rated energy hub (FFENERGYHUB-10, Renovagen, UK). Temperature, relative humidity and product quality parameters (weight loss, total soluble solids, vitamin C content and firmness were evaluated). The evaporative cooler temperatures reduced significantly ($P<0.05$) averaging 76.8±1.6% and 43±2.8% for ambient conditions. The average cooling efficiency in the

charcoal cooler was 83.0%. The percentage weight loss of the avocado was 3.9% and 7.5% for the cooler and outdoors respectively. The percentage vitamin C loss was 39.0% for the cooler and 49.6% for those kept outside. The total soluble solids in the cooler rose from 0.5 to 1.6 Brix and 0.5 to 2.6 Brix in ambient conditions. Firmness decreased from an average 65.0 N to 10.7 N and 65.0 N to 8.0 N after 12 days for samples in the cooler and ambient conditions, respectively. In conclusion, the evaporative charcoal cooler incorporated with thin-film PV system preserved the postharvest quality and extended the shelf life of hass avocado.

Key words: Evaporative charcoal cooler, Performance, Thin-film PV system

iPIC 2022-07

Performance evaluation of a portable common bean (*Phaseolus vulgaris L*) thresher

P. W. Wamalwa, C.L. Kanali, E.K. Ronoh, G.M. Kituu

Journal of Engineering in Agriculture and the Environment, Volume 8. No.2 2022

Abstract

Threshing and cleaning of common beans are some of the main post-harvest practices. Others are drying, grading and packaging. Threshing of beans can be done using heavy combine harvesters, use of stationary thresher or by use of traditional methods. The intercropping of beans combined with small scale farms in Kenya makes the use of combine harvesters unsuitable for beans threshing. Traditional threshing methods are also tedious, time consuming and labour intensive. Therefore, the focus of this study was to develop a portable common beans thresher customized to the needs of small-scale farmers in Kenya and other developing countries. The design process was through simulation, optimization, fabrication and evaluation. The thresher recorded a threshing efficiency of 99 % for all the drum speeds above 600 rpm at crop moisture content of 18% w.b. In addition, throughput capacity of 72 kg/hr and 125 kg/hr at a feed rate of 1 kg/min and 2.5 kg/min respectively was achieved at a drum speed of 800 rpm. Mechanical grain damage was less than 3.3% for drum speeds between 600 and 1000 rpm. At drum speed of 800 rpm and below, mechanical grain damage was 0.7%. The developed common beans thresher power requirement is 15.6 kWh per ton. Finally, the thresher had a cleaning efficiency of 78% at 800 rpm drum speed. Based on performance, the developed common beans thresher is recommended for use by small scale famers in beans production.

Key words; Performance evaluation, beans thresher, mechanical damage, throughput capacity and threshing efficiency

iPIC 2022-08

Effect of tilt angle on the performance of a thin-film photovoltaic system

Victor K. Langat, Christopher L. Kanali, Erick K. Ronoh, Stephen N. Ondimu, Samuel N. Ndirangu, Tony Roskilly, Mohammad Royapoor, Paul Laidler

Journal of Agriculture Science & Technology; JAGST 21 (3) 2022, 96-104

Abstract

Solar energy is among the cleanest and most sustainable ways to enhance electrical supply's resiliency and reliability for domestic and industrial use. A Photovoltaic (PV) system is the most effective way of capturing solar energy. Long-term warranty, low-cost maintenance, and vast

resource availability, solar power generation has an advantage over other approaches. Thin-film technology PV cells are a new kind of solar cell that offers an efficient technique of generating electricity from sunlight. The thin-film PV technology (FFMAT-10, Renovagen, UK) used in this study can supply 0.9 to 1.6 kW of energy to the fast-fold energy hub. The hub's system status and configuration display battery power input, battery's state of charge, thin-film PV power and AC power output. Two fast-fold mats (with a surface area of 25.3 m^2) were connected to the energy hub. Increasing energy demand coupled with frequent power outages, and inaccessibility of electricity in rural areas necessitates the usage of PV systems at their best performance level. The study objective, therefore, sought to assess the effect of tilt angle on the performance of the thin-film PV system. The study was conducted at Kimicha in Kirinyaga County Kenya, and Juja, Kenya at tilt angles between 0^o to 30^o. The results indicated that the mean peak PV power for Kimicha was 347.8±231.9 W at 5^o and 517.7± 131.3 W at 15^o for Juja. The maximum solar radiation during the study period was 1086.4 ±211.4 W/m^2 for Juja and 973.5±219.93 W/m^2 for Kimicha. From the study, it was realized that an optimal tilt angle yields optimum solar radiation that translates to maximum power production. Even though the study was conducted in two different regions, it may be applied to any other geographical location. The outcome of the study aids in acquiring self-sustaining power in the most remote locations where electricity is scarce as well as improving energy security.

Key words; Energy hub, Performance, Thin-film PV-system, Tilt angle, Solar radiation

iPIC 2022-09

Mechanical and durability performance of high-strength concrete with waste tyre steel fibres

Daudi Salezi Augustino, Richard Ocharo Onchiri, Charles Kabubo, Christopher Kanali

Hindawi; Advances in Civil Engineering Volume 2022, Article ID 4691972, 16 pages.

Abstract

Concrete with various fibre has been in practice over the years now to improve the internal characteristics of concrete. In most of the developing countries, there is a high rate of waste tyres due to the importation of used cars. Waste tyres increase the environmental burden due to their resistance to decomposition in landfills. To have alternative disposal of waste tyres, their components of steel fibres were utilized in concrete to assess their effect on the mechanical and durability performance of high strength concrete with a target mean strength of 70 MPa. Fibres had a diameter of 1.3mm and lengths of 30, 50, and 60mm with fibre contents of 0.3, 0.5, 0.75, and 1.0% in each length. Slump tests were performed on fresh concrete with and without fibres. The mechanical performance variables assessed were compressive strength, splitting tensile strength, flexural strength, flexural toughness, residual strength, static modulus, and Poisson's ratio. In addition, durability tests such as chloride ion penetration and absorption rate of water were investigated. The results showed that an increase in fibre length to 60mm and a 1.0% fibre content resulted in the high bond strength in the concrete matrix resulting in a smaller crack width. Moreover, these fibre length and content resulted in improved tensile and flexural strength to 21.5% and 71.1% of control mix, respectively. The increase in fibre length and content affected both the durability properties and the flowability of the concrete, and as for length (60 mm) and 1% content, concrete had a slump of 77.8% lesser compared to the control mix. The compressive strength improved to 15.2% for concrete with a .fibre length of 50mm and a fibre content of 0.5%. However, further increases in fibre content and length caused an increase in the number of weaker interfacial transition zones at the composite interface that reduces compressive stiffness, resulting in low compressive strength. Furthermore, the reduced fibre content and length (30 mm) improve

the static modulus linearly up to 0.75% fibre content; however, concrete with a fibre length of 50mm and content of 0.3% gives the best results.

iPIC 2022-10

The orientation effect of opening and internal strengthening on shear performance of deep concrete beam using recycled tyre steel fibres

Daudi Salezi Augustino, Charles Kabubo, Christopher Kanali, Richard Ocharo Onchiri

Results in Engineering 15 (2022) 100561

Abstract

A deep concrete beam is a structural member that transfers heavy loads from the introduced column(s) due to a change of function layout of a particular floor in the building. Due to its high depth, the service utilities are always accommodated by creating a transverse opening rather than at its soffit. However, this practice leads to a reduction of shear resistance and affects the serviceability of the beams. To reinstall this capacity, waste tyre steel fibres were used to assess their effectiveness in improving the shear resistance of the deep concrete beams with openings. Three sets of beams with, without fibres, and with fibre mesh that had openings of 160 × 86, 115 × 120, 86 × 160, and 165 × 170 mm were considered. A total of 16 beams with dimensions 150 × 400 × 1100 mm and a constant shear span-to-depth ratio of 0.8 were cast and tested. The steel fibres used had a diameter of 1.3 mm, a length of 50 mm, a fibre content of 0.5% and a fibre mesh of 110 × 100 mm. The main variables evaluated were the effect of the opening size and its orientation, the effect of stirrups, the random mixing of fibres in the matrix, and the internal strengthening of the fibre mesh in the anticipated strut line of the deep beam. The results showed that an interruption of the strut width affected the shear resistance of the beam. The beam with 160 × 86 mm had a lower capacity of 7.7% compared to 115 × 120 mm with the same opening area. The 160 × 86 mm control beam had a high shear capacity of 2.6% compared to 86 × 160 mm. The inclusion of fibre increased the compressive stiffness of the strut; The beam with fibre and opening size 165 × 170 mm had a shear capacity of 37.8% higher than the beam without fibres. The addition of mesh had a limited increase in shear capacity compared to random fibre mixes; however, the capacity was 21.6% higher than the control mix for a beam with an opening size of 165 × 170mm. Therefore, it is recommended to use recycled waste tyre steel fibres to improve the shear capacity of the deep concrete beam and less application of shear bars.

