



AFRICA-*ai*- JAPAN Project:

African Union -*african innovation* - JKUAT AND PAUSTI Network Project

Towards Enhancement of JKUAT-PAUSTI Research and Innovation Capacity

Abstracts of scientific publications: 2019-2020

September 2020

Preface

The AFRICA-*ai*-JAPAN Project phase I, an initiative of JICA-JKUAT collaboration to enhance the University's capacity for supporting PAUSTI, started in 2014 and ended in 2019 followed by an extension of 1 year to March 2020.

The Project operates through several sub taskforces which include: the (1) Integrated Prototyping Innovation and Innovation Centre (iPIC) which has the key objective of the employment of 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 alleviate food and nutrition insecurity, and support climate change mitigation. The iCB thematic areas are Bio-diversity and conservation, Animal Health and Production, Bio-resource and Waste Management; (3) the 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) the 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 has started with development of a centralized computer centre which would act as the central backbone serving the entire university with all the ICT requirements. The AFRICA-*ai*-JAPAN project works to deliver a number of outputs as described in the Project Design Matrix document.

The first output relates to 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 procurement 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 projects will be aligned to the national development agenda (Vision 2030 and the Big four) as well as Sustainable Development Goals.

The third output is development of a close academia-industry collaboration 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.

As direct result of the research and innovation environment created and arising from the activities of the AFRICA-ai-JAPAN project phase I, many publications in peer reviewed journals were published over the period of 2019-2020. 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 provide in the subsequent section. A total of **202 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
2019	124
2020	78
Total	202

Yours Sincerely,

AFRICA-ai-JAPAN Project Director

Prof. Victoria Wambui Ngumi (PhD)

AFRICA-ai-JAPAN Project Manager

Prof. Robert Kinyua (PhD)

Acknowledgement

A great level of appreciation is dedicated to the authors of the various **abstracts** from JKUAT within the period 2019 to 2020 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. Thank you very much and congratulations for a job well done. You are encouraged to keep publishing in high impact factor journals and share your peer review journal publications with JKUAT library for consolidated archiving.

Secondly, appreciation goes to the AFRICA-*ai*-JAPAN team at JKUAT led by Prof. Hiroshi Koaze, Dr. Shohei Aoki, and Ms. Mai Toda. Their effort complements the previous work towards documenting JKUAT scientific outputs (2014-2019). It is also a reminder that the genesis of the book of **abstracts** for all peer review journal publication papers stemmed from the urge of providing evidence for the outcomes of the of the implementation of AFRICA-*ai*-JAPAN Projects. These additional publications (2019-2020) further confirm that the seed which was planted in 2018 is growing. It is this conviction which led the JICA Chief Advisor to initiate work on collection of all peer review journal publications (2019-2020) supported by Ms. Bridgid Chebet and Mr Eric Njuguna. The efforts of Eric and Chebet are appreciated deeply and they are encouraged to continue working hard.

Thirdly, appreciation goes to the team of scientists and students that helped in collection of information and formatting of this book of **abstract**. Without the efforts and dedication of this team, this book of **abstracts** would not have been realized. The team comprised of senior scientists led by Prof. Daniel Ndaka Sila, Prof. Hiroshi Koaze, Dr. Shohei Aoki and Ms. Mai Toda. This team was supported by the secretariat team comprising of Ms. Bridgid Chebet, Eric Njuguna, Erastus Kiko and Daniel Musembi.

Lastly, special thanks are given to the JKUAT Management Team for providing a favorable environment towards implementation of AFRICA-*ai*-JAPAN project. We treasure every single minute dedicated towards supporting AFRICA-*ai*-JAPAN. 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, and through your 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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1. 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 abstracts from iPIC

Year	iPIC
2019	32
2020	15
Total	47

B. Summary of abstracts from iCB

Year	iCB
2019	69
2020	55
Total	124

C. Summary of abstracts from iCMoB

Year	iCMoB
2019	12
2020	5
Total	17

D. Summary of abstracts from iCCATS

Year	iCCATS
2019	11
2020	3
Total	14

2. Compilation of Abstracts from AFRICA-ai-JAPAN Taskforce

2.1 Abstracts from iPIC Sub-Taskforce

iPIC-2019-01

Experimental investigation on performance of a compression ignition engine fueled with waste cooking oil biodiesel–diesel blend enhanced with Iron-doped Cerium Oxide nanoparticles

Meshack Hawi, Ahmed Elwardany, Mohamed Ismail and Mahmoud Ahmed, 2019. *Energies*, 12, pg.798. DOI: 10.3390/en12050798.

Abstract

The effect of iron-doped cerium oxide (FeCeO₂) nanoparticles as a fuel additive was experimentally investigated with waste cooking oil methyl ester (WCOME) in a four-stroke, single cylinder, direct injection diesel engine. The study aimed at the reduction of harmful emissions of diesel engines including oxides of nitrogen (NO_x) and soot. Two types of nanoparticles were used: cerium oxide doped with 10% iron and cerium oxide doped with 20% iron, to further investigate the influence of the doping level on the nanoparticle activity. The nanoparticles were dispersed in the tested fuels at a dosage of 90 ppm with the aid of an ultrasonic homogenizer. Tests were conducted at a constant engine speed of 2000 rpm and varying loads (from 0 to 12 N.m) with neat diesel (D100) and biodiesel–diesel blends of 30% WCOME and 70% diesel by volume (B30). The engine combustion, performance, and emission characteristics for the fuel blends with nanoparticles were compared with neat diesel as the base fuel. The test results showed improvement in the peak cylinder pressure by approximately 3.5% with addition of nanoparticles to the fuel. A reduction in NO_x emissions by up to 15.7% were recorded, while there was no noticeable change in unburned hydrocarbon (HC) emissions. Carbon monoxide (CO) emission was reduced by up to 24.6% for B30 and 15.4% for B30 with nano-additives. Better engine performance was recorded for B30 with 20% FeCeO₂ as compared to 10% FeCeO₂, in regard to cylinder pressure and emissions. The brake specific fuel consumption was lower for the fuel blend of B30 with 10% FeCeO₂ nanoparticles, in low-to-medium loads and comparable to D100 at high loads. Hence, a higher brake thermal efficiency was recorded for the blend in low-to-medium loads compared to D100.

Keywords: Waste cooking oil methyl ester; iron-doped cerium oxide nano-particles; diesel engine; combustion characteristics; emission characteristics

iPIC-2019-02

Effect of compression ratio on performance, combustion and emissions characteristics of compression ignition engine fueled with jojoba methyl ester

Meshack Hawi, Ahmed Elwardany, Shinichi Ookawara and Mahmoud Ahmed, 2019. *Renewable Energy*, 141, pp. 632 - 645. DOI: 10.1016/j.renene.2019.04.041.

Abstract

The major challenges facing the energy sector are the cost of fossil fuel and its depletion. Therefore, the current work presents an experimental investigation on the effect of different blends of jojoba methyl ester (JME) in diesel engine performance, combustion and emissions characteristics. A numerical investigation on the effect of compression ratio (CR) on using neat JME is also presented. Thermophysical properties of JME and raw jojoba oil are measured and characterized by FT-IR and GC-MS analysis. Engine performance parameters, combustion characteristics and emission characteristics are measured for single cylinder, four-stroke, direct injection diesel engine fueled with diesel and different blends of JME in diesel (5%, 10%, and 20% by volume). A comprehensive numerical setup using ANSYS FORTE code is developed and validated against new measurements. Results illustrated that by increasing CR from 18 to 23 the peak in-cylinder

pressure is increased considerably. Additionally, increasing CR leads to higher NO_x and CO, UHC concentrations for diesel and JME100. The reduction in peak in-cylinder pressure resulting from using JME100 instead of diesel could be recovered by increasing CR from 21.5 to 23. This highlights the possibility of using neat JME in compression ignition engines with less emissions and minimal losses in the output power.

Keywords: Diesel engine; compression ratio; Jojoba methyl ester; engine simulation; combustion characteristics.

iPIC-2019-03

Effect of injection pressure and ambient density on spray characteristics of diesel and biodiesel surrogate fuels

Meshack Hawi, Hidenori Kosaka, Susumu Sato, Tsuyoshi Nagasawa, Ahmed Elwardany and Mahmoud Ahmed, 2019. *Fuel*, 254, 115674. DOI: 10.1016/j.fuel.2019.115674.

Abstract

This paper presents novel experimental investigations on the influence of varying injection pressure and ambient density on evaporating sprays of diesel, tetradecane (as a diesel surrogate) and methyl oleate (as a biodiesel surrogate) fuels. Evidently, adapting high injection pressure and ambient density would remarkably enhance the atomization process, and in return improve the engine combustion, performance, and emission characteristics. Measurements were carried out in a rapid compression and expansion machine (RCEM) working under diesel engine-like conditions. Furthermore, a shadowgraph optical technique was applied, using a high-speed camera to capture the spray development at 20,000 frames per second (fps) to obtain the vapor penetration length, liquid penetration length and spray cone angle. The tested fuel was injected into a pressurized nitrogen gas in a diesel engine-like condition without combustion where the injection pressure and ambient density were varied from 50 MPa to 150 MPa, and from 15 kg/m³ to 25 kg/m³, respectively. Results indicated that injection pressure and ambient density have a significant effect on the spray characteristics. Increasing the injection pressure from 50 MPa to 150 MPa results in the increase of vapor penetration by up to 33.2%, 21.5% and 24.4% for diesel, tetradecane and methyl oleate, respectively. Besides, increasing the ambient density from 15 kg/m³ to 25 kg/m³ results in a wider spray cone angle by up to 9.6%, 11.8% and 13.8%, for diesel, tetradecane and methyl oleate, respectively and a shorter vapor penetration by up to 9.2%, 11% and 13.1%, respectively. It is noticed that high injection pressure causes the least reduction in spray cone angle for biodiesel. The present measurements are considered bench-mark for validation of high-fidelity numerical simulation of diesel and biodiesel sprays.

Keywords: Evaporating spray; diesel; tetradecane; methyl oleate; RCEM.

iPIC-2019-04

Effects of photo-generated gas bubbles on the performance of tandem photoelectrochemical reactors for hydrogen production

Francis Njoka, Shinsuke Mori, Shinichi Ookawara and Mahmoud Ahmed, 2019. *International Journal of Hydrogen Energy*, 44, pp. 10286 – 10300. DOI: 10.1016/j.ijhydene.2019.02.194.

Abstract

Presence of gas bubbles in the vicinity of semiconductor electrodes interferes with their active surface areas and introduces inert voids in the electrolyte hindering its ionic conductivity. Furthermore, gas bubbles obstruct the radiation path through scattering. The aim of this work is to study the characteristic hydrogen- and oxygen-gas bubble behaviour and their effects on photoelectrochemical reactor performance. Findings of gas bubble formation, electrode coverage and curtain profiles based on macroscopic bubble graphical images are reported. Effects of increased convective forces are also observed. Further, the scattering of incident light implemented through simulations based on Mie scattering theory is reported. Results show that hydrogen gas bubbles are more extensive in coverage due to formation of a froth while oxygen bubbles coalesce

and rise easily. The growth of the bubble cover increases ohmic resistance reducing the current magnitude. Even at a modest current density of 10 mA/cm², the curtain thickness may rise to 2 mm or 3 mm for oxygen and hydrogen, respectively. Light scattering increases with increasing bubble size and is more pronounced for shorter wavelengths. It is also found that presence of multiple bubbles reduces light intensity by up to 2% and highest when the bubble radius is 150 mm. Increase in both photoelectrode and electrolyte resistances as well as radiation losses due to presence of bubbles hence undermine the performance of photoelectrochemical reactors.

Keywords: Water splitting; bubble coverage; bubble curtain; photography; light scattering

iPIC-2019-05

Analysis and Interpretation of Magnetotelluric Data in Characterization of Geothermal Resource in Eburru Geothermal Field, Kenya.

Justus Maithya, Yasuhiro Fujimitsu, 2019. *Geothermics* 81(1) pp. 12-31.

Abstract

The magnetotelluric method (MT) is an essential geophysical method for the exploration of geothermal systems. In this study, the MT method was used to assess the extent of the geothermal resource in Eburru geothermal field, Kenya, with the aim of delineating the electrical conductivity structure of the area. Dimensionality analyses demonstrated that the MT data could be interpreted using two-dimensional approaches, but some localized 3-D effects were detected. A 2-D MT inversion was performed to generate resistivity models of Eburru geothermal field. Given its ability to recover complex resistivity models for the ground, three dimensional (3-D) MT inversion was also carried out, and a joint interpretation made from the 2-D and 3-D models. Both inversion approaches gave similar results and revealed a low resistivity layer (< 10 Ωm) interpreted as clay cap, and an intermediate resistivity beneath interpreted as a geothermal reservoir immediately below the low resistivity. The sequence here infers the presence of geological structures controlling the geothermal system. The resistivity profiles analyzed revealed a structure of low resistivity (< 10 Ωm) interpreted as the fluid pathway. This structure trend an S-N direction which is consistent with the faults orientation in the field and serves as a conducting channel for transporting heat from the heat source to the shallow region approximately 2 km above sea level.

Keywords: Eburru Geothermal field, Magnetotellurics, 2-D inversion, 3-D inversion, Resistivity

iPIC-2019-06

Development of Computer Models for Simulating the Optimum Design Parameters of a Passive Solar Heating Chicken Brooder System.

Mulindi S. A., Kanali C., Kituu G., Ondimu S. and Mutwiwa U., 2019. *International Journal of Advanced Engineering, Management and Science (IJAEMS)* 5(5) pp. 304-310
<https://dx.doi.org/10.22161/ijaems.5.5.2> ISSN: 2454-1311.

Abstract

Brooding refers to early periods of growth when chicks require supplementary heat to maintain their normal body temperature. Generally, chicks kept in environmental temperatures outside their comfort zone suffer low growth and high mortality rates. Solar energy has a regular daily and annual cycle, and is unavailable during periods of bad weather. Hence requires special storage and distribution of the energy different from the utilization of conventional energy sources. In this study computer models were developed for simulating internal brooder envelope brooding Temperatures and ammonia gas concentration in ppm. Further, analysis was carried out to determine the influence of Trombe wall thickness on the variation of hourly internal brooder temperatures for various months of the year. The Trombe wall thickness were set at 100,150, 200, 250 and 300mm and hourly temperatures simulated using Matlab computer program. The wall thickness of 100mm and 150 mm yielded maximum brooding space temperature of 36.5 and 35.3°C, respectively. The resultant brooder temperatures were above the optimal brooding temperature range of 34°C for day one and 21 to 24°C for the 28th day of brooding. However, the

lowest brooder temperatures attained for 100mm and 150mm wall thickness were 29.5 and 30.8°C, respectively. The wall thickness of 300mm yielded temperature range of 25.7 to 28°C. From this study it is deduced that the wall thickness of 100 and 150mm are suitable for development of a chicks' brooder. Though, supplementary source of heat will be required to keep the birds comfortable for the first one week of brooding period. The brooder pH was set at 10 and the ammonia concentration simulated for 28 days at brooding floor temperatures of 14.8, 18.7, 22.6 and 27.4°C. The results were that the ammonia concentration increased exponentially from day one to the 28th day of brooding for all the floor temperatures. The highest emission of ammonia was recorded at the temperature of 14.8°C for the first 15 days; but after the 15th day the temperature of 18.7°C recorded the highest emission of ammonia. Conversely, the temperature of 27.4°C yielded the lowest ammonia emission. Therefore, it is essential in the design of brooders to have provision for facilitating removal of birds' droppings to minimize emission of the ammonia gas from the floor of the brooder.

iPIC-2019-07

Modelling the Relationships between the Solar Energy, Trombe Wall Brooder System Parameters and the Brooding Characteristics of Indigenous Chicken.