Key words; Waste tyre steel fibres, Deep concrete beam, Compressive stiffness, Shear resistance, D-region

iPIC 2022-11

Mechanical performance of laterite soil stabilized with cement and grewia bicolour bark juice for road base construction

Konice Yèyimè Déo-Gratias Aholoukpè, Christopher Kanali, Abiero Gariy, Humphrey Danso

International Journal of Engineering Trends and Technology Volume 71 Issue 2, 137-142,

Abstract

This paper aims to investigate the potential of the Grewia bicolour bush as a natural stabiliser for road construction. This study evaluates the feasibility of using Grewia Bicolour Bark Juice (GBBJ) as a partial replacement for cement in the stabilization of laterite soil. The soil is mixed with Ordinary Portland Cement (OPC) at different proportions of dry soil weight, ranging from 0 to 8%, with an interval of 2%. Californian Bearing Ratio (CBR) and Unconfined Compressive Strength (UCS) tests are performed on the soil-cement mixture to determine the optimum cement

content. The UCS value of 6% cement content, with a strength of 2.1 MPa after 7 days of curing, meets the standards set by the Kenya Roads Design Manual Part III. Therefore, 6% cement content is chosen as the optimum. The soil is then treated with a cement-GBBJ mixture by partially replacing the optimum 6% cement content with GBBJ at increasing steps of 1%. The results show that, regarding the standards and the targeted strength, the optimum mix proportion is 4% cement plus 2% GBBJ. The corresponding CBR and UCS values are 130.7% and 1.98 MPa, respectively. The results of the tests provide promising prospects for an economical and sustainable way of soil strengthening.

Key words; Cement, Grewia bicolour bark juice, Stabilization, Laterite soil, Road base

iPIC 2022-12

Simplified shear equation of deep concrete beam considering orientation effect of opening and mechanical properties of fibre-concrete interface

Daudi Salezi Augustino a,*, Christopher Kanali b, Richard Ocharo Onchiri c, Charles Kabubo

Abstract

In the present era of technology, the design of structural deep concrete beams is highly modernized through the use of computer-aided tools. However, theories for such design are the paramount aspects to be understood particularly when the beam has openings. To improve the mechanical properties of the deep beam with openings, recycled tyre steel fibres are required. To estimate the bond strength of the fibre-concrete interface, the concrete shrinkage strains for fibre lengths 30, 50 and 60 mm with a content of 0.5% were considered. To mitigate the conservativeness of some available shear models and improve the design of deep beams, the simplified shear equation model was developed. The model was established using a simplified compressive stress block, forces in steel reinforcement and shear stress at the fibre-concrete interface. The combined effect of opening height and length was also considered in the model. The results show that incorporating fibres in concrete increase the shear performance of deep concrete beams with openings due to high strains in the shear zone indicating high loads being transferred. For instance, beam BS2 had a strain of 0.0153 in the lower load path compared to 5.6×10^{-5} for beam BC2 There was a good correlation between measured and proposed shear capacities with *t*-test values of 0.46, 0.996 and 0.003 for beams without fibres, and with fibres and mesh respectively. Results also showed the model shear equation performed better compared to other equations with mean absolute error (MAE) and coefficient of variation (COV) of 9.3 and 18.9%, respectively for the control beams with openings. The model also showed a mean absolute error (MAE) and coefficient of variation (COV) of 11.6 and 7.4%, respectively for the beams with fibres. The COV and MAE for the proposed model were small than those in the database, therefore, the proposed model can provide the precise design of deep concrete beams with openings and fibres.

Key words; Shear capacity; Deep concrete beam; Simplified shear equation; Fibre-concrete interface; Internal strengthening

iPIC 2022-13

Reducing PAPR of OFDM signals using a tone reservation method based on ℓ_∞ -norm minimization

Stephen Kiambi, Elijah Mwangi and George Kamucha

Journal of Electrical Systems and Information Technology volume 9

Abstract

Orthogonal frequency division multiplexing (OFDM) continues to be the most preferred signal-multiplexing scheme for high-speed data communication. However, OFDM signals are known to have the problem of high peak-to-average power ratio (PAPR), especially when the number of subcarriers is large, which leads to nonlinear amplification in the high power amplifier and consequently to bit-error rate degradation and out-of-band radiation. In this paper, we propose a new optimal tone reservation method for reducing high PAPR in OFDM signals in order to avoid nonlinear amplification effects. The method employs Chebyshev-norm minimization to determine peak-reduction coefficients for OFDM signal. Simulation results show that the proposed method can achieve high PAPR reduction at the expense of a small loss in data rate and a slight increase in average transmit power. For example, with 4 out of 64 subcarriers reserved for peak-reduction coefficients, which represents 6.25% data-rate loss, the method can achieve 4.06 dB of PAPR reduction with only a 0.46 dB increase in average transmit power. Similarly, when 8 subcarriers or 12.5% of the total number of subcarriers are reserved, a PAPR reduction of 5.75 dB is achieved with a paltry 0.19 dB rise in transmit power.

iPIC 2022-14

Design and Analysis of a Multiple and Wide Nulling Collaborative Beamforming Scheme in the Domain of 3-Dimensional Wireless Sensor Networks

Robert Macharia Maina**,**[1] Philip Kibet Langat,[2] and Peter Kamita Kihato[3]

International Journal of Antennas and Propagation, Volume 2022

Abstract

Null steering is essential in collaborative beamforming (CB) in wireless sensor networks (WSNs) to ensure minimal radiation power and interference in the direction of unintended receivers. Current research in null steering in CB in WSNs is mainly from the perspective of planar arrangements of sensor nodes and sink(s). Furthermore, there is no research dedicated to the formation of multiple wide nulls during CB in 3-dimension WSNs. Wide nulls are ideal in scenarios featuring mobile unintended sink(s). A new multiple and wide null steering scheme applicable to CB in WSNs is presented in this work (from the perspective of a 3-dimensional random arrangement of static sensor nodes). It is assumed that desired nulling directions are implicitly known at a CB cluster head. A particle swarm optimization (PSO) algorithm variant is applied in concurrent node transmit amplitude and phase perturbation with an aim of achieving beam steering alongside multiple and wide null steering. The performance of the proposed null steering scheme is validated against a basic null steering approach (with reference to current literature). Furthermore, a comparative null depth, width, and nulling accuracy analysis are done upon varying the count of collaborating nodes and the collaborating cluster radius. An increase in the number of collaborating nodes is found to increase nulling depth at an exponentially decaying rate. An increase in the collaborating nodes' cluster radius yields a reduction in null width. The contributions of this work to the existing literature are as follows: (i) the design and investigation

of a null steering scheme from the perspective of a 3-dimension random arrangement of sensor nodes; (ii) the design of a concurrent beam steering and multiple wide null steering scheme on the basis of concurrent node transmit amplitude and phase perturbation whilst ensuring null depth uniformity; (iii) a statistical analysis of the impact of a count of collaborating nodes and collaborating cluster radius on nulling performance; (iv) investigation of capacity improvement at unintended receivers upon null steering.

iPIC 2022-15

Design and analysis of a multiple collaborative beamforming scheme in the realm of Wireless Sensor Networks featuring 3-dimension node configuration

Robert Macharia Maina, Philip Kibet Lang'at and Peter Kamita Kihato

Heliyon, Volume 8, Issue 5, E09398, May 2022

Abstract

Collaborative Beamforming (CB) is an essential tool towards achieving long-range transmission in Wireless Sensor Networks (WSNs). In some instances, there may be multiple intended data destinations (sinks) in a WSN. This calls for multi-CB. In comparison to sink-by-sink CB, multi-CB implies improved data rates and decreased co-channel interference; and consequently increased network capacity. In current literature, there is no research in multi-CB particularly in 3-dimension WSNs. In this paper, a novel multi-CB mechanism is brought to the fore. This is from the point of view of a random arrangement of sensor nodes in a 3-dimension manner. It is assumed that all sinks' directions are known at the CB cluster head. Node transmit amplitude and phase are optimized using a Particle Swarm Optimization (PSO) algorithm variant to concurrently achieve balanced multiple narrow beams and minimal radiation in undesired directions. The performance of the proposed scheme is checked against that of a pure multiple beam steering approach (without beam power balancing and minimization of radiation in undesired directions). Moreover, an analysis of beam power, width and steering accuracy is done upon varying the number of collaborating nodes and the collaborating cluster radius. Increasing the count of collaborating nodes yields improved beam precision/accuracy, lower radiation in undesired directions and appreciable stability in beam power performance Increasing the collaborating nodes' cluster radius yields narrow beams, improved beam precision and appreciably lower radiation in undesired directions. The contributions of this work to current literature include: (i) formulation and analysis of a multiple beamforming scheme in the realm of 3-dimension WSNs; (ii) design of a multi-CB scheme taking into account minimization of radiation in undesired directions; (iii) a statistical multi-CB performance analysis upon varying collaborating nodes' cluster radius and collaborating node count.