Mulindi S.A., Kanali C., Kituu G., Ondimu S. and Mutwiwa U., 2019. *International Journal of Advanced Engineering, Management and Science (IJAEMS)* 5(5), pp. 311-318 <https://dx.doi.org/10.22161/ijaems.5.5.3> ISSN: 2454-1311.

Abstract

A brooder is a structure where chicken are kept for stimulating optimal growth. Smallholder poultry production in Kenya faces the challenge of appropriate energy source for brooding. The study evaluated by simulation and modelling the performance of a Trombe wall in a small-scale brooder. The brooder system under study consist of brick walls and wooden slated floor. The internal dimensions of the brooder being 2.5 x 1.2 x 1.5 m. A dynamic model was used for predicting the brooding conditions based on; ambient temperatures, total solar radiation, ventilation size, thickness and colour of the heat absorption wall. The absorption coefficient for glazed brick is 0.35, absorption factor of black colour is 0.9, and the fraction of incident radiation absorbed is 0.89. Considering a wall thickness of 0.15m, thermal conductivity of 0.8 W/m K, density of bricks -1760 kg/m³, surface thermal resistance of the wall - 0.188 m² K, thermal wall surface area of 3.75 m² and the pen capacity at 30 chicks per square metre. The experimental model of the brooder was solved using a Matlab computer program with appropriate model equations. A case study of Eldoret town was used, where mean monthly solar radiation is 540Wh/m²/day to 640Wh/m²/day and daily ambient temperature of 14.2 to 28°C. The resultant glazed brooder surface temperatures were 77 to 85°C. In view of the appropriate brooding temperatures for day old chicks being 34°C while at 28 days of age required temperature range is 21-24°C. Consequently, the Trombe wall can be used to optimally regulate brooder temperatures. Further, the design expert software was used to establish relationship within solar radiation, Trombe wall surface temperatures and the optimal brooder envelope temperatures. The analyses showed a linear relationship amongst solar radiation, Trombe wall surface temperatures and the optimal brooding temperatures. The results are appropriate data for designing a brooder for physical and physiological studies of chicks.

iPIC-2019-08

Effects of Recycled Tyre Steel Fibres on the Compressive, Splitting Tensile and Flexural Strengths of Structural Lightweight Concrete Using Palm Kernel Shells as Partial Replacement of Coarse Aggregates.

Brains Jarwolu Dorr, Christopher L. Kanali, Richard Ocharo Onchiri, 2019. *Civil and Environmental Research* www.iiste.org; ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online) DOI: 10.7176/CER; 11(6) pp. 35-41.

Abstract

The improper handling and disposal of waste tyres in many African countries is still a serious problem which has caused environmental and health hazards. Like waste tyres, the proper reuse of agricultural wastes, such as palm kernel shells, is also a challenge as the production has increased over the years. In the field of civil engineering, effort have been made to recycle waste tyres and palm kernel shells in concrete production to mitigate some of the environmental problems arising from these wastes. The recycling of such waste for civil engineering applications has been heightened with the development of new technologies. This study was carried out to evaluate and assess the effects of recycled tyre steel fibres and palm kernel shells on the compressive, splitting tensile and flexural strengths of structural lightweight concrete, using recycled tyre steel fibres for reinforcement and palm kernel shells as partial replacement of coarse aggregates. Recycled tyres steel fibres were added in normal-weight concrete at 0.25, 0.50 and 0.75% (viz., 6, 12 and 18 kg/m³) content and aspect ratio of 20, 40, 60, 80 and 100% to determine the optimal fibres content and aspect ratio. The results show that recycled tyres steel fibres obtained from pyrolysis can improve the compressive and splitting strengths of normal-weight concrete. The optimal fibres content and aspect ratio were used with palm kernel shells at 25, 50, and 75% content to determine the optimal partial replacement of coarse aggregates with palm kernel shells. The maximum compressive and splitting tensile strengths values were obtained at an aspect ratio of 80, palm kernel shell content of 25% and steel content of 0.50%. Normal-weight concrete strength values in flexure were higher than lightweight concrete made with optimal values. Additionally, beams with 25 and 50% content of palm kernel shells with optimal fibre content and aspect ratios qualified as structural lightweight concrete.

iPIC-2019-09

Investigating the Shear Performance of Lightweight Concrete Beams Reinforced with Recycled Tyres Steel Fibres.

Brains Jarwolu Dorr, Christopher L. Kanali, Richard Ocharo Onchiri, 2019. *International Journal of Engineering Research and Technology*. ISSN 0974-3154, 12(10) pp. 1818-1823. <http://www.irphouse.com>

Abstract

This study investigated the shear performance of lightweight concrete beams reinforced with recycled tyre steel fibres. Two simply-supported beams, subjected to a monotonically increased, concentrated loading were tested to failure. Recycled tyres steel fibres of aspect ratio 80 and content of 0.50% (viz., 12 kg/m³ per concrete volume) were incorporated, while palm kernel shells were used in volume content of 25% as partial coarse aggregates replacement in the beam other than the control. The results demonstrated that lightweight concrete beams reinforced with recycled tyres steel fibres using palm kernel shells as partial replacement of coarse aggregates has a better load-carrying capacity, minimum deflection at ultimate load and higher shear capacity than the control beam.

iPIC-2019-10

Engineering Properties of Polyethylene Terephthalate Fibre Reinforced Concrete with Fly Ash as a Partial Cement Replacement.

Rebecca Belay Kassa1, Christopher Kanali, Nathaniel Ambassah, 2019. *Civil and Environmental Research*, 11(6) pp. 25-34. ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online) DOI: 10.7176/CER

Abstract

Although concrete has good qualities that make it suitable for a wide range of applications in the construction industry, it also has undesirable properties; one of which is its low tensile strength. Numerous studies are being carried out to improve the undesirable features of concrete by using substitute materials such as industrial, manufacturing, agricultural as well as domestic wastes. In

Africa, there is a pressing need for reusing and recycling waste materials. Following the extensive use of concrete in the vast construction industry, the incorporation of wastes like Polyethylene Terephthalate (PET) bottles and fly ash to improve its quality is a sensible intervention. PET bottles, used for packaging of beverages, and fly ash, generated during the combustion of coal, are causing severe environmental degradation. This study evaluated the effects of using PET fibres and fly ash on the performance of concrete. PET fibres with an aspect ratio of 50 (100mm length and 2mm width) were incorporated in the concrete mix at percentages of 0.5, 1.0 and 1.5% by weight of cement. On the other hand, fly ash was introduced as a cement replacement at percentages of 20, 22.5, 25, 27.5 and 30% by weight of cement. The performance of the modified concrete was evaluated based on workability, compressive strength, and splitting tensile strength. The combination of 1.5% PET fibres and 27.5% fly ash resulted in 33.45% tensile strength improvements, while keeping the workability and compressive strength unaffected.

iPIC-2019-11

Flexural Performance Evaluation of Polyethylene Terephthalate Fibre Reinforced Concrete with Fly Ash as a Partial Cement Replacement.

Rebecca Belay Kassa, Christopher Kanali, Nathaniel Ambassah, 2019. *International Journal of Engineering Research and Technology*, 12(9) pp. 1435-1440. <http://www.irphouse.com>.

Abstract

Waste disposal is becoming both economically and environmentally daunting in most African countries. Plastic wastes like Polyethylene Terephthalate (PET) bottles and powdered wastes like fly ash degrade the environment at an alarming rate. Using PET bottles and fly ash to improve concrete quality is a move in the right direction as it helps deal with the environmental issue and concurrently contributes to the construction industry's improvement. This paper is an outcome of a study that assessed the effects of using PET fibres and fly ash (as a partial cement replacement) on the structural performance of concrete. PET fibres with an aspect ratio of 50 (100mm length and 2mm width) were incorporated in the concrete mix at a percentage of 1.5% and fly ash at 27.5% by weight of cement. The flexural tests result show that the ductility and load carrying capacity at failure improved by 27.3 and 44.16%, respectively. There was delay in appearance of cracks and energy absorption increased by 60.55%. Flexural capacity also increased by 43.91% for the modified concrete mix as compared to the control. These results indicate that PET and fly ash wastes can effectively be utilized for the improvement of flexural performance of concrete in the construction industry.

iPIC-2019-12

Environmental and Cost Advantages of Using Polyethylene Terephthalate Fibre Reinforced Concrete with Fly Ash as a Partial Cement Replacement.

Rebecca Belay Kassa, Christopher Kanali, Nathaniel Ambassah, 2019. *Open Journal of Civil Engineering*, 9, pp. 281-290, <https://www.scirp.org/journal/ojce>, ISSN Online: 2164-3172, ISSN Print: 2164-3164.

Abstract

Solid waste disposal is an alarming problem in most African countries. Plastic wastes like Polyethylene Terephthalate (PET) bottles and powdered wastes like fly ash are severely persisting environmental hazards. They are brutally polluting the water bodies, landfills, as well as the atmosphere. The construction industry has been working towards improving concrete quality by developing alternative methods like partial cement replacement with different pozzolanic elements as well as using waste fibrous materials. Fly ash and PET bottle fibres are two common waste materials that can be used. This article is a part of a research that studied the combined effects of the addition of PET bottle fibres and fly ash (as a partial cement replacement) on the structural performance of concrete. From a purely engineering point of view, the research results indicate that the utilization and incorporation of PET and fly ash wastes in the construction industry are a

viable solution to make concrete quality better. This article presents, beyond the engineering properties and experimental works, the economic and environmental advantages of the addition of these waste materials to the conventional concrete mixture. The addition of PET bottle fibres and fly ash resulted in positive cost implications providing a production cost reduction of 19% over the conventional concrete mixture. The removal of these materials from the environment also showed reduction of the emission of toxic elements to landfills and water bodies that put human, animal and plant lives in danger.

iPIC-2019-13

Power Transformer Fault Severity Estimation Based on Dissolved Gas Analysis and Energy of Fault Formation Technique

Edwell T. Muharakurwa, G. N. Nyakoe and A. O. Akumu, 2019. *Journal of Electrical and Computer Engineering*, DOI: <https://doi.org/10.1155/2019/9674054>.

Abstract

Decision making on transformer insulation condition based on the evaluated incipient faults and aging stresses has been the norm for many asset managers. Despite being the extensively applied methodology in power transformer incipient fault detection, solely dissolved gas analysis (DGA) techniques cannot quantify the detected fault severity. Fault severity is the core property in transformer maintenance rankings. This paper presents a fuzzy logic methodology in determining transformer faults and severity through use of energy of fault formation of the evolved gasses during transformer faulting event. Additionally, the energy of fault formation is a temperature-dependent factor for all the associated evolved gases. Instead of using the energy-weighted DGA, the calculated total energy of related incipient fault is used for severity determination. Severity of faults detected by fuzzy logic-based key gas method is evaluated through the use of collected data from several in-service and faulty transformers. DGA results of oil samples drawn from transformers of different specifications and age are used to validate the model. Model results show that correctly detecting fault type and its severity determination based on total energy released during faults can enhance decision making in prioritizing maintenance of faulty transformers.

iPIC-2019-14

Design and Development of a Monolithic Gripper with Flexure Joints for Handling Kiwifruit

Ngonidzaishe N. Mrewa, Ahmed M. R. Fath El-Bab and George N. Nyakoe, 2019. *International Journal of Mechanical & Mechatronics Engineering IJMME-IJENS* 19(4), 109-121.

Abstract

This paper presents a robotic gripper design which relies on flexural joints rather than prismatic and revolute joints to ensure gripping action. The designed flexure-based gripper exhibits large displacement that fall within the millimetre scale range. With large displacements, the gripper is used to handle kiwifruit and at the same time determine its softness for sorting purposes. Flexural joint grippers with kiwifruit-size range of displacement are currently non-existent in the industry. Flexural joint mechanism is based on the intrinsic compliance of a material to achieve structural elastic deformation to achieve displacement. The gripper is monolithic in nature to properly accommodate flexure joints and also any further works in microelectronics process integration. The monolithic model exhibits more lumped compliancy displacement than distributed compliancy. The feasibility of the design is examined through a series of numerical analysis and simulations on COMSOL platform. Crucial design standards factored in are low fabrication and material costs, parallel gripping motion of fingers, large finger displacement, low joint stress concentrations and low output forces. A prototype is realised through subtractive fabrication of the prototype. Through a series of experiments the maximum range of motion for the gripper is found to be 20mm, half of which is contributed by each finger. Another set of experiments were done to investigate whether the gripper can accurately affirm the softness of the manipulated kiwifruits.

The flexural gripper was able to successfully grasp and manipulate kiwifruit, at the same time determining fruit softness.

Keywords: flexure joints, large displacement, softness detection, monolithic gripper.

iPIC-2019-15

Evolutionary PSO based optimal sizing and placement of solar PV distributed generation for voltage and power efficiency enhancement

Roy Orange, Christopher Maina M. and George N. Nyakoe, 2019. *International Journal of Electrical Engineering*, 12(1), pp. 45-59.

Abstract

The solar photovoltaic continues to be one of the most exploited renewable energy resource globally. It is being utilized both on small scale and large scale applications. In the recent times grid tied solar PV is gaining popularity. Integration of solar power to the main grid can either bring positive or negative impacts depending on how they are sized and where they are located. This paper looks at finding the optimal size and location of solar PV which is a type 1 distributed generation using evolutionary particle swarm optimization (EPSO) technique. The IEEE 30 bus system is utilized with the objective of reducing power loss as well as improve voltage profile. This methodology and its associated results was compared with other algorithms applied by other authors' results and the superiority of this methodology is evident.

iPIC-2019-16

Ranking of Line Contingency for Voltage Stability Assessment

Teshome G. Tella, Stanley S. Sitati and George N. Nyakoe, 2019. *Journal of Engineering Science and Technology*, 14(5), pp. 2601 – 2620.

Abstract

Excessive reactive power loading results in bus voltage instability and outage of power transmission lines, which leads to instability of the entire power network. For stable operation, finding the stability margin of buses and lines by identifying and ranking unstable lines under contingency is needed. The aim of contingency ranking is to recommend the stability improvement mechanisms for a secure and stable power network operation. This paper introduces a new line stability index that is used to rank lines to identify unstable lines based on the severity of load contingency. In addition, another new technique called Aggregated-Variance Stability Index (AVSI) in combination with adaptive neuro-fuzzy inference system is used to rank the lines based on the severity of line outage contingency due to excessive reactive power loading. Further, to account for the effect of inductive load on bus voltage and power transmission line stability, only load reactive power is increased up to its maximum stability limit. The line stability index is then determined using Newton Raphson power flow solution and lines are ranked based on the severity of bus loading. In this study, N-1 line contingency is used to examine the effect of increased bus loading on line stability and lines are then ranked based on the severity of line outage. The effectiveness of the new stability indices is evaluated against conventional line stability indices based on IEEE-14 bus standard system. Results show that the proposed AVSI-ANFIS performs better in ranking line contingency compared to AVSI.

Keywords: Aggregated-variance, ANFIS, Critical bus ranking, Line stability index, Stability index.

iPIC-2019-17

Power Transformer Hot Spot Temperatures Estimation based on Multi-attributes

Edwell T. Muharakurwa, George N. Nyakoe and A. O. Akumu, 2019. *International Journal of Applied Engineering Research*, 14(7) pp. 1584-1592.

Abstract

Operational thermal stresses due to dynamic loading and changing environmental conditions enhance the weakening of the power transformer insulation system. During the operation of power transformers, insulation hot spot temperature is a critical parameter that needs to be held under recommended threshold. This is because, amid other factors, cumulative effect of insulation aging depends on time change of hot spot temperatures. In this paper, a multi-parameter based thermal model established upon a thermal-electric circuit scheme to estimate transformer hot spot temperatures is proposed. The model includes the effects of solar irradiation, varying ambient temperatures, dynamic loading and the nonlinear thermal resistance of oil-paper insulation. Moisture effect is considered in estimating the thermal resistance of cellulose, whilst in calculation of oil insulation nonlinear thermal resistance, a universal thermal model is proposed which uses some transformer design-dependent variables and considers different heat transfer modes inside a transformer. The multi-parameter model is validated using data collected from in-service mineral oil immersed transformers. Simulated results of the proposed thermal model are in agreement with the onsite measured values with good model accuracy.

Keywords: dynamic loading, hot spot temperatures, thermal resistance, thermal stress.

iPIC-2019-18

Fuse-Fuse Protection Scheme ETAP Model for IEEE 13 Node Radial Test Distribution Feeder

Kemei Peter Kirui, David K. Murage, and Peter K. Kihato, 2019. *European Journal of Engineering Research and Science (EJERS)*, 4(9), 224-234.

Abstract

According to NEC 240.101 regulations each and every component of a power system distribution network has to have an over-current protective device (OCPD) for its protection. The OCPDs must coordinate with other devices both upstream and downstream for a reliable operation and protection of the power systems distribution network. There are four equipment/components for the IEEE 13 node radial test feeder each modelled in this paper to be protected by fuses. These components are namely the nodes, the underground cables, the overhead distribution lines and the transformers. Equipment protection is an important and necessary exercise of performing power systems protection coordination processes. The equipment and their over-current protective device's time-current characteristic (TCC) curves are important tools used to show and to indicate the protection requirements, landmark points and damage curves for all power systems equipment. Individual equipment protection requirements and limitations are described and identified by use of their various landmarks and damage curves. These damage curves and the landmark points are all superimposed with the Time-Current Characteristic curves of the Over-Current Protective Devices used in protecting the equipment on one composite TCC graph. Equipment damage curves which fall to the right and above the Over-Current Protective Device's TCC curves with sufficient margins are considered to be protected by the OCPDs. Equipment damage curves which fall to the left and below the OCPD's TCC curves are considered not to be protected by the OCPDs. IEEE Standard 241 states that on all power systems, the OCPDs should be selected and set to open before the Ampacity mark, the short circuit damage curves, and both the thermal and the mechanical damage curves limits of the protected components are exceeded. This paper presents a detailed Fuse-Fuse protection scheme for the IEEE 13 node radial test feeder as modeled on the Electrical Transients Analysis Program (ETAP).
Index Terms—Transformer Magnetizing In-rush Points, Transformer Thermal Damage Curves, Transformer Mechanical Damage Curves, Transformer Full Load Ampere Mark, Conductor Intermediate Thermal Overload Limit Curves, Conductor Short Circuit Damage Curves, Fuse TCC Curves, Equipment TCC Curves.

Keywords: Transformer Magnetizing In-rush Points, Transformer Thermal Damage Curves, Transformer Mechanical Damage Curves, Transformer Full Load Ampere Mark, Conductor

Intermediate Thermal Overload Limit Curves, Conductor Short Circuit Damage Curves, Fuse TCC Curves, Equipment TCC Curves.

iPIC-2019-19

Impacts of Placement of Wind Turbine Generators with Different Interfacing Technologies on Radial Distribution Feeder Fuse-Fuse Protection Coordination Scheme.

Kimei Peter Kirui, David Murage and Peter K. Kihato, 2019. *Engineering Journal of Engineering Research and Science (EJERS)*, 4(10), 59-77.

Abstract

The ever increasing demand on the electrical energy has led to the diversification on the electrical energy generation technologies especially from the renewable energy sources like the wind and the solar PV. Micro-grids powered by distributed generators utilizing renewable energy sources are on the increase across the globe due to the natural abundance of the resources, the favorable government policies and the resources being environmentally friendly. However, since the electrical power distribution networks have always been passive networks, the connection of the distributed generations (DGs) into the network has associated several technical implications with distribution network protection and Over-Current Protective Devices (OCPDs) miss-coordination being one of the major issues. The need for a detailed assessment of the impacts of the wind turbine generation (WTGs) on the distribution networks operations has become critical. The penetration of the WTGs into a distribution network has great impacts on the short circuit current levels of the distribution network hence eventually affecting the OCPDs coordination time margins. The factors which contribute to these impacts are: The size of the WTG penetrating the distribution network, the location at which the WTG is connected on to the network and the Type of the WTG interfacing technology used. An important aspect of the WTGs impacts studies is to evaluate their short circuit current contribution into the distribution network under different fault conditions. The magnitudes of these short circuit currents, both the three phase and the single-line-to-ground (SLG) faults, are needed for sizing the various Over-Current Protective Devices (OCPDs) utilized in protecting the distribution network. The sizing of the OCPDs entails among other procedures coordinating them with both the upstream and the downstream OCPDs so that there is sufficient time margin between their Time Current Characteristic (TCC) curves. For Fuse-Fuse protection coordination, the ANSI/NEC rules stipulate that a minimum of 0.025seconds or more time margin should be maintained between the primary/downstream fuse and the secondary/upstream/back-up fuse. Due to the topological and operational differences between the different types of WTGs interfacing technologies, the electrical generators design industry has divided wind turbine generators into four different types labeled as Type I, Type II, Type III and Type IV. This paper presents a detailed study of the impacts brought upon by integrating wind turbine generators on a conventional Fuse-Fuse protection coordination scheme. A conventional Fuse-Fuse protection coordination scheme was modeled in Electrical Transients Analysis Program (ETAP) software and WTG with different interfacing technologies connected. A study of the impacts brought by the integration of the WTGs on Fuse-Fuse Miss-coordination was performed. IEEE 13 Node Radial Distribution Test Feeder was used for the study.

Keywords: Fuse Protection Coordination, Coordination Time Margins, SLG Faults, Three Phase (3Phase) Faults

iPIC-2019-20

On the Use of Machine Learning for Temporal Performance Prediction in Lte Advanced Networks

Maureen N. Mureithi, Peter K. Kihato and Agnes Mindila, 2019. *International Journal of Scientific and Technology research* 8(10).

Abstract

Performance prediction is an indispensable topic to any mobile network operator. It allows the operators to be aware of future network scenarios and take actions before they occur. This paper explores various machine learning approaches to predict performance. Real world data is mined and analyzed to identify the geospatial distribution of samples and their temporal relationships. Time series techniques based on general additive model, auto-regressive model and deep learning are evaluated. Long-term short-term deep learning model was used, and it performed better compared to the others giving results that are adequate for most planning and optimization tasks. Index Terms: deep learning, Machine Learning, Neural networks, Reference Signal Received Power (RSRP), Reference Signal Received Quality (RSRQ), signal-to-interference-plus-noise ratio (SINR), time series.

Keywords: Deep learning, Machine Learning, Neural networks, Reference Signal Receive Power (RSRP), Reference Signal Received Quality (RSRQ), signal-to-interference-plus-noise ratio (SINR), and time series.

iPIC-2019-21

Mobile Subscriber Mobility Analytics and Prediction in Wireless Networks Using Machine Learning Techniques

Oscar L. Mwale, Peter K. Kihato, and Agnes Mindila, 2019. *International Journal of Scientific & Technology Research* 8(11).

Abstract

In radio network planning user mobility is an important factor that can reveal the user's needs and hence allows the proactive adaptation of services. By predicting mobility of subscribers, the network can do proactive resource management and take prior precautionary measures when need arises. This paper presents a machine learning prediction algorithm that be used in capturing some of the mobility patterns exhibited by the users moving in a wireless environment and can then predict the future locations of these users. To identify the important locations of the target user from his/her trajectory the data is analyzed to find out insights in terms of movement of the subscribers and mobile data used. An unsupervised clustering technique using Density-based spatial clustering of applications with noise (DBSCAN) is performed to extract various clusters for different locations. Finally, to predict the location of the subscribers into the clusters/locations above several supervised machine learning classifier models are proposed with Random forest showing the best results. When tested on real data, the model achieved 94% of the future locations' prediction accurately. In a future work, future locations predicted will be used to proactively and dynamically allocate mobile resources to the subscribers.

Keywords: Density Based Clustering, Data Mining, Location prediction, Logistic Regression, Machine Learning, Naïve Bayes, Random Forest, Support Vector Machines, Trajectory.

iPIC-2019-22

Eagle View Camp. Landscape Performance Series.

Karanja, D., and Nthiwa, C.W., 2019. *Landscape Architecture Foundation*. <https://doi.org/10.31353/cs1521>

Abstract

The LPS Case Study Briefs are produced by the Landscape Architecture Foundation (LAF), working in conjunction with designers and/or academic research teams to assess performance and document each project. The project assessed economic, environmental and social benefits accruing from retrofitting and operation of Mara Naboisho Eagle View Camp from a conventional safari camp to an eco-friendly eco-tourism destination.

Keywords: Landscape performance, metrics, benefits.

iPIC-2019-23

Personal Computer-Based Control and Monitoring System for Biodiesel Algae Photobioreactor

Ondimu Stephen, Raude James Messo and Wanjala Geodfrey, 2019. *Journal of Engineering in Agriculture and the Environment* 5 (1), pp. 31-40, ISSN: 1562-6946

Abstract

Growing of Algae for biodiesel production has gained popularity in recent times. This is because biodiesel from algae has an economic advantage over other oil crops. The oil content that can be extracted from microalgae biomass depends on the culture conditions and microalgae species. This means that besides selecting the best microalgae species, it is also necessary to ensure and maintain the best culture conditions for optimal biodiesel production. Optimum algae growth conditions can be best be provided by a Controlled Environment Bioproduction System (CEBS) for the algae called as photobioreactor (PBR). This paper reports design and fabrication of a PC based control system for a PBR production system for algae being developed at the School of Biosystems and Environmental Engineering (SoBEE) in Jomo Kenyatta University of Agriculture and Technology (JKUAT) in Kenya. The control system is intended to ensure that optimum PH, temperature, nutrients content; light intensity/duration and salinity of growth medium for algae are maintained. The paper covers the design and fabrication of the PC control and monitoring system. The control and monitoring system consists of a computer program and a microcontroller connected to sensors and actuators. The computer program (master) provides the graphical user interface (GUI) consisting of control buttons and means for real time data logging and analysis as well as real-time simulation of PBR activities. It is available in executable file that can be run in any windows OS computer. The microcontroller program (slave) provides the means for connecting sensors and is used to measure as well as monitor the conditions in the PBR tanks. Communication between the computer program and the microcontroller is achieved through the universal serial bus (USB). The control system consists of both open and closed loop systems. The open loop system is used to control the light duration at predetermined intervals of time. The closed loop system is used to control the nutrient concentration, light intensity, PH and oxygen: carbon dioxide ratio.

Keywords: Control and Monitoring system, Graphical User Interface, Microcontroller, Microalgae, Photo-Bioreactor, Response time

iPIC-2019-24

Optimization Model for Recirculating Aquaculture Systems (RASs) for Nile Tilapia in Kenya

Daniel M. Wambua, Patrick G. Home, James M. Raude, and Stephen Ondimu, 2019. *Journal of Sustainable Research in Engineering* 5(2), pp.78-90 ISSN (Online): 2409-1243

Abstract

Simulation in aquaculture necessitates dynamic modeling that provides a deeper insight into the aquaculture performance. The development towards the use of simulation models in aquaculture has been witnessed in the last few years. Most of the simulation models originate from ecological modeling and applies to through-flow systems. On the other hand, studies on Recirculating Aquaculture Systems (RAS) which consider wastewater treatment, use basic steady-state models of the treatment processes, where the efficiency is set to either a fixed percentage removal or a fixed removal rate. For a farmer, the major target is to improve the efficiency and predictability of intensive aquaculture operations. These improvements are subject to accurate quantification of metabolic rates of the fish coupled with the relationships between water quality and fish growth. Moreover, improvements and refinement of water reuse technologies are inevitable towards the improvement of intensive aquaculture systems. Computer models are effective tools for analyzing water treatment units and fish metabolic response effects on overall system performance. This study aimed at developing a RAS simulation and optimization model to help in predicting water

quality and cost optimization of recirculating aquaculture systems. A general standard model development procedure was used in the development of the RAS model. Matrix Laboratory (MATLAB) programming language was used to accomplish the model development task. The data collected on energy consumption, running costs, biofilter efficiency, and flow rates through the connection pipes were used to calibrate and validate the model. From the model evaluation, the Nash-Sutcliffe Efficiency (NSE) values for ammonia, pH, Dissolved Oxygen (DO), Electrical conductivity (EC) and Energy were, -4.26, 0.97, 0.77, 0.59 and 0.94 respectively. Similarly, the coefficient of determination (R²) for ammonia, pH, Dissolved Oxygen (DO), Electrical conductivity (EC) and Energy were, 0.96, 0.89, 0.23, 0.87 and 0.85 respectively. The model also showed that low stocking densities (2.3 kg/m³ to 5.0 kg/m³) led to longer payback periods as compared to higher stocking densities (7.0 kg/m³ to 10.0 kg/m³). The model gave a good prediction for most water quality parameters. On profit optimization, most of the good cost scenarios did not coincide with the best water quality conditions. More sub-models to the models to be added to capture aspects of different water treatment and other fish species other than Nile Tilapia.