Keywords; Wireless Sensor Network, Collaborative beamforming, multiple beamsteering

iPIC 2022-16

Implementation of Message Queuing Telemetry Transport Protocol in Model Rocket

Muchiri I. Ngethe Yator C. Kiplimo and Shohei Aoki

Proceedings of the 2022 Sustainable Research & Innovation (SRI) Conference. 12.11.2023

Abstract
Microcontroller devices are incorporated in the flight computer that convey data to the ground station in the design and implementation of model rocketry. In the field of rocketry, data transfer speed and precision are critical. Due to its small code footprints and low network bandwidth requirements, the Message Queuing Telemetry Transport (MQTT) messaging protocol tackles both of these issues. MQTT uses Transmission Control Protocol (TCP) which ensures packet delivery, as opposed to User Datagram Protocol (UDP), which is faster but does not guarantee packet delivery or even the sequence in which packets are delivered. MQTT also uses a single connection to send messages, making it faster than Hypertext Transfer Protocol (HTTP), which requires a three-way TCP handshake every time a message is transmitted. This paper describes how to incorporate MQTT messaging protocol to the flight software to facilitate communication between the onboard computer and the ground station. Publish and subscribe architecture in MQTT was utilized where the onboard computer published sensor values to particular topics and the ground station subscribed to these topics so as to receive the data. This communication was facilitated by MQTT broker that acted as an intermediary between the two clients. From field tests carried out, data transmission was found to be fast and reliable as all the data packets transmitted were received from a distance of 300 m, the onboard computer and the ground station were able to interact through Wi-Fi, and the sensor data from the onboard computer was plotted and displayed on the ground station dashboard.

Keywords: HTTP, microcontrollers, model rocketry, MQTT, MQTT broker, TCP, UDP

iPIC 2022-17
Fractional Frequency Reuse Optimal SINR Threshold Selection Using NIR and ISODATA
Peter Kihato, Stephen Musyoki and Antony Onim
Telecom 2022, *3*(3), 433-447; https://doi.org/10.3390/telecom3030023

Abstract
A vital part of cellular network evolution has been long-term evolution networks. In these networks, it is important to mitigate inter-cell interference. Fractional frequency re-use has been proposed to address this. The method involves the division of cells into two regions based on a signal-to-interference-plus-noise-ratio threshold value. The inner region adopts a frequency re-use of one (1), while the outer region uses a higher frequency re-use factor. Setting the threshold value is a critical problem addressed in this paper. The proposed approach adapts techniques used in image processing called global-thresholding techniques. The approaches considered are iterative self-organizing data analysis and native integral ratio. Mobile stations in a cell continuously report their signal-to-interference-plus-noise-ratio values to the base station. These reported values are used to determine a threshold which dictates which subscribers fall in the inner and outer regions. The threshold value is periodically updated based on the new reported values over time. Simulations are used to assess the performance using throughput and fairness metrics. By setting the threshold optimally, better throughputs and fairness are then achieved. We concluded that native integral ratio marginally outperformed the iterative self-organizing data analysis method, and it significantly outperformed static fractional frequency reuse techniques.

Keywords: fractional frequency reuse; native integral ratio; throughput; fairness; iterative self-organizing data analysis

iPIC 2022-18

Selection of optimal SINR threshold in fractional frequency reuse by comparing Otsu's and entropy method

Antony Onim, Stephen Musyoki and Peter Kihato.

Heliyon. 2022 Nov 25;8(11):e11736. doi: 10.1016/j.heliyon.2022.

Abstract

Interference is a major challenge in cellular networks and has been mitigated by introducing a frequency re-use factor to alternate the frequency used by adjacent cells. Fractional Frequency Re-use is an approach that is utilized in handling interferences which occur between cells, particularly in cellular networks using long-term evolution and leads to better bandwidth utilization. The basic cell structure is split into two regions, a partial re-use region and a full re-use region. The full re-use region uses the same frequency for all the cells while the partial re-use regions adopt a re-use factor to mitigate interference with neighboring cells. The Signal-to-Interference-plus-Noise-Ratio threshold is a vital parameter to be set in Fractional Frequency re-use since it sets the basis of determining the subscribers that will fall within the full re-use region and those that will fall in the partial re-use region. The bandwidth is then allocated proportionately based on the number of subscribers in respective regions using a frequency partitioning ratio. The focus of this paper develop a dynamic thresholding technique by testing the performance of two thresholding techniques which are mostly used in image processing and include Otsu's, and entropy methods The results are validated by comparing the performance metrics of throughput and fairness with a dynamic thresholding technique from literature called centralized dynamic frequency allocation technique. The cell Signal-to-Interference-plus-Noise-Ratio value obtained from subscribers in the network are used to set threshold which is periodically updated as the subscribers continuously report their signal values. Simulation results show that Otsu's method outperforms entropy method in terms of throughput averagely by 29% and 23.3% in terms of fairness. Otsu outperforms centralized dynamic frequency allocation technique averagely by 39% in throughput and 32.9% in fairness.

Keywords: Dynamic FFR; Entropy thresholding; Fairness; Otsu thresholding.

iPIC 2022-19

Impact of Electric Vehicle Charging on the Nairobi Aerial Distribution Network

Willy Stephen Tounsi Fokui, Michael Saulo and Livingston Ngoo

Proceedings of the 2022 Sustainable Research & Innovation (SRI) Conference. 12.11.2022

Abstract

Kenya has a strong interest in electric vehicles (EVs), which are quickly being deployed in key cities such as Nairobi. The problem with the increasing number of EVs in the country is that they will lead to an increase in electrical power demand and excessive power losses. This paper seeks to analyze the impact of the large adoption of electric vehicles on the Nairobi aerial distribution network, with a focus on the Juja section. The methodology in this work assumes that 50% of the

households in the study area own EVs. Two types of chargers to service the EVs are considered; Level 1 chargers and Level 2 chargers. Levels 1 chargers are installed at homes and are used to charge the EVs at night when the owners are back home, while Level 2 chargers are installed at commercial parking lots and are used to charge the EVs during the day when the EV owners are at work. A 24 hours Time Domain Analysis is performed using ETAP software considering two scenarios; the first being that all the EVs are charged at night from 9 pm to 6 am the next day using Level 1 chargers, and the second being that all the EVs are charged during the day from 10 am to 2 pm using Level 2 chargers. Simulation results show that charging all the EVs at night leads to an increase in the total daily active power loss in the study network from 0.57MW with no EVs to 190.36MW, while charging the EVs during the day using Level 2 chargers leads to an active power loss of 271.616MW. From this study, it is recommended that appropriate charging schemes must be put in place as the number of EVs keeps growing in Nairobi, and other parts of Kenya.