Keywords: Model, Optimization, RAS, Simulation, Water quality

iPIC-2019-25

Sediment distribution and accumulation in Lake Naivasha, Kenya over the past 50 years

Caroline W. Maina, Joseph K. Sang, James M. Raude, Benedict M. Mutua and Daniel N. Moriasi, 2019. *Lakes & Reserv.*, 24, pp.162–172; DOI: 10.1111/lre.12272

Abstract

Although surface waterbodies are water sources for socio-economic activities and ecosystems, their functions are threatened by sedimentation. Sedimentation of lakes and reservoirs can result in a loss of storage capacity and altered water quality. The present study assessed the sedimentation status of Lake Naivasha, Kenya, based on sediment distribution and accumulation over the past 50 years, using a Bathymetric Survey System (BSS). The BSS uses multi-frequency Acoustic Profiling System (APS) to map recently deposited sediments. Sediment core samples were collected with a vibro-coring device and dated. Sediment layers corresponding to a period of the past 20 and 50 years were identified. Sediment cores and acoustic images were subsequently used to determine sediment thickness within the lake. The collected depth data from multi-frequency APS, and dated cores were processed in DepthPic and Surfer software. The sediment depth was extracted in DepthPic, while the sediment volume and distribution were generated from Surfer software. The results from present study indicated that sediment distribution varied from one part of the lake to another for the past 20 and 50 years. High sediment thickness observed in the south-west and eastern parts of the lake. Between 1996–2016 and 1966–2016 periods, the maximum accumulated sediment thickness was found to be about 0.55 and 1.9 m, with an average sediment thickness of 0.25 and 0.56 m, respectively. The mean sediment load corresponding to the 1966–1996 and 1996–2016 periods was 2.78×10^5 and 4.61×10^5 t/year, respectively. It was found that sediment load into Lake Naivasha has been increasing in the recent past. Based on the present study, it was found that combined use of BSS, sediment cores and dating can be adopted in many lakes and reservoirs to determine sediment thicknesses even where no prior bathymetric surveys exist for comparison.

Keywords: bathymetric survey system, Lake Naivasha, multi-frequency acoustic profiling system, sediment, sediment load

iPIC-2019-26

Geochronological and spatial distribution of heavy metal contamination in sediment from Lake Naivasha, Kenya

Caroline W. Maina, Joseph K. Sang, James M. Raude, Benedict M. Mutua and Daniel N. Moriasi W., 2019. *Lakes & Reservoirs*: <https://doi.org/10.1080/16878507.2019.1593718>

Abstract

Sediment cores hold large information on the history of human interactions with lakes and surrounding environments. Hence, this study investigated the geochronological and heavy metals characteristics of sediment from Lake Naivasha, Kenya. Geochronological characteristics were established from sediment cores, using ^{210}Pb and ^{137}Cs . On the other hand, heavy metals; Al, As, Cr, Cu, Fe, Mn, Ni, Pb, and Zn were analyzed using Inductively Coupled Plasma - Optical Emission Spectrometer (ICP – OES). Their probable sources were predicted using Pearson's correlation and Principal Component Analysis (PCA) while heavy metal contamination levels were assessed using geoaccumulation Index (Igeo), Contamination Factor (CF) and Enrichment Factor (EF) pollution indices. Results showed that the cores were about 140 years old with an estimated average mass sedimentation rate of $0.32 \text{ g/cm}^2/\text{yr}$. Vertical fluctuations of heavy metal contamination were observed along the sediment cores with high values recorded near the surface. Further, PCA and pollution indices showed that Al, Cr, Cu, Ni, and Pb were from natural sources while, Zn, Mn, Fe, and As, (in order of contamination levels), were both from natural and anthropogenic sources. Therefore, this study showed the geochronological trends of sedimentation and impacts of human activities on Lake Naivasha.

Keywords: Sediment, Lake Naivasha, heavy metals, geochronology, mass sedimentation rate, pollution indices (Igeo, CF and EF)

iPIC-2019-27

The Storage and Water Quality Characteristics of Rungiri Quarry Reservoir in Kiambu, Kenya, as a Potential Source of Urban Water

Winfred Kilonzo, Patrick Home, Joseph Sang, and Beatrice Kakoi, 2019. *Hydrology*, 6(4), pg. 93. <https://doi.org/10.3390/hydrology6040093>

Abstract

Urbanization has caused limitations on water resources, while climate change has reduced amounts of surface water in some parts of the world. Kikuyu, a suburban area in Kiambu County, Kenya, is facing this challenge. The major challenge in the study is scarcity of potable water, resulting in inadequate water supply to Kikuyu residents. Currently, only 63.6% of the population is being supplied with water by Kikuyu Water Company, the company mandated to supply water to the area. Water demand was $2972 \text{ m}^3/\text{day}$ in 2015 and was projected to be $3834 \text{ m}^3/\text{day}$ by 2025. This has put pressure on the already exploited clean water resources, making it necessary to seek additional sources of domestic water. Storage capacity and water quality of surface water bodies, especially small reservoirs whose water can be used to ease the demand, need to be assessed for supplemental water supply. This study aimed at assessing the suitability of the abandoned quarry reservoir as a source of potable urban water by determining its storage capacity characteristics and water quality status. Volume characteristics were determined using bathymetry survey in January 2019. Water samples were collected in January and August 2019 and analyzed for chemical, physical, and bacteriological quality, as per the American Public Health Association (APHA) standard methods for water and wastewater. Parameters were evaluated based on World Health Organization (WHO) and Kenya Bureau of Standards (KEBS) guidelines for drinking water, and rated based on the drinking water quality index (WQI). The reservoir's maximum storage capacity was found to be $128,385 \text{ m}^3$, the surface area was $17,699 \text{ m}^2$, and the maximum depth was 15.11 m. Nineteen of the twenty-five investigated parameters were within the acceptable standards. However, the concentrations of manganese (Mn), cadmium (Cd), iron (Fe), turbidity, total coliforms, and *Escherichia coli* (*E. coli*) were above the acceptable limits. Manganese and iron levels increased with depth. The overall WQI of the reservoir was 82.51 and 85.85 in January and August, respectively. Therefore, based on WQI rating, the water scored a good quality rating and could be used for domestic supply upon treatment. The original achievement of this study is

establishment of the volume of the water in the quarry as an additional source of water to the nearby community, along with water quality status.

Keywords: bathymetry survey; depth–volume–area characteristics; water quality; quarry reservoir

iPIC-2019-28

Projecting Wet Season Rainfall Extremes Using Regional Climate Models Ensemble and the Advanced Delta Change Model: Impact on the Streamflow Peaks in Mkurumudzi Catchment, Kenya

Wendso Awa Agathe Ouédraogo, John Mwangi Gathenya and James Messo Raude, 2019. *Hydrology*, 6(3), pg. 76; <https://doi.org/10.3390/hydrology6030076>

Abstract

Each year, many African countries experience natural hazards such as floods and, because of their low adaptative capabilities, they hardly have the means to face the consequences, and therefore suffer huge economic losses. Extreme rainfall plays a key role in the occurrence of these hazards. Therefore, climate projection studies should focus more on extremes in order to provide a wider range of future scenarios of extremes which can aid policy decision making in African societies. Some researchers have attempted to analyze climate extremes through indices reflecting extremes in climate variables such as rainfall. However, it is difficult to assess impacts on streamflow based on these indices alone, as most hydrological models require daily data as inputs. Others have analyzed climate projections through general circulation models (GCMs) but have found their resolution too coarse for regional studies. Dynamic downscaling using regional climate models (RCMs) seem to address the limitation of GCMs, although RCMs might still lack accuracy due to the fact that they also contain biases that need to be eliminated. Given these limitations, the current study combined both dynamic and statistical downscaling methods to correct biases and improve the reproduction of high extremes by the models. This study's aim was to analyze extreme high flows under the projection of extreme wet rainfall for the horizon of 2041 of a Kenyan South Coast catchment. The advanced delta change (ADC) method was applied on observed data (1982–2005), control (1982–2005) and near future (2018–2041) from an ensemble mean of multiple regional climate models (RCMs). The created future daily rainfall time series was introduced in the HEC-HMS (Hydrologic Engineering Center's Hydrologic Modeling System) hydrological model and the generated future flow were compared to the baseline flow at the gaging station 3KD06, where the observed flow was available. The findings suggested that in the study area, the RCMs, bias corrected by the ADC method, projected an increase in rainfall wet extremes in the first rainy season of the year MAMJ (March–April–May–June) and a decrease in the second rainy season OND (October–November–December). The changes in rainfall extremes, induced a similar change pattern in streamflow extremes at the gaging station 3KD06, meaning that an increase/decrease in rainfall extremes generated an increase/decrease in the streamflow extremes. Due to lack of long-term good quality data, the researchers decided to perform a frequency analysis for up to a 50 year return period in order to assess the changes induced by the ADC method. After getting a longer data series, further analysis could be done to forecast the maximum flow to up to 1000 years, which could serve as design flow for different infrastructure.

Keywords: extreme wet rainfall; peak flows; regional climate models; advanced delta change

iPIC-2019-29

Analysis of Land Use Change and Its Impact on the Hydrology of Kakia and Esamburmbur Sub-Watersheds of Narok County, Kenya

Nzitonda Marie Mireille, Hosea M. Mwangi, John K. Mwangi and John Mwangi Gathenya, 2019. *Hydrology*, 6(4), pg. 86; <https://doi.org/10.3390/hydrology6040086>

Abstract

Narok town is one of the places in Kenya which experience catastrophic floods. Many lives have been lost and valuable property destroyed in recent years. Change in land use/land cover upstream

of the town area may have contributed significantly to the severity and frequency of flooding events. Runoff, which contributes to floods in Narok town, comes from Kakia and Esamburmbur sub-catchments of Enkare Narok watershed. The objective of this study was to assess the impact of land use/land cover change on the hydrology of Kakia and Esamburmbur sub-watersheds. To detect land use/land cover change, Landsat satellite images from 1985 to 2019 were used. Using supervised classification in Erdas Imagine 2014, land use of the study area was classified into four classes, i.e., forest, rangeland, agriculture and built-up areas. Five land use maps (1985, 1995, 2000, 2010, and 2019) were developed and used to perform land use change analysis. There was rampant conversion of forest to other land uses. Between 1985 and 2019, the forest and rangeland declined by 40.3% and 25.6% of the study area, respectively, while agriculture and built-up areas increased by 55.2% and 10.6% of the study area respectively. Analysis of soil hydrological properties indicate that the infiltration rate and soil hydraulic conductivity were greatest in forest than in other land use types. The basic infiltration rate in forest land was 89.1 cm/h while in rangeland and agricultural land, it was 7.9 cm/h and 15 cm/h respectively. At the top-soil layer, average soil hydraulic conductivity under forest was 46.3 cm/h, under rangeland, 2.6 cm/h and under agriculture, 4.9 cm/h. The low hydraulic conductivity in rangeland and agriculture was attributed to compaction by farm machinery (tractors) and livestock respectively. An interesting observation was made in rangelands where the top layer (0–20 cm) had a higher bulk density and a lower hydraulic conductivity as compared to the next deeper layer (20–40 cm). This was attributed to the combined impact of compaction and localised pressure by hooves of livestock which only have an impact on the top layer. The findings of this study show that land use has a major impact on soil hydrological properties and imply that the observed land use changes negatively affected the soil hydrological properties of the watershed. The decreased infiltration in the increasing areas of degraded land (mainly agriculture and rangeland) and increase in built-up area in Narok town are the possible causes of the increased flood risk in Narok town. It is recommended that flood risk management strategies in Narok town include watershed management to enhance water infiltration

Keywords: land use/cover change; soil hydrological properties; watershed; flood management

iPIC-2019-30

The Temporal Variability of Rainfall and Streamflow into Lake Nakuru, Kenya, Assessed Using SWAT and Hydrometeorological Indices

Alice Nyawira Kimaru, John Mwangi Gathenya and Charles K. Cheruiyot, 2019. *Hydrology*, 6(4), pg. 88; <https://doi.org/10.3390/hydrology6040088>

Abstract

Temporal variability analysis of rainfall and river discharges is useful in determining the likelihood of the occurrence of extreme events such as drought or flooding for the purposes of developing policies to mitigate their effects. This study investigated the temporal variability of rainfall and discharges into Lake Nakuru, Kenya using meteorological drought indicators and hydrological drought indicators from 1981 to 2018. The standardized precipitation index (SPI) and standardized precipitation evaporation index (SPEI) were used to characterize meteorological drought, while the streamflow drought index (SDI) was used to characterize hydrological drought. A SWAT model was applied for the prediction of streamflow on five tributaries of Lake Nakuru (Njoro, Ngosur, Nderit, Larmudiac, and Makalia Rivers). The model was successfully calibrated on Njoro River at the upstream of river gauging station 2FCO5 from 1984 to 1996, and the parameters were validated from 1997 to 2007. The SUFI-2 algorithm was applied in SWATCup to perform the calibration of the model. The model performance was considered satisfactory in daily time step (NSE = 0.58, R² = 0.58 during calibration and NSE = 0.52, R² = 0.68 during validation). The average annual water balance revealed that out of 823 mm received annual precipitation, 154 mm was surface runoff and 178 mm was the annual average water yield. The average annual actual evapotranspiration (ET) was 607 mm. The results for the temporal variation of the SPI and SDI for the five subcatchments indicated that the drought events identified by the 12-month SPI/SPEI

were almost all identified by the 12-month SDI. At the catchment scale, SPI showed an equal distribution of wet and dry periods, with 50.00% of positive anomalies and 50.00% of negative anomalies being observed from 1981 to 2018, while SDI observes a high frequency of dry periods (52.63%) and a lower frequency of wet periods (47.37%). There is a higher frequency of wet periods compared to dry periods for both indices from 2009 to 2010 at 60.00% and 40.00% for SPI and 90.00% and 10.00% for SDI, respectively. Both indices observed that 1984 and 2000 were severely dry years (SPI/SPEI < -2.00), while 2018 was severely wet (SPI/SPEI > 2.00). The results for the variability in rainfall and streamflow indices revealed that the last 10 years (2009–2018) were wetter than the period from 1981 to 2008.

Keywords: variability; standardized precipitation index; standardized precipitation evaporation index; streamflow drought index; calibration; validation; model performance

iPIC-2019-31

Geospatial delineation and mapping of groundwater potential in Embu County, Kenya

Mary Christine Chepchumba, James Messo Raude and Joseph Sang, 2019. *Acque Sotteranee - Italian Journal of Groundwater*: AS29-369: 39 – 51; DOI: 10.7343/as-2019-369

Abstract

Integration of Remote Sensing (RS) and the Geographical Information System (GIS) approaches in the field of groundwater resources management is a breakthrough. The RS and GIS geospatial approaches can enhance the assessment, monitoring, and conservation of groundwater resources. In this study, RS and GIS geospatial techniques were applied with the aim of identifying groundwater potential zones in Embu County, Kenya, based on selected multi influencing factors. Lineament layer was obtained by processing Landsat 8 ETM+ image using Principal Component Analysis in ENVI@4.7 and automatic extraction from Principal Component Image using the LINE module in Geomatica software. The resultant groundwater potential map showed that approximately 78% of the total area ranged from 'high' to 'very high' zones indicating that almost half of the study area has good groundwater potential. About 20% showed moderate potential while only 2% fell under the low potential zone. The proposed study approach can be used as a new way of modeling geospatial data for identification and mapping of groundwater potential zones. The study findings are useful to first-hand information planners and local authorities for assessment, planning, management and administration of groundwater resources in Embu County.

Keywords: groundwater exploration, Principal Component Analysis, lineament extraction, remote sensing, geographic information system.

iPIC-2019-32

Assessment of Water Flow and Sedimentation Processes in Irrigation Schemes for Decision-Support Tool Development: A Case Review for the Chókwe Irrigation Scheme, Mozambique

Lateiro Salvador de Sousa, Raphael Muli Wambua, James Messo Raude and Benedict Mwavu Mutua, 2019. *AgriEngineering*, 1(1), 100-118; <https://doi.org/10.3390/agriengineering1010008>

Abstract

Kajiado County is an arid and semi-arid area in Kenya that experiences frequent flash floods. Most of the water evaporates due to the high temperatures experienced in the area. However, to attain reasonable crop yield the soil moisture can be conserved for longer provision to the plants. The objective of this research was to assess the best technique in retaining the soil moisture content of a spate-irrigated sorghum field in Ewaso Nyiro South Drainage Basin. The conservation techniques used were Chloris gayana grass-mulch, ridges and ridge-furrow mulch. The techniques were then compared to the control which was the traditional way of growing sorghum in the area. The experiment was set-up in a Randomized Complete Block Design (RCBD) of three blocks of 10m by 10m. The blocks were further subdivided into four equal plots of 5m by 5m. The effect of the treatments on moisture retention was monitored using YL-69 sensors installed at depths 20 cm and 40 cm respectively for 125 days. At the 20-cm depth, there was no significant difference in

terms of moisture retention from the different treatments. However, at the 40-cm depth, mulch treatment had the highest moisture retention value of 31.69%. This was closely followed by the combined ridges and mulch, ridges and control which had means of 31.61%, 31.59% and 30.39% respectively. These findings are important as they can be used by agriculturalists, farmers and relevant stakeholders in prioritizing soil moisture conservation techniques for increased crop production.

Keywords: Mulch, ridges, ridge-furrow mulch, soil moisture, spate irrigation, YL-69 moisture sensors

iPIC-2020-01

Analysis of gravity data to delineate structural features controlling the Eburru geothermal system in Kenya.

Justus Maithya, Yasuhiro Fujimitsu and Jun Nishijima, 2020. *Geothermics* 85, pp. 1-14.

Abstract

The gravity modeling of the Eburru was conducted in an attempt to delineate geological structures controlling the geothermal system and estimate the geothermal reservoir extent. A total of 375 data points were used and a Bouguer density of 2.27 g/cm³ to generate a complete Bouguer anomaly map of the area. Gravity data were separated into regional and residual components to enhance the structural features from the sedimentary and basement rocks in the study area. The gravity data were analyzed using gradient interpretation techniques for edge detection, such as horizontal derivative and an improved normalized horizontal tilt angle. For carrying out the three-dimensional (3-D) modeling, a volume of 12 × 13 km and 5 km deep was selected. The model was constrained using the estimated densities of cuttings obtained from the drilled wells. This study presents the interpretation results of various gravity anomaly maps and 3-D inversion model. Interpretation of horizontal derivative and improved normalized horizontal tilt angle of gravity data indicate the existence of high gradient anomalies. The anomaly maps were used to identify several faults that compared well with the mapped faults. The 3-D model revealed a high dense body interpreted as the geothermal reservoir with a volume of about 3.0 km³ and an average block density value of 2.45 g/cm³. Beneath this body is a less dense body likely to be caused by magmatic fluid components arising from deeper sources responsible for heating the reservoir. There appears to be a close relationship between the faults system and the geothermal reservoir. These faults serve as fluid pathways from deeper parts to shallow regions. The results obtained from this study will lead to an improved understanding of the geothermal system in the study area and aid the future geothermal exploration of the field.

Keywords: Eburru Geothermal field, Gravity data, Bouguer anomaly, Gravity derivative, 3-D Inversion.

iPIC-2020-02

Prevalence of Musculoskeletal Disorders among Nurses in Kenya: Part 1, Anthropometric Data and MSDS.

Joseph T. Mailutha, Juliet Mugga, Christopher L. Kanali, 2020. *International Journal of Emerging Technology and Advanced Engineering*. Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, 10(4), pp. 158-163.

Abstract

The nursing profession is a very demanding physical work and ranked among the top occupations with the highest rate of musculoskeletal disorders (MSDs). The work involves excessive manual handling of patients in awkward postures. The objectives of the study were to assess the prevalence and magnitude of musculoskeletal disorders among Kenyan nurses, and the contributory anthropometric factors. A self-administered questionnaire was used to gather information from 314 randomly selected nurses working at the hospital, which is Kenya's largest hospital. Two hundred and forty-four questionnaires were completed translating to 78% response rate.

Information on the nurses' anthropometric data and work experience were collected and analysed to establish prevalence of musculoskeletal risk factors. The study established that the prevalence of reported incidences of MSDs among the nurses was 74.2%. The most vulnerable parts of the body were found to be the back, feet and shoulders, revealing a rate of 32.5, 21.5 and 20.4%, respectively. Further, the study found out that age in the female nurses was significant in the etiology of MSDs but independent among their male counterparts.

iPIC-2020-03

Effectiveness of an evaporative charcoal cooler for the postharvest preservation of tomatoes and kales.

Ronoh E.K., Kanali C.L., Ndirangu S.N., 2020. *Research in Agricultural Engineering*, 66, pp. 66-71.

Abstract

The preservation of fresh produce can provide rural households with better diets all-year round and income by reducing their deterioration. Promotion of low-cost temporary storage technologies requires evidence of their effectiveness to attain conducive conditions. Therefore, this study was conducted to assess the effectiveness of an evaporative charcoal cooler for the preservation of tomatoes and kales. The cooler microclimate and outdoor conditions were investigated by measuring the air temperature and relative humidity. During the study period, the maximum temperature difference between the cooler and the outdoors was found to be 9.2 °C while the maximum relative humidity difference was 36.8%. Due to the presence of light rain and, consequently, low solar radiation, the temperature and relative humidity differences were significantly reduced. Despite the light rain, the cooler still registered a maximum relative humidity of 83.5% and a maximum cooling efficiency of 91.5%. Overall, the cooler demonstrated promising results in terms of favourable microclimate conditions, the shelf-life and colour changes for tomatoes and kales.

iPIC-2020-04

Behaviour of Reinforced Concrete Beams using Wire Rope as Internal Shear Reinforcement.

Gerald M. Colyvas, Yann Malecot, Yannick Sieffert, Sylvester Aboudha, Christopher Kanali, 2020. *Engineering, Technology & Applied Science Research* 10(4), pp. 5940-5946.

Abstract

Wire ropes as internal shear reinforcements could be an economic alternative to conventional stirrups in rectangular concrete beams, mainly due to their attractive advantages such as high flexibility, light weight, and strength. The aim of this study is to enhance the understanding of the shear behaviour of concrete beams with continuous spiral-type wire rope as internal shear reinforcement. In order to achieve this objective, an experimental program involving the testing of six beam specimens under four-point load was conducted. Digital image correlation technique was employed to study the crack formation and propagation in the beam specimens. The test results demonstrated that using continuous spiral-type wire rope as shear reinforcement is highly favourable for diagonal crack control. In particular, spiral-type wire rope specimens attained serviceability crack width at a higher load than that of normal stirrup beam specimens.

iPIC-2020-05

Noise-induced Hearing Loss in Workshops and Laboratories in Kenyan Universities.

Daniel Omondi Onyango, Robert Kinyua, Abel Nyakundi Mayaka, Christopher Kanali, 2020. *Journal of Environment Pollution and Human Health*, 8(2) pp. 79-87; Available online at <http://pubs.sciepub.com/jephh/8/2/5>; DOI: 10.12691/jephh-8-2-5

Abstract

Noise-induced hearing loss in workplaces is a challenge, which may lead to accidents and interference with communication. In order to protect workers and students exposed in engineering

workshops and laboratories, it is important to determine the magnitude and understand causative factors to adequately address the problem. The present study aimed at identifying predisposing factors that lead to noise-induced hearing loss in public universities in Kenya. The study was conducted in 10 technical universities, identified through purposive non-probability quarter sampling from a population of 49. Noise profiling was used to identify and characterize sources and types. An integrating sound level meter was used to record the noise levels for the different clusters and results compared with statutory requirements. Existing controls for noise pollution were also assessed. The results show that a large proportion (84.1%) of the noise types identified was continuous. The continuous noise emanated mainly from hand grinding (18%) and internal combustions engines (25%) with resultant values being above the statutory upper action limit of 85 dBA. The sources of impulsive noise were mainly intermittent actions of electric-powered (47.6%) and manually-operated (52.4%) tools. Impulsive noise levels were found to be below the maximum permissible exposure limit of 140 dBA. Although one of the universities had a safety and health committee and a risk management department, hearing protection was not used by those exposed. Noise-induced hearing loss in workshops and laboratories in public universities in Kenya is likely to occur from continuous noise exposure since there are inadequate control measures taken

iPIC-2020-06

Performance Evaluation and Economic Feasibility of a Solar-Biomass Hybrid Greenhouse Dryer for Drying Banana Slices.

F.G. Kiburi, C.L. Kanali, G.M. Kituu, P.O. Ajwang and E.K. Ronoh, 2020. *Renewable Energy Focus*, 34; pp. 60-68.

Abstract

A greenhouse dryer consisting of drying chamber, drying trays, biomass unit and heat exchanger was used in this study. Three energy modes were considered namely solar, biomass and solar-biomass. The dryer performance was evaluated based on drying air properties, drying rates, energy efficiency, energy utilization and exergy efficiency. During drying, the temperature difference between inside and outside was found to be 12.96 ± 5.25 , 8.88 ± 1.38 and 13.21 ± 6.21 °C for solar, biomass and solar-biomass modes, respectively. This had a corresponding relative humidity difference of 8.76 ± 8.28 , 24.26 ± 8.83 and 27.51 ± 10.24 %, respectively. The mean drying rates were found to be 0.28 ± 0.04 , 0.21 ± 0.03 and 0.23 ± 0.06 g/gdm/hour for solar, biomass and solar-biomass modes, respectively. The results showed significant difference between means of the drying rates of banana slices for the three energy modes. Further analysis showed insignificant difference between drying rates of solar and solar-biomass as well as biomass and solar-biomass. Energy efficiency and exergy efficiency for solar mode were found to be lower than that of biomass and solar-biomass modes. In addition, average energy utilization ratio in the greenhouse dryer was noted as 35.58 ± 24.78 , 40.60 ± 10.52 and 33.46 ± 13.45 % for solar, biomass and solar-biomass modes, respectively.

iPIC-2020-07

Islanded microgrid congestion control by load prioritization and shedding using ABC algorithm.

L. O. Mogaka, G. N. Nyakoe and M. J. Saulo, 2020. *International Journal of Electrical & Computer Engineering*, 10(5). DOI: 10.11591/ijece.v10i5.pp4552-4561.

Abstract

The continued growth in load demand and the gradual change of generation sources to smaller distributed plants utilizing renewable energy sources (RESs), which supply power intermittently, is likely to strain existing power systems and cause congestion. Congestion management still remains a challenging issue in open access transmission and distribution systems. Conventionally, this is achieved by load shedding and generator rescheduling. In this study, the control of the system congestion on an islanded micro grid (MG) supplied by RESs is analyzed using artificial

bee colony (ABC) algorithm. Different buses are assigned priority indices which forms the basis of the determination of which loads and what amount of load to shed at any particular time during islanding mode operation. This is to ensure as minimal load as possible is shed during a contingency that leads to loss of mains and ensure a congestion free microgrid operation. This is tested and verified on a modified IEEE 30-bus distribution systems on MATLAB platform. The results are compared with other algorithms to prove the applicability of this approach. islanded micro grid (MG) supplied by RESs is analyzed using artificial bee colony (ABC) algorithm. Different buses are assigned priority indices which forms the basis of the determination of which loads and what amount of load to shed at any particular time during islanding mode operation. This is to ensure as minimal load as possible is shed during a contingency that leads to loss of mains and ensure a congestion free microgrid operation. This is tested and verified on a modified IEEE 30-bus distribution systems on MATLAB platform. The results are compared with other algorithms to prove the applicability of this approach.

iPIC-2020-08

Power Prioritization and Load Shedding in an Island with RESs Using ABC Algorithm.

L. O. Mogaka, G. N. Nyakoe and M. J. Saulo, 2020. *Journal of Engineering*. DOI: <https://doi.org/10.1155/2020/8131952>.

Abstract

The main aim of a power utility company is to supply quality and uninterrupted power to customers. This becomes a growing challenge as the continued increase in population calls for proportional increase in power supply to additional loads. If not well planned, this steady increase in power demand can lead to voltage collapse and eventual power blackouts. In instances where power demand exceeds generation within islanded microgrid or due to an occurrence of a contingency, optimum load shedding should be put in place so as to enhance system security and stability of the power system. Load shedding is traditionally done based on under voltage measurements or under frequency measurements of a given section of the grid. However, when compared with conventional methods, metaheuristic algorithms perform better in accurate determination of optimal amount of load to be shed during a contingency or undersupply situations. In this study, an islanded microgrid with high penetration of Renewable Energy Sources (RESs) is analyzed, and then Artificial Bee Colony (ABC) algorithm is applied for optimal load shedding. The results are then compared with those of Genetic Algorithm (GA), Particle Swarm Optimization (PSO), and GA-PSO hybrid. Both generation and overload contingencies are considered on a standard IEEE 30-bus system on a MATLAB platform. Different buses are assigned priority indices which forms the basis of the determination of which loads and what amount of load to shed at any particular time. There was no statistical difference between the exergy efficiency of drying air for the three energy modes used. The payback period of the dryer was found to be <1 year which is lower than expected life of the dryer (4 years).

iPIC-2020-09

Residents' Attitudes towards the Built Environment in Historic Parklands in Nairobi, Kenya.