Keywords: Electric vehicles, Charging stations, Nairobi, Power losses

iPIC 2022-20

Comparison of Software Packages for Unbalanced Load Flow Analysis: ETAP Versus PSCAD

Willy Stephen Tounsi Fokui, Michael Saulo and Livingstone Ngoo

Proceedings of the 2022 Sustainable Research & Innovation (SRI) Conference. 12.11.2023

Abstract

Power systems analysis also called load flow analysis is a very crucial aspect of power systems as it helps in enabling the effective planning and operation of the power system. The prime objective of load flow analysis is to ensure that the power generated at generating units is supplied to consumer load centers in a stable, economical, and reliable manner. Several methods have been developed for load flow calculations, the most common of these being the Newton-Raphson method, the Gauss-Seidel method, and the Fast-Decoupled method. To make power systems analysis easier and more convenient, several software packages have been developed making use of one or more of the mentioned methods. Each of these software packages has its error margin in load flow calculation. The objective of this paper is to compare the efficacy of two software; Electrical Transient and Analysis Program (ETAP), and Power System Computer-Aided Design (PSCAD) in unbalanced load flow analysis. Three IEEE test feeders are used; the IEEE 4 node, 13 node, and 34 node test feeders. Unbalanced load flow analysis of the test networks is done using ETAP and PSCAD, and the results obtained are compared with benchmarked results. For The 4 node and 13 node test networks, it is observed that the resulting node voltages with ETAP agree closer with published results compared to those obtained with PSCAD. In the case of the 34 node test feeder, the results obtained using PSCAD are better than those obtained with ETAP. To validate the overall efficacy of one software for unbalanced load flow analysis over the other, a larger number of unbalanced networks need to be analyzed with both tools and the results compared against benchmarked results.

Keywords: ETAP, PSCAD, Unbalanced load flow, Distribution network, Power systems analysis.

iPIC 2022-21

Developing a Techno-Economic Modelling Tool for Small Scale Utility Solar PV Technology for Quantifying Environmental Impacts

S. Kibaara and D. K. Murage

Proceedings of the 2022 Sustainable Research & Innovation (SRI) Conference. 12.11.2023

Abstract

Throughout the growth of the energy industry in the world, photovoltaics have received a trajectory of growth. This has witnessed many plants being installed to augment the existing grid or as alternatives to those living away from the grid. Solar Photovoltaics plants occupy large tracts of land, which would have been used for other economic activities for revenue generation such as agriculture, forestry, and tourism in archaeological sites. The negative impacts slow down the application of Solar PV. Still, a modeling tool that can quickly and quantitatively assess the effects in monetary form would accelerate the Solar PV application. This paper presents a developed modeling tool that determines not only the techno-economic impacts but also the environmental impacts in monetary form for one to be able to assess the viability of a plant in a given region. Solar-PV based Power and Environmental Cost Assessment (SPECA) model was developed to help in the following ways: (i) understanding of Solar PV based power generation and its interactions with the resource inputs, the private costs, externalities, external costs, and hence the environmental and social-economic impacts over the lifespan of the plant (ii) aiding investors of Solar PV with a tool which has a clear graphical and user interface for detection of the main drivers of the Levelized Cost of Energy (LCOE) (iii) creating an enabling environment for decision-makers aided by a visual SPECA modeling tool which takes into account the financial viability and the environmental impacts of Solar PV.

Keywords: Externalities, LCOE, USSE, ECOS Model, LECOE

iPIC 2022-22

Optimization of Flow Parameters for Waste Lubricating Oil Combustion

Dorcas Makworo, Robert Kiplimo, Meshack Hawi, Bernard Owiti

World Journal of Engineering and technology, Vol. 10, 2022, DOI: 10.4236/wjet.2022.104056

Abstract

The global energy demand has continued to skyrocket, exacerbating the already severe energy problem and environmental pollution, prompting researchers to look for alternative energy sources. Exploration of waste lubricating oil (WLO) as an alternative source of fuel has gained prominence among researchers due to its availability at low cost and the potential to generate energy while providing a safer means of disposal. The main challenge with WLO combustion is proper regulation of fuel and oxidizer during combustion to realize a near stoichiometric result. Additionally, WLO has high viscosity, hence preheating of the oil is necessary to lower the viscosity and enhance atomization, for a more efficient combustion process. This paper presents the optimization of flow parameters for combustion of WLO in a burner system by use of response surface methodology (RSM). The effects of air flow rate, injection pressure and fuel flow rate on combustion performance of a WLO burner were investigated. The highest flame temperature recorded was 1200˚C at an air flow rate of 1 m^3/min, fuel flow rate of 0.08 m^3/hr and injection

pressure of 20 bar. Tests on physical and chemical properties of WLO were conducted and characterized according to ASTM standard to ascertain its potential as an alternative fuel. The calorific values of WLO from petrol and diesel engines were found to be 41.23 MJ/kg and 42.65 MJ/kg respectively. Therefore, recycling of WLO by utilizing it as a fuel for burners has double benefits of mitigating environmental pollution and harnessing energy for process heating and power generation.

Keywords: Waste Lubricating Oil, Combustion, Burner, Optimization, Flame Temperature, Response Surface Methodology

iPIC 2022-23

Performance Simulation of a Modified Geothermal Grain Dryer Based at Menengai Well 3 in Kenya

Levi Kulundu, Hiram Ndiritu, Gareth Kituu and James Kimotho

World Journal of Engineering and Technology > Vol.10 No.1, February 2022

Abstract

Geothermal energy can be effectively utilized for grain drying to reduce carbon emissions and also cut operational costs associated with conventional methods. The main challenges encountered in the use of the geothermal grain dryer, such as in Menengai, Kenya, include uneven grain drying and long throughput times. Grains near the hot air inlet dry at a faster rate compared to those near the exhaust end. Therefore, the grains must be recirculated within the dryer to achieve uniform moisture distribution. Grain recirculation is energy-intensive as it utilizes electricity running the elevator motors in addition to the suction pump. A Computational Fluid Dynamics (CFD) model was developed to study the airflow pattern and its impact on drying of maize. The model was simulated in ANSYS 21 and validated using experimental data. Finite volume discretization method was employed for meshing. Pressure-based segregated solver was used in the Computational Fluid Dynamics (CFD) simulation. Also, K-Omega turbulent model was used for enhancing wall treatment. The findings indicate that non-uniform hot air distribution across the grain buffer section causes uneven drying. Introducing filleted flow-guides results in a relatively uniform velocity, temperature, and turbulence kinetic energy distribution across the dryer. The average velocity and temperature magnitudes in lower compartments increased by 153.3% and 0.25% respectively for the improved dryer. In the upper compartments, the velocity and temperature increase were 176.5% and 0.22% respectively.

Keywords: Filleted Flow-Guides, Flow Distribution, Geothermal Grain Dryer, Computational Fluid Dynamics

iPIC 2022-24

Mesophilic Process and Kinetics Studies of Selected Biomolecules as Potential Enhancers of Biomethanization of Cow Dung in an Anaerobic Tubular Batch Reactor

Paul Njogu, Francis Xavier Ochieng, Benard Ogembo, Stephen Ondimu, Christopher Kanali, Erick Ronoh, Daniel Omondi and Hiram Ndiritu

Energy and Power Engineering > Vol.14 No.3, March 2022

Abstract
Mesophilic biogas production and substrate decomposition is one of the significant limiting steps in biogas generation. The rate of generation and quality often affect the viability of biogas systems. This study assessed the potential for biogas process catalysis using powdered Sorghum bicolor L., Zea mays, and Pennisetum glaucum. The kinetics and biogas generation processes were studied. Experiments were conducted in 1 m3 tubular batch reactors, where batches were dosed with various organic biomolecules. Results show that the use of P. glaucum L. and S. bicolor L. reduced the biogas retention times significantly. Biogas generation commenced after the first day for digesters fed with S. bicolor L. and P. glaucum L. while one with Z. mays and control occurred on day two. The rate of biomethanation and methane content were enhanced. S. bicolor L. led to the highest methane content. Findings reveal that locally available organic biomolecules improved biogas quality and quantity.