Njiiri W, Mugwima B, Karanja D., 2020. *Current Urban Studies*, 8(2). DOI: [10.4236/cus.2020.82007](https://doi.org/10.4236/cus.2020.82007).

Abstract

Contemporary attitudes shaping urban areas are not always sympathetic to the historic character of built heritage, meaning heritage contexts are subject to loss of scale, visual quality and associated values. This study sought to identify attitudes associated with this built heritage in order to establish community values necessary for the urban conservation of Historic Parklands in Nairobi. The Cultural Worldview (CV) scale was used to assess attitudinal preferences for the built environment among 302 respondents who were asked to rate 32 statement items on a 7-degree Likert scale designed for responses. Statements with shared variances were grouped together under

factor analysis and the degree of variability within shared variances distilled 3 attitudinal preference dimensions. From the rated attitudinal statements, the identified preference dimensions included the following; One, cultural heritage loss which scored a high mean of 5.29 perceived as the disappearance of architectural, historic and aesthetic values. Two, cultural heritage recognition which scored a mean of 4.79 confirming that heritage assets were acknowledged as important legible site markers. Three, cultural heritage linkage which scored a mean of 4.34 supported by the perceived associational, cultural and social values. This study recommends three action points. First, a heritage monitoring database that assigns the priorities of preservation, rehabilitation and adaptive-reuse to mitigate cultural heritage loss. Second, buffer zones to classify and protect recognized built heritage from unplanned urban growth process. Third, a heritage walk to foster the interactions between residents, visitors and the host place in order to reinforce the interpretation qualities of built heritage responsible for enhancing history, community values and collective identity.

Keywords: Cultural Heritage, Attitudes, Values, Urban Conservation

iPIC-2020-10

Mainstreaming secondary schools' physical environment in to enhance learning outcomes: case of secondary schools in Nairobi County, Kenya.

Aloyo, P, Mwaniki, S, Mireri C, Kamau P & Karanja D., 2020. *International Journal of Current Research* 12(6), pp. 12045-12052, DOI: <https://doi.org/10.24941/ijcr.38875.06.2020>.

Abstract

Globally, stakeholders in learning institutions have strived to improve schools' physical environments in an attempt to enhance learning outcomes. It is not known whether the physical environment in public secondary schools in Nairobi County have been mainstreamed to positively influence learning outcomes. The objective of the study was to explore the quality of the physical environment in public secondary schools in Nairobi City County, Kenya The study applied a case study design. A sample size of 39 was proportionally allocated by gender and geopolitical location resulting in 9 boys', 12 girls' and 18 mixed schools. A revised Commonwealth Association of Physical Environment questionnaire was used to collect data. The overall average quality of mixed schools' index (126) was lower than that of boys' and girls' schools (134 for both). A framework of funding improvement of school facilities including the building stock and associated infrastructure is proposed.

Keywords: Physical Environment, Learning Outcomes.

iPIC-2020-11

Walkable Streets: A Study of Pedestrians' Perception, and Attitude towards Ngei Street in Machakos Town.

Kinyingi, J, Mugwima, N, Karanja, D., 2020. *Current Urban Studies*, 8, pp. 381-395 <https://www.scirp.org/journal/cus> ISSN Online: 2328-4919 ISSN Print: 2328-4900 DOI: 10.4236/cus.2020.83021.

Abstract

Street walkability is an indication of the suitability of the built environment to walking. Walkability of any street will increase when safe, comfortable and accessible infrastructure is provided for pedestrians. Urban designs influence how an individual perceives the built environment, including the desirability of walking and all other physical activities involved. Three street factors (accessibility, congestion and cleanliness) along a 900 meters long central segment of Ngei Street in Machakos Town were directly measured by use of standardized questionnaires. The number of pedestrians in the segment was estimated using Fischer's formula and 96 of them were sampled using judgmental technique. Majority (51%) of pedestrians who responded to the questionnaire indicated that the street was wide enough and accessible while 12%, 15%, 3% and 17% strongly agreed, disagreed, neutral and agreed respectively. In addition, the results revealed

that densities of movement increase with increased width of the walkways. With little consideration of pedestrians and other road users' this has led to high congestion in Ngei Street which was affirmed by 47% of the majority respondents. Lastly, 56% of the respondent confirmed that the Ngei Street (understudy) was well maintained and clean. This study recommends improvement and addition of non-continuous pedestrian walkways, designation of pedestrian crossing across all street segments to ease traffic management and reduce vehicle congestion in addition to periodic walkways maintenance and regular pavement cleaning.

Keywords: Street Walkability, Built Environment, Pedestrian, Desirability, Cleanliness and Maintenance

iPIC-2020-12

Current Status of Modeling High-Enthalpy Arcjet Flows

Bernard O. Owiti, Takeharu Sakai, Kazuhiko Yamada, Toshiyuki Suzuki and Kazuhisa Fujita, 2020. *Trans. JSASS Aerospace Tech. Japan*, 18(4) pp. 133-139. DOI 10.2322/tastj.18.133.

Abstract

The prediction accuracy of arcjet flow using a computer code named ARCFLO3+ is examined by comparing the arc heater operational characteristic data, pitot pressure and cold-wall heat flux data obtained from a segmented constrictor-type arc-heated wind tunnel at JAXA. Results are mainly presented to discuss how the discrepancy between the calculated and measured arc heater operational characteristic data obtained impact the core of the arcjet flow in the test section. Results show that the present computational approach gives a conservative estimation of the arcjet flow core properties within the test section when the mass-averaged enthalpy value obtained through the arc heater is replicated.

Keywords: Arc-heated Wind Tunnel, Numerical Simulation, Pitot Pressure, Cold-wall Heat Flux, Enthalpy.

iPIC-2020-13

Radiative Transfer in a Low-Density Ablative Material under Arcjet Flow Conditions

Bernard O. Owiti, Takeharu Sakai and Yuichi Ishida, 2020. *Journal of Thermo-physics and Heat Transfer*, 34(1) pp. 181-192. <https://doi.org/10.2514/1.T5746>

Abstract

Highly porous carbon-based materials, referred to as 120, 150, and 270 kg/m³ materials hereafter, are heated in nitrogen arcjet conditions; and their respective thermal responses are analyzed both experimentally and numerically. Experiments are conducted in a 1 MW constrictor-type arcjet wind tunnel. A coupling method is used to account for the heating processes between the arcjet flow and material thermal responses. Modeling of radiative transfer in each of the test materials is done using effective radiative conductivity and evaluated using their respective optical radiative extinction coefficients. These extinction coefficients are evaluated from ray tracing calculations using X-ray computed tomography models for each material. A comparison of the results suggests that acceptable agreement between calculated and measured in-depth temperature distributions is possible with the inclusion of radiative heat transfer in the calculations.

iPIC-2020-14

Roof-Harvested Rainwater Use in Household Agriculture: Contributions to the Sustainable Development Goals

Caleb Christian Amos, Aatur Rahman, John Mwangi Gathenya, Eran Friedler, Fazlul Karim and Andre Renzaho, 2020. *Water*, 12, 332; DOI: 10.3390/W12020332.

Abstract

Food and water are at the heart of sustainable development. Roof-harvested rainwater kept in rainwater storage systems (RSS) and used in household agriculture (HA) has the potential to increase yields and supplement household nutrition. Combined systems may contribute to at least

eight of the United Nations' 17 Sustainable Development Goals (SDGs). In this paper, a daily analysis tool, ERain, is used to assess what area of vegetables can be reliably irrigated by roof-harvested rainwater. A socio-economic context is built around an orphanage in the semi-humid region of Nakuru, Kenya. Comparisons are made with the semi-arid region of East Pokot. A 225 kL closed masonry tank and a 1 ML open reservoir with an additional 8 kL/day of recycled water entering are analysed for various roof sizes. The 225 kL RSS connected to 1000 m² of roof and irrigating 1000 m² could increase yields from 1850 to 4200 kg/year in Nakuru. If evaporation was controlled, the 1mL RSS and recycled water system could support 4000 m² of land, yielding nearly 20,000 kg/year, which is enough to meet the WHO recommended vegetable dietary requirements of the orphanage. A combination of crops, some for consumption and some for sale, could be grown.

Keywords: sustainable development goals; rainwater harvesting; rainwater storage systems; agricultural water use from harvested rainwater; household agriculture; urban agriculture; village; Kenya

iPIC-2020-15

Effectiveness of Moisture Conservation Techniques in Sorghum Production under Spate Irrigation: A Case Study of Ewaso Nyiro South Drainage Basin

Celestine Kilongosi, James Messo Raude, Raphael Muli Wambua, Maimbo Malesu and Alex Oduor, 2020. *Water*, 12, 332; DOI: 10.3390/W12020332.

Abstract

Food and water are at the heart of sustainable development. Roof-harvested rainwater kept in rainwater storage systems (RSS) and used in household agriculture (HA) has the potential to increase yields and supplement household nutrition. Combined systems may contribute to at least eight of the United Nations' 17 Sustainable Development Goals (SDGs). In this paper, a daily analysis tool, ERain, is used to assess what area of vegetables can be reliably irrigated by roof-harvested rainwater. A socio-economic context is built around an orphanage in the semi-humid region of Nakuru, Kenya. Comparisons are made with the semi-arid region of East Pokot. A 225 kL closed masonry tank and a 1 ML open reservoir with an additional 8 kL/day of recycled water entering are analysed for various roof sizes. The 225 kL RSS connected to 1000 m² of roof and irrigating 1000 m² could increase yields from 1850 to 4200 kg/year in Nakuru. If evaporation was controlled, the 1mL RSS and recycled water system could support 4000 m² of land, yielding nearly 20,000 kg/year, which is enough to meet the WHO recommended vegetable dietary requirements of the orphanage. A combination of crops, some for consumption and some for sale, could be grown.

Keywords: sustainable development goals; rainwater harvesting; rainwater storage systems; agricultural water use from harvested rainwater; household agriculture; urban agriculture; village; Kenya

2.2 Abstracts from iCB Sub-Taskforce

iCB-2019-01

Farmers' Knowledge and Practices in the Management of Insect Pests of Leafy Amaranth in Kenya.

Esther L Nampeera, Gail R Nonnecke, Sue L Blodgett, Sharon M Tusiime, Dorothy M Masinde, John M Wesonga, Lucy K Murungi, Joseph J Baidu-Forson, Mary O Abukutsa-Onyango, 2019. *Journal of Integrated Pest Management*, 10(1) pg. 31, <https://doi.org/10.1093/jipm/pmz029>

Abstract

Amaranth (*Amaranthus* L.) species are grown for their grain or leaves and contribute to farmers' livelihoods and nutritional food security. Leafy amaranth (LA) is consumed widely as a vegetable

in Kenya. An assessment of current farmers' knowledge of pest management practices provides information about future educational needs. Six-hundred LA farmers were interviewed, focus group discussions with farmers, and interviews with key informants were completed in four Kenyan counties. The majority (71%) of survey respondents grew LA on less than 0.25 acre (<0.1 ha) and 59.2% were female. Constraints of LA production differed by counties surveyed. Farmers indicated insects and birds were important in Kiambu and Kisumu counties, whereas in Vihiga and Kisii, capital, markets, and land area for production were important. Farmers stated and ranked importance of the insects they observed during LA production. Eighty-seven percent stated aphids (Hemiptera: Aphididae), as a major pest and 96.8% ranked aphids as the number-one insect pest of LA in all four counties. Two other pests of LA included cotton leafworm, *Spodoptera littoralis* (Lepidoptera: Noctuidae) (0.8%) and spider mites, *Tetranychus* spp (Trombidiformes; Tetranychidae) (0.7%). Forty-two percent of all LA farmers managed aphids, with 34% using synthetic insecticides and 8% using nonsynthetic methods. Biological controls and host-plant resistance were not mentioned. Educational programs that train farmers about integrated pest management (IPM) in LA production are needed. Future research should determine successful IPM strategies for aphids on LA to reduce insecticide use and improve sustainability and nutritional food security for small-landholder farmers and consumers.

Keywords: farmer knowledge, *Amaranthus* spp., aphid, pesticide, integrated pest management

iCB-2019-02

The effect of different processing methods on nutrient and isoflavone content of soymilk obtained from six varieties of soybean grown in Rwanda

Marguerite Niyibituronsa, Arnold Nola Onyango, Svetlana Gaidashova, Samuel Imathi, Mathilde Uwizerwa, Emelda Phillis Ochieng, Fredrick Ng'ang'a, Josephine Birungi, Sita Ghimire, Jagger Harvey, 2019. *Food Science and Nutrition*, 7(2), pp. 457-464

Abstract

Soymilk is rich in nutrients and isoflavones, and could greatly promote nutrition and health. However, this product is not widely accepted due to an objectionable beany flavor. Several methods involving heat treatment and soaking in basic solutions prior to soymilk extraction have been reported to reduce the objectionable flavor. However, the effects of such treatments on the nutritional value and isoflavone content of soymilk, and the responses of different soybean varieties to nutrient extraction by these methods is not well studied. The aim of this study was to determine the effect of three processing methods on protein, fat, minerals, and isoflavone content in soymilk from six soybean varieties grown in Rwanda (Peka-6, SB 24, Sc. Sequel, Sc. Squire, and a local variety) to find the best variety and processing method. The first method (M1) involved soaking soybeans in water for 12 hr prior to milk extraction, M2 involved blanching in NaHCO₃ prior to extraction and M3 involved soaking in NaHCO₃ solution for 16 hr and subsequent cooking prior to extraction. M1 resulted in significantly higher nutrient and isoflavone extraction than M2 and M3. Thus, M1 extracted more nutrients and can be recommended for soymilk production. However, where consumers prefer soymilk obtained by M2 or M3, Sc Squire and the local variety may be recommended. Sc. Squire has another advantage of higher isoflavone content than the other varieties. Further comprehensive studies on the sensory acceptability of products made from different varieties by different methods among different consumer categories will be necessary.