Keywords: Mesophilic, Kinetics, Biomolecules, Biomethanation, Reaction Rates, Anaerobic

iPIC 2022-25
Hydrodynamic performance study of a fixed–floating asymmetric chamber offshore oscillating water column–wave energy conver
Kiptoo Hillary, Christiaan A. Adenya and Hiram M. Ndiritu
Journal of Sustainable Research in Engineering, Vol. 7(1) 2022, 11 -30

Abstract
For the design and optimization processes of Oscillating Water Column (OWC) systems, knowledge of their hydrodynamic performance behavior is essential. While there have been extensive research efforts on understanding the hydrodynamic performance behavior of fixed-floating offshore OWCs, studies focusing on quantifying the effect of applied damping over a broad range of incoming wave heights are limited. Besides, no attempt has thus far been undertaken to optimize the hydrodynamic efficiency of fixed-floating offshore OWCs using the sequential optimization procedure proposed and used in a 2D onshore OWC in the literature. This paper addresses these omissions by deeply investigating the influence of wave height, wave period, and turbine damping parameters on the hydrodynamic performance behavior of a fixed-floating offshore OWC system. To realize these objectives, a nonlinear 3D incompressible Computational Fluid Dynamics (CFD) model based on the Reynolds-Averaged Navier-Stokes (RANS) equations and the Volume of Fluid (VOF) approach was implemented in the open-source OpenFOAM® suite to numerically simulate fluid-structure interaction under regular wave conditions. The validity of this numerical model was verified using experimental measurements in the literature, where a reasonably good correlation was achieved. The results demonstrate that the aforementioned design parameters strongly affect the device's hydrodynamic performance. It has also been shown through a sequential optimization approach that at an optimum wave period of 1.07 s, optimum wave height of 0.01948 m, and a pneumatic damping value of 0.02 m, about 87% of peak hydrodynamic efficiency is possible for the fixed-floating offshore OWC device used in the study.

Keywords: Offshore oscillating water column device, turbine damping, wave height, wjsre.

iPIC 2022-26

Coco peat Drying Techniques: A Review

Mercy N. Kilee, Peter O. Oketch and Hiram M. Ndiritu

Proceedings of the 2022 Sustainable Research and Innovation ConferenceJKUAT Main Campus, Kenya5 -6 October, 2022.

Abstract

Coco peat is a light soil-like material that is created as a by-product of the extraction of coco coir from coconut fibre. When wet, coco peat is a bulky material and possess a challenge in transportation. Drying removes moisture in the coco peat which then is compacted into bricks thus offering a solution to transportation. Different drying techniques for coco peat are used all over the world. This then serves as the foundation for this review, as the goal of this research is to comprehend and explain the various techniques used in the drying of coco peat. The coir industry is gradually expanding, and coco peat as a by-product is in high demand. This has resulted in an increase in the global valuation of the coco peat market; therefore, this review will concentrate its discussion on the existing methods used in coco peat drying, such as open-air sun drying, solar dryers and their various models, and will also analyse the existing peat drying machines manufactured for industrial or commercial purposes.

Keywords: Coconut husks, Coco pear, drying, solar, technique

iPIC 2022-27

Study of Forced Convective Geothermal Grain Drying and Cooling in Menengai Well 3

Levi M. Kulundu, Hiram M. Ndiritu, Gareth M. Kituu and James K. Kimotho

Journal of Sustainable Research in Engineering Vol. 7(2) 2022, 89-95

Abstract

Geothermal energy provides an efficient means for grain drying without significant environmental pollution. However, one of the challenges encountered in geothermal grain drying is eliminating the final moisture points. In this research, forced convective grain drying and cooling were studied to quantify the resulting energy savings. Two experiments were conducted to compare the rate of moisture reduction for an all-heat system and the use of forced convective cooling. In the first experiment, heating stopped at 2% above the desired grain moisture content, and then ambient air was pumped into the grain buffer. In the second experiment, continuous grain drying was conducted until the desired moisture content was attained. The study indicates that the use of forced convective geothermal grain drying and cooling results in 19.62% energy saving.

Keywords: All-heat system, moisture content, forced convective cooling, energy savings

iPIC 2022-28

Optimization of fused deposition modelling process parameters and the effect on residual stresses of built parts

Gaudence Nyiranzeyimana, James Mutuku Mutua, Thomas Ochuku Mboya and Bruno Robert Mose

Abstract
Fused deposition modelling (FDM) is one of the most used additive manufacturing techniques for the fabrication of functional parts from composite filaments. Despite the widespread application spectra, FDM is still limited in its applicability due to inherent problems, one of which is the significant accumulation of residual stresses during part building. Residual stresses are generated due to thermo-cyclic loading in subsequent layers. The effect of residual stresses is significant for the mechanical integrity of the manufactured parts. Since it is impossible to manufacture parts without internal residual stresses, it is prudent to optimize the process parameters that would result in minimal residual stresses. In this study, Digimat additive manufacturing 2020 software with Taguchi design of experiment was used to predict the effect of printing temperature, layer thickness, and print speed on the generated residual stresses. Generic algorithm was used to determine the optimum combination levels for the minimum residual stresses. Results showed a near convergence between simulation and experimental residual stress values with an error of 3.7 %. The mechanical properties of 3D printed carbon fiber composite products were found to have tensile strength; 71.48 MPa, compressive strength; 135.8 MPa, Young's Modulus; 7.6 GPa, and percentage elongation; 1.86 %. These properties fell within the acceptable range for the actual parts to be replaced. The results of this study will serve as a pragmatic approach to 3D printing of components devoid of trial and error strategies that have currently slowed the adoption of the FDM technique as a rapid prototyping tool for enhanced manufacturing.

Keywords: Functional parts, Composite. Fused deposition modelling, Residual stresses, Mechanical properties

iPIC 2022-29
Comparative Analysis of Low Global Warming Working Fluids for Geothermal-Solar Hybrid Cycle
Hofni Venomhata, Peter Oketch, Benson Gathitu and Paul Chisale
Proceedings of the 2022 Sustainable Research and Innovation ConferenceJKUAT Main Campus, Kenya5 -6 October, 2022

Abstract
Low quality brine discharged from the separator at Olkaria II power plant is normally reinjected back into the ground. Utilizing waste brine in an organic rankine cycle technology can result in cycle efficiency of around 12%. The efficiency can further be improved by the integration of parabolic trough collector to the geothermal cycle. Previous studies on geothermal-solar hybrid cycles have been analyzed using higher global warming potential working fluids such as R134a and R245fa. These organic working fluids pose danger to the environment and contravene protocols such as the Montreal Protocol, Kyoto Protocol and Paris Agreement which insist on the substitution of harmful substances that are accelerating global warming. In this study R-600a (isobutane), R-290 (propane), R-1150 (ethylene) and R152a (difluoroethane) which are low global warming potential organic working fluids are analyzed in terms of pump power, power output and net power output using geothermal-solar hybrid cycle for waste brine at Olkaria II power plant in Kenya. The results obtained show that R1150 produces the highest power output and net power followed by R290, R152A and R600A.

Keywords: Organic Rankine cycle, Parabolic trough, Global warming potential, Cycle efficiency

iPIC 2022-30

Optimization of polygonal cross-sectioned conformal cooling channels in injection molding

Laura W. Simiyu, James M. Mutua, Patrick I. Muiruri and Bernard W. Ikua

International Journal on Interactive Design and Manufacturing (IJIDeM) (2023). *https://doi.org/10.1007/s12008-023-01226-7*

Abstract

In injection molding process, cooling time accounts for up to 80% of the whole cycle time, and this has a significant effect onproductivity. Cooling time can be reduced by use of cooling channels in molds. This paper presents a study on optimization of conformal cooling channels with various cross-sectional shapes, depths, and pitches. The depth of sink marks, volumetric shrinkage, warpage, and cooling time, are estimated using Solidworks Plastics 2021® using Taguchi design of experiments. Simulations on cooling time were carried out for a mold with straight cooling channels and experiments were carried out toverify the simulation results. Simulations were then carried out on molds with conformal cooling channels and the resultswere analyzed using Analysis of variance, principal component analysis, and grey relational analysis. It is seen that themulti-response Taguchi-Grey optimization method is suitable for the selection of the best cooling channel design. It is further seen that the shortest cooling time with smallest product defects can be achieved through the use of a cooling channel witha decagonal cross-section and a depth equal to the pitch. Moreover, pitch is the most critical factor influencing sink marks, shrinkage, warpage, and cooling time concurrently.

Keywords: Injection molding · Conformal cooling channel · Optimization · Grey-based Taguchi Quality criterion.

iPIC 2022-31

A comparative analysis of additive manufacturing filaments developed from recycled high-density polyethylene and recycled polypropylene: Extrusion process optimization

Maurine N. Andanje, James Wamai Mwangi, Bruno R. Mose and Sandro Carrara

Proceedings of the 2022 Sustainable Research and Innovation ConferenceJKUAT Main Campus, Kenya5 -6 October, 2022

Abstract

Plastic solid waste continue to present opportunities. The use of recycled plastic material in additive manufacturing, also known as 3D printing, is expected to make the process more sustainable and help to address the global problem of plastic waste. However, there are still limitations to using recycled plastics as filament material such as getting the right quality of filaments that are well characterized. There is growing interest among researchers on the development of filaments from recycled plastics towards the realization of a circular economy in the additive manufacturing technology. In this paper, we present outcomes about filaments fabricated from recycled high density polyethylene and recycled polypropylene using the extrusion method. The extrusion process parameters considered in the fabrication of the filaments included extrusion temperature, screw speed and fan cooling. These parameters were analyzed and optimized using the Taguchi design of experiments technique. The response variable was the filament diameter which was desired to be 2.85 ± 0.05 mm with a circular cross section. The fabricated filaments were characterized and compared to establish their sustainability for fused

filament fabrication. The results from this study are very significant in the development of printable filaments that meet the standards for 3D printing.

Keywords: Additive manufacturing (AM), Fused filament fabrication (FFF), High density polyethylene (HDPE), Polypropylene (PP), Taguchi design of experiments, ANOVA

iPIC 2022-32

Development of a Solid Propellant Motor for High-Powered Model Rockets Washington K. Kigani

Felix W. Gateru, Maureen W. Gichia, Valerian K. Nyerere, Jeff Mboya, Bernard Owiti and Shohei Aoki

Proceedings of the 2022 Sustainable Research and Innovation ConferenceJKUAT Main Campus, Kenya5 -6 October, 2022

Abstract

High powered rocketry involves rockets with a total mass of more than 1,500 grams, a fuel mass of more than 125 grams and a propellant of more than 160 Newton-seconds of total impulse or a motor with an average thrust of 80 Newtons or more. Such rockets require high powered propulsion systems to be developed in order to achieve the required thrust and apogee. This paper highlights the design, simulation, and development of a high-powered propulsion system for the Nakuja-2 rocket with a desired apogee of 500 m. The design process was done with the goal to ensure the required thrust is achieved while ensuring safety. During the process, data was collected remotely by means of a developed data acquisition system and the developed solid propellant motor was able to generate an average thrust of 151.7 Newtons, getting the rocket to an apogee of 280 m.

Keywords: solid rocket propellant, model rocket, thrust

iPIC 2022-33

Comparison of Deep Learning Architectures for Late Blight and Early Blight Disease Detection on Potatoes

Soumo Emmanuel Arnaud, Ndeda Rehema, Shohei Aoki and Murungi Lucy Kananu

Scientific Research, Vol.12 No.5, May 2022. DOI: 10.4236/ojapps.2022.125049

Abstract

Potato late blight and early blight are common hazards to the long-term production of potatoes, impacting many farmers around the world, particularly in Africa. Early detection and treatment of the potato blight disease are critical for promoting healthy potato plant growth and ensuring adequate supply and food security for the fast-growing population. As a result, machine-driven disease detection systems may be able to overcome the constraints of traditional leaf disease diagnosis procedures, which are generally time-consuming, inaccurate, and costly. Convolutional Neural Networks (CNNs) have been shown to be effective in a variety of agricultural applications. CNNs have been shown to be helpful in detecting disease in plants because of their capacity to analyze vast volumes of data quickly and reliably. However, the method hasn't been widely used in the detection of potato late blight and early blight diseases, which reduce yields significantly. The goal of this study was to compare six cutting-edge CNN architectural models, taking into

account transfer learning for training and four hyperparameters. The CNN architectures evaluated were AlexNet, GoogleNet, SqueezeNet, DenseNet121, EfficientNet b7, and VGG19. Likewise, the hyperparameters analyzed were the number of epochs, the batch size, the optimizer, and the learning rate. An open-source dataset containing 4082 images was used. The DenseNet121 architecture with a batch of 32 and a Stochastic Gradient Descent (SGD) optimizer with a learning rate of 0.01 produced the best performance, with an accuracy of 98.34% and a 97.37% f1-score. The DenseNet121 model was shown to be useful in developing computer vision systems that aid farmers in improving their disease management systems for potato cultivation.

Keywords: Image Classification, Convolutional Neural Networks, Transfer Learning, Hyperparameters

iPIC 2022-34

An Investigation of the Effects of Thermal Interference between Adjacent Nitinol Spring Actuators in a Tactile Display

Kudzanai Sekerere, Rehema Ndeda and Karanja Kabini

Scientific Research, Vol.11 No.1, February 2023. DOI: 10.4236/wjet.2023.111010

Abstract

Over the years, there has been increased research interest in the application of Nitinol as an actuator, due to its shape memory behaviour, simplicity, high power-to-weight ratio, compactness, and extreme high fatigue resistance to cyclic motion, and noiseless operation. Nitinol has found application in tactile displays which reproduce tactile parameters such as texture and shape, depending on the application. This paper presents the effects of thermal interference between adjacent Nitinol spring actuators in a tactile display. The tactile display is made of a 3 by 3 pin array whose spatial resolution was varied from 4 mm to 6 mm in steps of 1 mm while a current of 1.5 A was used to actuate 8 of the springs, and the centre spring was left unactivated to observe the thermal effects on it due to the heat gradient formed. A Finite Element (FE) model was developed using COMSOL Multiphysics and the results were further verified through experimentation. In both cases, there was visible thermal interference between actuators. The increase in spatial resolution saw a decrease in thermal interference by 12.7%. Using a fan to introduce forced convection, reduced the thermal interference in the simulation by 20% and during experimentation by 11%. The results of this research indicate a spatial resolution of 6 mm reduced the thermal inference to a negligible rate. However, thermal interference could not be eliminated with these two methods.

Keywords: Finite Element Analysis (FEA), Shape Memory Alloy (SMA), Nitinol (NiTi) Spring Actuator, Tactile Display, Thermal Interference

iPIC 2022-35

Simulation and Topology Optimization of a Vehicle Door Hinge for Additive Manufacturing

G. H. Okoth, R. Ndeda, P. Raghupatruni and E. O. Olakanmi

Proceedings of the 2022 Sustainable Research and Innovation Conference. JKUAT Main Campus, Kenya. 5 - 6 October, 2022

Abstract
Additive manufacturing technologies offer unique capabilities that result in the creation of innovative, high-performance complex design geometries at reduced material cost. These novel design approaches can be fully realized through topology optimization which allows for greater material distribution usually optimized against a specific design objective. A vehicle door hinge design was analyzed using a finite element analysis which was then optimized to be additively manufactured with AlSi10Mg alloy. Based on the results of the structural analysis, topology optimization was performed to remove material from areas that did not significantly contribute to carrying the required loads. From the topology optimization results, the part was then remodeled in CAD software for additive manufacture using the AlSi10Mg alloy. Additional finite element analyses were carried out on the new CAD model to determine the load-carrying capacity of the design. The final design was then prepared for the final additive manufacturing.

Keywords: additive manufacturing, aluminum alloy, compliance, finite element analysis, topology optimization.

iPIC 2022-36
Effect of Polyethylene Terephthalate Fibres on the Structural Performance of Beams with Openings in the Shear Region
Michael Mwendwa, A Mwonga, Charles B. Kabubo and Naftary Gathimba
Proceedings of the 2022 Sustainable Research & Innovation (SRI) Conference. 12.11.2022

Abstract
The provision of transverse openings in beams to allow passage of services reduces the cracking and ultimate load capacities of the beams and increases deflection under the openings. Strengthening of the pre-planned opening regions by use of special steel reinforcements causes reinforcement congestion and difficulties in compaction, calling for alternative ways of strengthening beams with openings. In this study, concrete material was modified by the use of Polyethylene Terephthalate (PET) fibres produced from waste plastic bottles to improve the tensile properties and hence reduce the cracking around the openings and improve the overall performance of the beams. To evaluate the performance of PET fibres in beams with openings, eight (8) reinforced concrete beams with and without fibres of dimensions (150*250*2000 mm) were cast with varying opening sizes. The horizontal position of the openings was fixed at 300 mm from the support while the vertical position was maintained at the mid-depth of all beams. This performance was evaluated in terms of ultimate and first cracking loads, mid-span deflections, ductility, crack patterns and failure modes, and strain behavior. Test data showed that incorporating PET fibres in beams with openings resulted in a slight increase in ultimate load of 4.1% and 5.82% for 0.25 h and 0.35 h beam opening sizes respectively, beyond which the strength was reduced by 9.57% for beams with 0.45 h opening size, where h was the overall depth of the beam. The first cracking loads increased by 44.12%, 48.48%, and 9.38% for 0.25 h, 0.35 h, and 0.45 h opening sizes, respectively. In addition, a slight improvement in the ductility of PET fibre beams for all opening sizes was observed. The PET fibre beams exhibited a slight change in the mode of failure from dominant shear failure to combined shear and flexure failure characterized by multiple cracks in the flexure region with minimal spacing. An increase in the concrete compressive and tensile

strains accompanied by a reduction in concrete and steel shear strains was observed because of the tension stiffening effects of the fibres. The
incorporation of PET fibres, therefore, showed a significant improvement in strengthening beams with openings.