Keywords: *Glycine max* (L.) Merrill; chemical composition; fat; minerals; protein.

iCB-2019-03

Chemical composition of the seed and 'milk' of three common bean (*Phaseolus vulgaris* L) varieties

Calvince Anino, Arnold N. Onyango, Samuel Imathi, Julius Maina, Faith Onyangore, 2019. *Journal of Food Measurement and Characterization*, 13 pp. 1242-1249

Abstract

Beans are a good source of nutrients and a variety of phytochemicals such as flavonoids, tannins and phytates. On the one hand, these non-nutrient phytochemicals reduce nutrient bio availability, but on the other hand they have some health benefits including reducing the risks for aging-related diseases. This study investigated the content of nutrients and non-nutrient phytochemicals in three varieties of common beans, namely red haricot, pinto and yellow kidney beans, and their corresponding milk extracts. Carbohydrates were the most abundant nutrient in the beans (63–66%), followed by proteins (21–24%), crude fiber (5–7%), crude ash (4–5%), and crude fat (2–3%). The beans were also rich in non-nutrient phytochemicals. The protein, carbohydrate and fat contents of the milk (18–26%, 63–67%, and 3–4%, respectively) did not differ much from the beans. Unlike the beans, the milk lacked crude fiber, and had greatly reduced ash (2%) and phytochemicals. Consistent with the reduction in ash, there was a reduction in minerals; calcium, iron, zinc and magnesium in the milk. The reduction in minerals was less than the reduction of phytates, indicating that the milk may have higher bioavailability of minerals than the beans. The milk also had higher protein digestibility. Thus, consumption of bean milk may be encouraged as an alternative way of bean consumption, especially by individuals whose greater needs are for nutrients rather than phytochemicals. The bean varieties had significant differences in the retention of nutrients and phytochemicals, and such differences should be considered during bean milk production.

Keywords: Vegetable milk; Nutrients; Phytochemicals

iCB-2019-04

Effect of Lactic Acid Bacteria Starter Cultures on Vitamin and Oligosaccharide Composition of Milk Extracted from Three Common Bean (*Phaseolus Vulgaris L*) Varieties

Calvince Anino, Arnold Onyango, Samuel Imathiu, Julius Maina, 2019. *Journal of Food Research* 201, 8, pp. 103-110, doi:10.5539/jfr.v8n3p103

Abstract

Fermented foods have in recent times attracted consumer interest mainly due to perceived health benefits of probiotic microorganisms. This study characterized changes in the concentrations of selected B-complex vitamins and oligosaccharides of common bean milk during fermentation by a common dairy starter culture, YFL-903 (*Streptococcus thermophilus* + *Lactobacillus Bulgaricus* subs *Debulgaricus*), and three probiotic cultures namely ABT (*Lactobacillus acidophilus* La-5 + *Bifido-bacterium animalis* Bb-12 + *Streptococcus thermophilus*), Yoba (*Lactobacillus rhamnosus* yoba + *Streptococcus thermophilus*), and Yoba Fiti (*Lactobacillus rhamnosus* GR1 + *Streptococcus thermophilus*). Bean milk was prepared from three common bean varieties. It was found that, apart from thiamine (vitamin B1) and riboflavin (vitamin B2), fermentation with each of the mixed cultures caused significant increase in the vitamin B complex. Significant reductions ($p < 0.05$) in the oligosaccharides concentration of the bean milks were observed upon fermentation. Highest reduction in the oligosaccharide sugars of 77.8% was found in milk from pinto bean variety fermented with ABT culture. These findings suggest that LAB probiotic cultures have a potential for improving biosynthesis of vitamins and removal of the verbascose, stachyose and raffinose oligosaccharides, thus making the product more digestible and the nutrients more bioavailable.

Keywords: common bean, bean milk, fermentation, vitamin biosynthesis

iCB-2019-05

The growth of different probiotic microorganisms in soymilk from different soybean varieties and their effects on antioxidant activity and oligosaccharide content

Marguerite Niyibituronasa, Arnold Onyango, Svetlana Gaidashova, Samuel Imathiu, Marthe De Boevre, Diederik Leenknecht, Ellen Neyrinck, Sarah De Saeger, Pieter Vermeir, Katleen Raes, 2019. *Journal of Food Research*, 8, pp. 41-51

Abstract

Soymilk is a good source of proteins and health-promoting isoflavones, but it contains oligosaccharides that cause flatulence. Fermenting it with probiotic bacteria may reduce the oligosaccharides and enhance its health benefits. The present study determined the growth of different lactic acid bacteria (LAB) in soymilk obtained from soybean varieties grown in Rwanda and the effect of fermentation on oligosaccharides that cause flatulence (stachyose, raffinose and verbascose), and antioxidant activity of fermented soybean milk. After fermentation at 30°C for 24 hours, *Lactobacillus plantarum*, *Lactobacillus acidophilus*, *Lactobacillus brevis*, *Lactobacillus reuteri*, *Lactobacillus rhamnosus*, *Lactococcus cremoris* and *Lactobacillus casei* attained around 8 log CFU/ml, which is sufficient for probiotic effects. However, only *L. reuteri*, *L. brevis* and *L. plantarum* caused sufficient drop in pH and increase in viscosity characteristic of a good fermented product. Soymilk from different soybean varieties did not show significant differences in the growth of these three LAB. These LAB reduced content of oligosaccharides and total polyphenols, but increased antioxidant activity in soymilk, which translate into health benefits of fermented soybean products.

Keywords: fermentation, lactic acid bacteria, polyphenols, raffinose

iCB-2019-06

The relationship between patient characteristics and glycemic control (HbA1c) in type 2 diabetes patients attending Thika level five hospital, Kenya

Thuita AW, Kiage BN, Onyango AN and AO Makokha, 2019. *African Journal of Food Agriculture & Nutrition Development*, 19(4): 115041-15059 DOI: 10.18697/ajfand.87.18420

Abstract

Type 2 Diabetes Mellitus is a metabolic disorder characterized by hyperglycemia due to relative insulin secretion deficiency and insulin resistance. It is a global public health concern with increasing prevalence each year. Social demographic, lifestyle and metabolic characteristic, play a crucial role in development and progression of Type 2 diabetes mellitus. Poor glycemic control worsens the condition, leading to complications that are very costly to treat. This calls for a need to explore the relationship between patient characteristics and glycemic control (HbA1c). One hundred and fifty-three (153) participants with Type 2 diabetes mellitus aged 20-79 years and attending the Thika Level Five Hospital were enrolled in the study. Sociodemographic, clinical and lifestyle data were obtained using questionnaires. The nutrition status was determined by anthropometry. Lipid profile that included total cholesterol, (TC); high density lipoprotein-cholesterol, (HDL-c); low density lipoprotein cholesterol, (LDL-c) and triglyceride, (TG,) were determined by enzymatic method while glycated hemoglobin (HbA1c) and fasting blood sugar (FBS) were determined using high-performance liquid chromatography (HPLC) and glucose oxidase methods, respectively. Blood pressure of the patients was also determined. Overall sample size was 153 (40.5% men and 59.5% women). The overall mean age of patients was 56.07 years, and the mean age of patients with poor glycemic control (HbA1c>7%) was 56.79 years. The prevalence of the poor glycemic control (HbA1c>7%) was 77.8%. Participants with HbA1c > 7% showed statistically significant higher means for FBG, TC, and LDL-c than their counterparts with good glycemic control [11.71±3.11mmol/l vs. 8.54±3.19; 5.11±1.21mmol/l vs. 4.48±1.16 and 2.66±1.07 mmol/l vs. 2.22±1.04, respectively, (P<0.005; 0.000, 0.008 and 0.034, respectively)]. The study showed a significant strong positive correlation between HbA1c and FBG (r=0.679, p<0.01); family history of diabetes, (FHD) (r=0.165, p<0.05); systolic blood pressure, (SBP) moderated with FHD (r=0.168, p<0.05); and diastolic blood pressure (DBP) moderated with FHD(r=0.181, p<0.05). In conclusion, poor glycemic control is associated with high/ blood pressure, high blood glucose and dyslipidemia, which are risk factors for macrovascular, microvascular and cardiovascular complications.

Keywords: Type 2 Diabetes Mellitus, glycemic control, cardiovascular risk, Patient characteristics

iCB-2019-07

Characteristics of Type 2 Diabetes Patients and Their Association with the Metabolic Syndrome and Cardiovascular Risk Factors at Thika Level Five Hospital in Kenya

Thuita Ann Watetu, Kiage Nyanchama Beatrice, Onyango Arnold N., Makokha Anselimo, 2019. *International Journal of Diabetes and Endocrinology*. 4(2), pp. 35-48. doi: 10.11648/j.ijde.20190402.11

Abstract

Type 2 diabetes is a public health problem and one of the most common life threatening conditions globally, due to its related complications that are usually very costly to treat, with increasing number of people being diagnosed with this condition each year. Presence of the metabolic syndrome (MetS) and cardiovascular risks in Type 2 Diabetes patients increases the risk to complications. The objective of this study was to determine characteristics of type 2 diabetes patients and their association with MetS and associated cardiovascular risk. The study employed a cross section design method. Subjects with Type 2 Diabetes were recruited for the study from Thika Level Five Hospital in Kenya. Socio-demographic, clinical and lifestyle data were obtained using questionnaires. The nutrition status was determined by anthropometry. Other laboratory parameters that were determined included total cholesterol (TC), high density cholesterol (HDL-c) and low density cholesterol (LDL-c), triglyceride (TG), fasting blood glucose (FBG), glycated haemoglobin (HbA1C), and blood pressure (BP). Overall 153 (40.5% men and 59.5% women) Type 2 diabetic patients aged 20-79 years were included in the study. The overall mean age of patients was 56.07 years. The prevalence of the metabolic syndrome was 86.3% as per WHO criteria. The MetS components were elevated waist circumference (WC, 90.8%), increased waist hip ratio (WHR, 86.9%), elevated blood pressure (65.7% & 72.5%) and elevated triglycerides (64.8%). The prevalence of occurrence of the components of the MetS was not significantly different among male and female patients except for WC, BMI and reduced serum HDL-C where women were at a significantly higher risk than men ($P \leq 0.00$). The current study showed that income was associated with elevated diastolic blood pressure (BP), secondary education and years lived with diabetes were associated with elevated TG, while occupation showed some association with high WHR. Additionally Gender, marital status and type of residence were associated with elevated HDL while education, family history of diabetes and alcohol intake was associated with obesity. The prevalence of the MetS and associated cardiovascular risk among Type 2 Diabetes patients was high and similar among males and females. Enhanced surveillance on MetS and associated cardiovascular risk in Type 2 Diabetes in addition to application of preventive measures are critical in order to reduce the risk of macro vascular complications as well as increased cardiovascular risks in Type 2 Diabetes patients.

Keywords: Metabolic Syndrome, Type 2 Diabetes, Cardiovascular Risk and Patient Characteristic

iCB-2019-08

The growth of different probiotic microorganisms in soymilk from different soybean varieties and their effects on antioxidant activity and oligosaccharide content.

Marguerite Niyibituronasa, Arnold Onyango, Svetlana Gaidashova, Samuel Imathiu, Marthe De Boevre, Diederik Leenknecht, Ellen Neyrinck, Sarah De Saeger, Pieter Vermeir and Katleen Raes, 2019. *Journal of Food Research*, 8, pp. 41-51. DOI: 10.5539/jfr.v8n1p41.

Abstract

Soymilk is a good source of proteins and health-promoting isoflavones, but it contains oligosaccharides that cause flatulence. Fermenting it with probiotic bacteria may reduce the oligosaccharides and enhance its health benefits. The present study determined the growth of different lactic acid bacteria (LAB) in soymilk obtained from soybean varieties grown in Rwanda and the effect of fermentation on oligosaccharides that cause flatulence (stachyose, raffinose and

verbascose), and antioxidant activity of fermented soybean milk. After fermentation at 30°C for 24 hours, *Lactobacillus plantarum*, *Lactobacillus acidophilus*, *Lactobacillus brevis*, *Lactobacillus reuteri*, *Lactobacillus rhamnosus*, *Lactococcus cremoris* and *Lactobacillus casei* attained around 8 log CFU/ml, which is sufficient for probiotic effects. However, only *L.reuteri*, *L.brevis* and *L.plantarum* caused sufficient drop in pH and increase in viscosity characteristic of a good fermented product. Soymilk from different soybean varieties did not show significant differences in the growth of these three LAB. These LAB reduced content of oligosaccharides and total polyphenols, but increased antioxidant activity in soymilk, which translate into health benefits of fermented soybean products.

Keywords: fermentation, lactic acid bacteria, polyphenols, raffinose, Rwanda

iCB-2019-09

Bacterial contamination of selected fruits, fresh juice contact surfaces and processor's hands: potential risk for consumers' health in Uganda.

Phoebe P. Kaddumukasa, Samuel M. Imathiu, Julius M. Mathara and Jesca L. Nakavuma, 2019. *Journal of Food Science and Nutrition Research*, 2, pp. 199-213.

Abstract

A cross sectional study to assess bacteriological safety of 60 fruits, 85 juice contact surfaces and 30 hands was carried out in Kampala, Uganda. Sampling was done according to ISO 18593. Mean aerobic plate counts of 8.3, 8.6 and 8.5 log₁₀CFU/cm² on passion, mango and pineapple fruit surfaces respectively, were obtained. Juice dispensers, refrigerators and hands had mean aerobic plate counts of 5.6, 5.9 and 7 log₁₀ CFU/cm² respectively. Mean coliform counts of 4, 3.9 and 3.7 log₁₀ CFU/cm² were observed for dispenser, refrigerator and hands respectively. Mean *S. aureus* count of 5 log₁₀ CFU/cm² and range from no detection to 6.8 log₁₀ CFU/cm² was observed for dispenser surfaces. Thirty-eight (56.7%), n=67 refrigerators were contaminated with *S. aureus* above the detection limit. Eighteen (60%), of 30 hand samples were contaminated with *S. aureus* above the detection limit. *Staphylococcus aureus* was the most prevalent pathogen while *Salmonella* and *Listeria* spp were absent from all samples. One (6.7%) out of 15 coagulase positive isolates was positive for the *mecA* gene. These findings show that fruit, fresh juice contact surfaces and hands can be potential vehicles through which bacterial contamination could occur in fresh juices. There is therefore great need to emphasize stringent hygiene and use of good manufacturing practices to ensure production of microbiologically safe products.

Keywords: Bacterial contamination, food contact surfaces, fruit juice, microbial quality, refrigerators

iCB-2019-10

Effect of pretreatments prior to drying on antioxidant properties of dried mango slices

Isaac O. Nyangena, Willis O. Owino, Samuel Imathiu and Jane Ambuko, 2019. *Scientific African*, 6, 1-9. DOI: <https://doi.org/10.1016/j.sciaf.2019.e00148>.