Keywords: Beams with openings, first cracking load, Polyethylene Terephthalate fibres, ultimate load

iPIC 2022-37
Stochastic Modelling of Biomass Fuel Mix Cost for Boilers in Tea Processing
Veronicah K. Ngunzi, Christopher K. Kanali, Gareth M. Kituu and Erick K. Ronoh
Proceedings of the 2022 Sustainable Research & Innovation (SRI) Conference. 12.11.2023

Abstract
Wood fuel is the main supply of heat energy for withering and drying of tea. With the diminishing trends of wood fuel caused by reducing land mass due to increased population and government ban on logging of wood fuel from the forest, tea factories are looking for alternative biomass fuels to supplement the wood fuel. However, most biomass are faced with uncertainties such as availability and calorific value which is affected by moisture content. This work presents a stochastic modelling approach for a reliable biomass fuel mix strategy of wood and macadamia nutshells taking into account the stochastic nature of the availability and calorific value of the biomass. These variables determine the quantity of biomass
consumed to produce the required 400 kg of steam per hour at pressure of 10 bar and temperature of 180□C. The variables also determine the cost of energy per kg of processed tea which affects the profits and competitive advantage of tea factories. The model generated randomly 40 values of moisture content between 12% and 50% and 40 values of wood availability between 60% and 100%. The moisture content and wood availability were used to calculate the energy content and mass of wood fuel used. The model subsequently calculated the mass of macadamia nutshells required to supply the deficit energy. In addition, the model calculated the total cost of the fuel mix. The model was iterated 20 times to generate more data sets to check the consistency of the model. Sensitivity analysis was also carried out to test the validity of the model. This model will be beneficial to the factory management and the Kenya Tea Development Agency in developing policy and strategies for biomass fuel acquisition.

Keywords: Biomass fuel, calorific value, fuel mix, moisture content, stochastic model

1.4. Compilation of Abstracts from iCCATS Subtaskforce

iCCATS 2022-01
Target Sentiment Analysis Ensemble for Product Review Classification.
Ogutu Rhoda Viviane, Rimiru Richard, Otieno, Calvins. (2022),
Journal of Information Technology Research (JITR) Volume 15 Issue 1 Pages 1-13

Abstract

Machine learning can be used to provide systems the ability to automatically learn and improve from experiences without being explicitly programmed. It is fundamentally a multidisciplinary field that draws on results from Artificial intelligence, probability and statistics, information theory and analysis, among other fields that impact the field of Machine Learning. Ensemble methods are techniques that can be used to improve the predictive ability of a Machine Learning model. An ensemble comprises of individually trained classifiers whose predictions are combined when classifying instances. Some of the currently popular ensemble methods include Boosting, Bagging and Stacking. In this paper, we review these methods and demonstrate why ensembles can often perform better than single models. Additionally, some new experiments are presented to demonstrate the computational ability of Stacking approach.

iCCATS 2022-02

K-Means Clustering with Deep Learning for Fingerprint Class Type Prediction

E Mukoya, R Rimiru, M Kimwele, D Mashava,

IJCSNS International Journal of Computer Science and Network Security, VOL.22 No.3.

Abstract

In deep learning classification tasks, most models frequently assume that all labels are available for the training datasets. As such strategies to learn new concepts from unlabeled datasets are scarce. In fingerprint classification tasks, most of the fingerprint datasets are labelled using the subject/individual and fingerprint datasets labelled with finger type classes are scarce. In this paper, authors have developed approaches of classifying fingerprint images using the majorly known fingerprint classes. Our study provides a flexible method to learn new classes of fingerprints. Our classifier model combines both the clustering technique and use of deep learning to cluster and hence label the fingerprint images into appropriate classes. The K means clustering strategy explores the label uncertainty and high-density regions from unlabeled data to be clustered. Using similarity index, five clusters are created. Deep learning is then used to train a model using a publicly known fingerprint dataset with known finger class types. A prediction technique is then employed to predict the classes of the clusters from the trained model. Our proposed model is better and has less computational costs in learning new classes and hence significantly saving on labelling costs of fingerprint images.

iCCATS 2022-03

Multi-task Neural Networks Convolutional Learning Model for Maize Disease Identification.

D. Niyomwungere, W. Mwangi and R. Rimiru,

2022 IST-Africa Conference (IST-Africa), Ireland, 2022, pp. 1-9,

Abstract:

Maize is an essential cereal for humans and animals worldwide, and it is one of the staple food in Kenya. One of the main challenges facing the maize crop in Kenya is the presence of diseases spreading quickly. Early recognition of maize pathogen and disease help at preventing the disease from spreading throughout the field. This paper proposes a regularized Multitask learning (MTL)–Convolutional Neural Networks (CNN) model for simultaneously identifying maize disease and

its pathogen from diseased maize images. MTL allows training one model for multiple tasks at a time, which may improve the accuracy of each task by taking advantage of their commonalities. Our baseline is made of two CNN classification models, one of them being overfitting. We then build an MTL based on the two models, which increases the test accuracy of the overfitting model from 60.08% to 74.48%. The results show that the accuracy rises to 77.44% while combining MTL to the Early stopping method. However, the test accuracy goes up to 85.22 percent when MTL is combined with Early Stopping and Transfer Learning. The model is deployed to an android mobile application for maize farmers as end-users which is very important for costs reduction and time saving.

iCCATS 2022-04

GaborNet: investigating the importance of color space, scale and orientation for image classification.

Rimiru RM, Gateri J, Kimwele MW, 2022,

PeerJ Computer Science 8:e890 https://doi.org/10.7717/peerj-cs.890

Abstract:

Content-Based Image Retrieval (CBIR) is the cornerstone of today's image retrieval systems. The most distinctive retrieval approach used, involves the submission of an image-based query whereby the system is used in the extraction of visual characteristics like the shape, color, and texture from the images. Examination of the characteristics is done for ensuring the searching and retrieval of proportional images from the image database. Majority of the datasets utilized for retrieval lean towards to comprise colored images. The colored images are regarded as in RGB (Red, Green, Blue) form. Most colored images use the RGB image for classifying the images. The research presents the transformation of RGB to other color spaces, extraction of features using different color spaces techniques, Gabor filter and use Convolutional Neural Networks for retrieval to find the most efficient combination. The model is also known as Gabor Convolution Network. Even though the notion of the Gabor filter being induced in CNN has been suggested earlier, this work introduces an entirely different and very simple Gabor-based CNN which produces high recognition efficiency. In this paper, Gabor Convolutional Networks (GCNs or GaborNet), with different color spaces are used to examine which combination is efficient to retrieve natural images. An extensive experiment using Cifar 10 dataset was made and comparison of simple CNN, ResNet 50 and GCN model was also made. The models were evaluated through a several statistical analysis based on accuracy, precision, recall, F-Score, area under the curve (AUC), and receiving operating characteristic (ROC) curve. The results show GaborNet model effectively retrieve images with 99.68% of AUC and 99.09% of Recall. The results also show different images are effectively retrieved using different color space. Therefore, research concluded it is very significance to transform images to different color space and use GaborNet for effective retrieval.

iCCATS 2022-05

Accelerating deep learning inference via layer truncation and transfer learning for fingerprint classification

Esther Mukoya, Richard Rimiru, Michael Kimwele, Consolata Gakii, Grace Mugambi,

First published: 05 January 2023 https://doi.org/10.1002/cpe.7619

Abstract
Biometric systems have been used extensively in the identification and verification of persons. Fingerprint biometrics stands out as the most effective due to their characteristics of Permanence, uniqueness, ergonomics, throughput, low cost, and lifelong usability. By reducing the number of comparisons, biometric recognition systems can effectively deal with large-scale databases. Fingerprint classification is an important task used to reduce the number of comparisons by dividing fingerprints into classes. Deep learning models have demonstrated impressive classification performance in fingerprint classification tasks. The high-level features of deep learning models can affect the transfer learning in deep learning models. Furthermore, the high-level features involve high computational costs that can render difficulty in the deployment of the applications. This work proposes an improved system for fingerprint classification through the truncation of layers and transfer learning. Our approach modifies the ResNet50 model to improve its network inference speed and performance in fingerprint classification by removing some deep convolutional layers. We then finetune the modified model and train it using a fingerprint dataset. The results show that the finetuned modified model improves classification accuracy at a reduced computational cost. At only 5.1M parameters, our model obtained a classification accuracy of 93.3% and precision of 93.4% performing better than previous studies based on its size-performance ratio.

iCCATS- 2022-06

Improved Medical Imaging Transfer learning through conflation of domain features

Raphael Wanjiku, Lawrence Nderu and Michael Kimwele (2022),
1st International Conference on Technological Advancement in Embedded and Mobile Systems (ICTA-EMOS), Arusha, Tanzania 24th – 25th November 2022, ISBN 978-3-8142-2408-4

Abstract
Transfer learning has made deep learning more accessible in many fields, such as medical imaging. However, data adaptation in medical imaging transfer learning remains a challenge. With the release of many pre-trained models, there is a need to address target data adaptation in these pre-trained modes. This paper proposes the use of conflation of textural features, testing it on three medical imaging datasets and two pre-trained models among them a MobileNetV2 to demonstrate the approach usefulness in mobile systems. From the experiments, it can be seen that selecting images with lower textural KullbackLeibler divergence can improve the performance accuracy of the models by a margin of 13.17% in LBP and 6.47% for GLCM methods. This approach en-sures that the pre-trained models can be used with much confidence and assist in generating more quality data samples for effective transfer.

iCCATS 2022-07

Face Recognition under Partial Occlusion: A Detection and Exclusion of Occluded Face Regions Approach. Pattern Recognition and Artificial Intelligence.

Abiero, J., Kimwele, M., Chemwa, G. (2022), MedPRAI 2021. Communications in Computer and *Information Science, Vol 1543. Springer, Cham.* *https://doi.org/10.1007/978-3-031-04112-9_2*

Abstract
Partial face occlusions such as scarfs, masks and sunglasses compromise face recognition accuracy. Therefore, this paper presents a face recognition approach robust to partial occlusions. The approach is based on the assumption that the human visual system ignores occlusion and solely focuses on the non-occluded sections for recognition. Four sections derived from a whole/un-occluded image and the whole face are used to train a classifier for recognition. For testing, an occluded face image is also divided into the four sections above from which, the non-occluded or the least occluded section is selected for recognition. Two strategies were used for occlusion detection; skin detection and the use of haar cascade classifiers. This paper mitigated weaknesses from literature review such as use of datasets that simulate real world occlusion scenarios, use of less data in training and not requiring any type of occlusion variation in training data. Additionally, the classifier performed relatively well in the classification task with an accuracy of 92% on the Webface-OCC dataset and 96% on the Pubfig dataset.

iCCATS 2022-08

Transfer Learning Data Adaptation using Conflation of Low-level Textural Features

Raphael Ngigi Wanjiku, Lawrence Nderu, Michael Kimwele (2022),
Engineering Reports, *https://doi.org/10.1002/eng2.12603*, *November 2022.*

Abstract
Adapting the target dataset for a pre-trained model is still challenging. These adaptation problems result from a lack of adequate transfer of traits from the source dataset; this often leads to poor model performance resulting in trial and error in selecting the best-performing pre-trained model. This paper introduces the conflation of source domain low-level textural features extracted using the first layer of the pre-trained model. The extracted features are compared to the conflated low-level features of the target dataset to select a higher-quality target dataset for improved pre-trained model performance and adaptation. From comparing the various probability distance metrics, Kullback-Leibler is adopted to compare the samples from both domains. We experiment on three publicly available datasets and two ImageNet pre-trained models used in past studies for results comparisons. This proposed approach method yields two categories of the target samples with those with lower Kullback-Leibler values giving better accuracy, precision and recall. The samples with the lower Kullback-Leibler values give a higher margin accuracy rate of 0.22%–9.15%, thereby leading to better model adaptation and easier model selection process for the target transfer learning datasets and tasks

iCCATS 2022-09

Dynamic Fine-tuning Layer Selection Using Kullback–Leibler Divergence

Raphael Ngigi Wanjiku, Lawrence Nderu, Michael Kimwele (2022),
Engineering Reports, *https://doi.org/10.1002/eng2.12595*, *November 2022*

Abstract
The selection of layers in the transfer learning fine-tuning process ensures a pre-trained model's accuracy and adaptation in a new target domain. However, the selection process is still manual and without clearly defined criteria. If the wrong layers in a neural network are selected and used, it could lead to poor accuracy and model generalization in the target domain. This paper introduces the use of Kullback–Leibler divergence on the weight correlations of the model's convolutional

neural network layers. The approach identifies the positive and negative weights in the ImageNet initial weights selecting the best-suited layers of the network depending on the correlation divergence. We experiment on four publicly available datasets and six ImageNet pre-trained models used in past studies for results comparisons. This proposed approach method yields better accuracies than the standard fine-tuning baselines with a margin accuracy rate of 10.8%–24%, thereby leading to better model adaptation for target transfer learning tasks.

iCCATS 2022-10

Sentiment Analysis on Social Media Tweets Using Dimensionality Reduction and Natural Language Processing

Erick Odhiambo Omuya, George Okeyo, Michael Kimwele (2022),
Engineering Reports, https://doi.org/10.1002/eng2.12579, *September 2022*

Abstract

Social media has been embraced by different people as a convenient and official medium of communication. People write or share messages and attach images and videos on Twitter, Facebook and other social media platforms. It there-fore generates a lot of data that is rich in sentiments. Sentiment analysis has been used to determine the opinions of clients, for instance, relating to a particular product or company. Lexicon and machine learning approaches are the strategies that have been used to analyze these sentiments. The performance of sentiment analysis is, however, distorted by noise, the curse of dimensionality, the data domains and the size of data used for training and testing. This article aims at developing a model for sentiment analysis of social media data in which dimensionality reduction and natural language processing with part of speech tagging are incorporated. The model is tested using Naïve Bayes, support vector machine, and K-nearest neighbor algorithms, and its performance com-pared with that of two other sentiment analysis models. Experimental results show that the model improves sentiment analysis performance using machine learning techniques.

iCCATS 2022-11

Contrastive Environmental Sound Representation Learning

P.Ochieng, D.Kaburu, 2022, https://doi.org/10.48550/arXiv.2207.08825

Abstract

Machine hearing of the environmental sound is one of the important issues in the audio recognition domain. It gives the machine the ability to discriminate between the different input sounds that guides its decision making. In this work we exploit the self-supervised contrastive technique and a shallow 1D CNN to extract the distinctive audio features (audio representations) without using any explicit annotations.We generate representations of a given audio using both its raw audio waveform and spectrogram and evaluate if the proposed learner is agnostic to the type of audio input. We further use canonical correlation analysis (CCA) to fuse representations from the two types of input of a given audio and demonstrate that the fused global feature results in robust representation of the audio signal as compared to the individual representations. The evaluation of the proposed technique is done on both ESC-50 and UrbanSound8K. The results show that the proposed technique is able to extract most features of the environmental audio and gives an improvement of 12.8% and 0.9% on the ESC-50 and UrbanSound8K datasets respectively.

iCCATS 2022-12

An Enhanced Automatic Generation of CRUD Operations in React-JS

Timothy Karungu, Lawrence Nderu, Dennis Kaburu. An Enhanced Automatic Generation of *CRUDO Operations in React-JS, Authorea April 13,2022*

Abstract

Seeing that coding React-JS can be repetitive and prone to errors like most other programming languages, which makes it a daunting task, Automatic Code Generation (ACG) tools exist to help tackle this. The current model used in most of the ACG tools for React-JS comes up with components which is a fraction of the entire application when it comes to coming up with the entire Create, Retrieve, Update and Delete (CRUD) applications. Developers still need to come up with the logic of how CRUD functionalities will be implemented in the code that was generated by these models. This study seeks to address this gap by proposing an enhanced automatic generating model for Single Page Applications (SPA) in React-JS coined CRUD-Bolt. The study employs the USE questionnaire to test its usability whereby 38 React-JS developers across the globe fill the questionnaire after testing it. The results are imported into Statistical Package for the Social Sciences (SPSS) to evaluate CRUD-Bolt. The outcome of the study is threefold: achieve an enhanced model coined CRUD-Bolt, make it available to developers, and test its usability via SPSS.