Abstract

Chemical, thermal or osmotic pretreatments prior to drying can improve the quality aspects of dried foods. Three pretreatments prior to drying were evaluated for antioxidant capacity in two mango varieties viz. Ngowe and apple that were dehydrated in either, oven (50 and 65 °C) and solar dryer. The antioxidant properties analyzed included polyphenols, vitamin C, carotenoids, flavonoids and total antioxidant activity. Total polyphenol content was determined through Folin–Ciocalteu method and quantified using UV-Spectrophotometer. Vitamin C was analyzed by HPLC system while total carotenoids, total antioxidants, and flavonoids were analyzed using UV-Spectrophotometer at varied wavelengths. Method of drying and pretreatment type had significant effect ($p \leq 0.01$) on the flavonoid content, total carotenoids and β -carotene for differently pretreated and dried mango slices. The results showed increased content in total antioxidants, polyphenols and flavonoids for the pretreated and dried slices compared to the fresh samples of

both varieties. The highest flavonoid content (43.66 ± 1.27 mg/100 g) was recorded in 1% citric acid pretreated samples dried at 50 °C while the lowest amount (16.73 ± 1.14 mg/100 g) was recorded in blanched Ngowe oven dried at 65 °C. Vitamin C decreased with increased drying temperature from 50–65 °C and the largest value (78.87 ± 0.46 mg/100 g) was observed in fresh Apple mango variety while the lowest value (28.45 mg/100 g) was observed in Ngowe variety samples oven dried at 65 °C for 10 h. β -carotene for dried mango slices ranged from 6.65 mg/100 g to 40.88 mg/100 g among the differently pretreated and dried mango slices and the values were lower than the content in fresh samples in the respective varieties. Total polyphenol content varied from 5.83–29.9 mg (GAE)/100 g. This research demonstrated that appropriate pretreatments in this case, 1% citric acid pretreatment prior to drying at 50 °C can enhance retention of antioxidants in dried mango product.

Keywords: Antioxidants, drying, mango, phenolics, pretreatment, vitamin C

iCB-2019-11

Enhancement of anaerobic batch digestion of spineless cacti (*Opuntia ficus indica*) feedstock by aerobic pre-treatment.

H. Myovela, A.M. Mshandete and S. Imathiu, 2019. *African Journal of Biotechnology*, 18, 12-22. DOI: <https://doi.org/10.5897/AJB2018.16652>.

Abstract

One of the best options for African countries to meet rural energy needs is to grow care-free crassulacean acid metabolism plants on a massive scale in waste lands. This can enable bioenergy production without disrupting food supplies and hence sustainable energy supply for the future. *Opuntia ficus indica* is an ideal plant for arid regimes but has barely been studied as a potential bioenergy source. This study investigated the effect of aerobic pretreatment on methane yield of *O. ficus indica* biomass. This effect was investigated in batch bioreactors which were exposed to aerobic conditions by varying time from 3 to 72 h before the start of anaerobic digestion. Reducing sugar content and dissolved oxygen levels after pretreatment period was analyzed. Reducing sugar content in bioreactors increased with increase in pretreatment time from 12.22 ± 0.69 to 59.08 ± 5.35 g/L in the untreated and 72 h pretreated batches, respectively. Methane yields after pretreatment were observed to range from 0.286 to 0.702 L/kg volatile solids at 9 and 72 h of pre-treatment, respectively. A 9 h pre-treatment of feedstock prior to anaerobic digestion yielded 123% higher methane yield when compared to that without pre-treatment. The findings that there was an increase in reducing sugar production and methane yield at 9 h of aerobic pre-treatment suggests that there was increased hydrolysis with pretreatment. Hence, short pre-treatment period could be an option to increasing solubilization of cladodes and promoting methane productivity. Therefore, pre-aeration of *O. ficus indica*, was shown to be an effective method for enhancing both its digestibility and improved methane yield during anaerobic digestion.

Key words: Anaerobic digestion, biogas, methane, *Opuntia*, pretreatment, spineless cacti.

iCB-2019-12

Microbial quality of edible grasshoppers *Ruspolia differens* (Orthoptera: Tettigoniidae): From wild harvesting to fork in the Kagera Region, Tanzania.

J. Ng'ang'a, S. Imathiu, F. Fombong, M. Ayieko, J. Vanden Broeck and J. Kinyuru, 2019. *Journal of Food Safety*, 39, e12549. DOI: <https://doi.org/10.1111/jfs.12549>.

Abstract

In Tanzania, edible *Ruspolia differens* are still harvested from the natural environments. In this perspective, little is known about the microbiological quality of wild harvested *R. differens*. This study was conducted to assess the microbiological quality of wild harvested *R. differens* and evaluate the efficacy of conventional processing methods in reducing microbial load. Two districts (Bukoba rural and Muleba) within the Kagera region were purposively selected for the study. Sampling was done from the same batches along the *R. differens* food chain as follows: (a) at

harvest points in the villages, (b) after transportation to the market and plucking of wings and legs, (c) after rinsing with potable tap water, and (d) after processing using conventional methods. Generally, high microbial counts, that is, total viable aerobic count (TVC), *Enterobacteriaceae*, lactic acid bacteria, bacterial endospores, and yeasts and molds were observed in raw *R. differens* samples. A significant increase in microbial counts after transportation and plucking was only observed for TVC, bacterial endospores, and yeasts and molds. A statistically significant reduction in all types of counts, with the exception of bacterial endospores, was observed after processing. All processed samples analyzed were devoid of salmonellae, *Listeria monocytogenes*, and *Escherichia coli*.

Keywords: entomophagy, microbial counts, processing methods, bacterial endospores, handling.

iCB-2019-13

The effect of different processing methods on nutrient and isoflavone content of soymilk obtained from six varieties of soybean grown in Rwanda.

M. Niyibituronsa, A.N. Onyango, S. Gaidashova, S. Imathiu, M. Uwizerwa, Emelda Phillis Ochieng, Fredrick Ng'ang'a, Josephine Birungi, Sita Ghimire and Jagger Harvey, 2019. *Food science and nutrition*, 7, 457-464. DOI: <https://doi.org/10.1002/fsn3.812>.

Abstract

Soymilk is rich in nutrients and isoflavones, and could greatly promote nutrition and health. However, this product is not widely accepted due to an objectionable beany flavor. Several methods involving heat treatment and soaking in basic solutions prior to soymilk extraction have been reported to reduce the objectionable flavor. However, the effects of such treatments on the nutritional value and isoflavone content of soymilk, and the responses of different soybean varieties to nutrient extraction by these methods is not well studied. The aim of this study was to determine the effect of three processing methods on protein, fat, minerals, and isoflavone content in soymilk from six soybean varieties grown in Rwanda (Peka-6, SB 24, Sc. Sequel, Sc, Squire, and a local variety) to find the best variety and processing method. The first method (M1) involved soaking soybeans in water for 12 hr prior to milk extraction, M2 involved blanching in NaHCO₃ prior to extraction and M3 involved soaking in NaHCO₃ solution for 16 hr and subsequent cooking prior to extraction. M1 resulted in significantly higher nutrient and isoflavone extraction than M2 and M3. Thus, M1 extracted more nutrients and can be recommended for soymilk production. However, where consumers prefer soymilk obtained by M2 or M3, Sc Squire and the local variety may be recommended. Sc. Squire has another advantage of higher isoflavone content than the other varieties. Further comprehensive studies on the sensory acceptability of products made from different varieties by different methods among different consumer categories will be necessary.

Keywords: chemical composition, fat, *Glycine max* (L.), *Merrill*, minerals, protein

iCB-2019-14

Effect of selected pretreatments prior to drying on physical quality attributes of dried mango chips.

I. Nyangena, W. Owino, J. Ambuko and S. Imathiu, 2019. *Journal of food science and technology*, 56, 3854-3863. DOI: <https://doi.org/10.1007/s13197-019-03857-9>.

Abstract

This study investigated the effect of pretreatments namely citric acid, lemon juice and blanching on the physical attributes of dried chips from two popular commercial mango varieties grown in Kenya viz 'Apple' and 'Ngowe'. The pretreated mango chips were either subjected to a convective dryer or solar drying. Moisture content, extent of dryness, rehydration characteristics, water activity and color retention were determined to establish the effect of the pretreatments before drying on physical quality attributes of dried mango chips. Moisture content, water activity and color were determined using standard procedures. Equilibrium relative humidity was estimated using Drycard™. Results obtained indicated that optimal drying was achieved with dryer

temperatures of 50 °C and 65 °C for 10 and 7 h respectively that reduced moisture content to ~11% and water activity to below 0.65 (sufficient for inhibited spoilage). The best color parameters and rehydration characteristics were observed with 1% citric acid and 0.5 v/v lemon acid pretreated samples. Blanched as well as control (untreated) samples showed relatively poor color retention in relation to flesh mango chips and had the least rehydration ratio (1.65 ± 0.01) and coefficient of rehydration (0.33 ± 0.1). As pretreatments before drying affect physical parameters of dried mango chips, the best choice of pretreatments should be made to produce high quality end products. Citric acid and lemon juice pretreatments before drying at 50 °C and 65 °C had the optimal outcome and produced the best physical quality parameters.

Keywords: Fruits, drying, equilibrium relative humidity, moisture content, dehydration, mango

iCB-2019-15

Socio-demographic characteristics of vendors and manufacturing practices of fresh unpasteurized fruit and vegetable juices in Kampala, Uganda.

Phoebe Kaddumukasa, Samuel Imathiu, Julius Maina Mathara and Jesca L. Nakavuma, 2019. *International Journal of Advanced Research*, 7, 372-379. DOI: 10.21474/IJAR01/8337

Abstract

Fresh juices as beverages are valued because they offer numerous health benefits to consumers. However, the manufacturing methods used in their preparation produce a great variation in terms of product quality. The aim of this study was to examine fresh juice production practices and determine the socio-demographic characteristics of vendors involved in the juice business in Kampala. A structured questionnaire was used to examine the practices of ninety juice vendors using the interview method. Findings from the study indicate that different blends of fresh juice were made with passion fruit as the main type of a single beverage. Poor manufacturing practices used in extraction of the juices were statistically significant ($p < 0.05$). Women (74%) with low level of education dominated the production and vending of juices. Statistically significant ($p < 0.05$) vending practices were observed for the following manufacturing practices namely; fruit vegetable and juice storage; sanitation of equipment, transportation of fresh produce and level of education within the food establishments. Great need in the use of good manufacturing practices by all juice vendors should be promoted and encouraged by the government and all concerned regulatory bodies in Kampala.

Keywords: Fresh juice, preparation, practices, storage, vending.

iCB-2019-16

Comparative Genomic Analysis of *Lactobacillus rhamnosus* BFE5264, a Probiotic Strain Isolated from Traditional Maasai Fermented Milk Microbiol.

Haeyoung Jeong; Sanghaeng Choi; Gun-Seok Park; Yosep Ji; Soyoun Park; Wilhelm Heinrich Holzappel; Julius Maina Mathara and Jihee Kang, 2019. *Biotechnol. Lett.* 47(1), pp. 25–33

Abstract

Lactobacillus rhamnosus BFE 5264 isolated from a Maasai fermented milk product 'Kule Naoto' was previously shown to exhibit bile acid resistance, cholesterol assimilation and adhesion to HT29-MTX cells in vitro. In this study we re-annotated and analyzed previously reported complete genome sequence of strain BFE 5264. The genome consists of a circular chromosome of 3,086,152bp and a putative plasmid, which is the largest one identified among *L. rhamnosus* strains. Among the 2,883 predicted protein coding genes those with carbohydrate related functions were the most abundant. Genome analysis of strain BFE5264 revealed two consecutive CRISPR regions and no known virulence factors or antimicrobial resistance genes. In addition, previously known highly variable regions of the genomes of *L. rhamnosus* were also evident in strain BFE 5264. Pairwise comparison of the most studied probiotic strain *L. rhamnosus* GG revealed strain BFE 5264 specific-deletions, probably due to insertion sequence-mediated recombination. The latter is associated with loss of the spaCBA pilin gene cluster and exopolysaccharide biosynthesis genes.

Comparative genomic analysis of the sequences from all available *L. rhamnosus* strains revealed that they were clustered into two groups, being within the same species boundary based on the average nucleotide identities. Strain BFE5264 had a sister group relationship with the group that contained strain GG, but neither ANI-based hierarchical clustering nor core-gene-based phylogenetic tree construction showed a clear distinctive pattern associated with the isolation source, implying that the genotype alone cannot account for their ecological niches. These results provide insights into the probiotic mechanisms of strain BFE5264 at the genomic level.

Keywords: Lactobacillus, Lactobacillus rhamnosus, genome analysis, comparative genomic analysis, probiotics

iCB-2019-17

Characterization of the Chemical and Phytochemical Profiles during Fruit Development and Ripening in Selected Cultivars of African Nightshade (*Solanum Nigrum Complex*) Edible Berries.

Elijah Heka Kamau, Julius Maina Mathara, Glaston Mwangi Kenji, 2019. *Journal of Agricultural Studies*, 8(2) pp. 806-819. ISSN 2166-0379.

Abstract

Solanum nigrum complex is a green, indigenous leafy vegetable that grows in many parts of the world and its utilization can deliver more nutrients and phytochemicals into the diet. Even though it can help in alleviating the burden of hidden hunger, only the leafy part is utilized whereas the plant has edible berries. This study sought to address the problem of underutilization by looking at the benefits that can be derived from the berries. Four varieties of the plant were harvested through four stages; green, colour break, ripe and at senescence. Chemical analyses of the berries were done to determine the content and changes in macro and micro-nutrients and the phytochemical content of the berries as they ripened. Analysis of Variance (ANOVA) was used to determine the significant difference between nutrient and phytochemical composition of the different *S. nigrum* varieties at different ripening stages. The results show that fibre, ash and protein increased at senescence while carbohydrates decreased. Magnesium was the most abundant mineral. As berries ripened, oxalates, total phenols, flavonoids and phytates decreased while Vitamin C, tannins and total carotenoids increased. Conclusively, the berries in this study have comparable nutritional value with other commonly consumed fruits and could, therefore, be incorporated into the family pot.

Keywords: African nightshade, Berries, Ripening, Indigenous vegetables, Phytochemicals

iCB-2019-18

Socio-Demographic Characteristics of Vendors and Manufacturing Practices of Fresh Unpasteurized Fruit and Vegetable Juices in Kampala, Uganda.

Phoebe P. Kaddumukasa, Samuel M. Imathiu, Julius M. Mathara and Jesca L. Nakavuma, 2019 *International Journal of Advanced Research* 7(1), 372-379

Abstract

Fresh juices as beverages are valued because they offer numerous health benefits to consumers. However, the manufacturing methods used in their preparation produce a great variation in terms of product quality. The aim of this study was to examine fresh juice production practices and determine the socio-demographic characteristics of vendors involved in the juice business in Kampala. A structured questionnaire was used to examine the practices of ninety juice vendors using the interview method. Findings from the study indicate that different blends of fresh juice were made with passion fruit as the main type of a single beverage. Poor manufacturing practices used in extraction of the juices were statistically significant ($p < 0.05$). Women (74%) with low level of education dominated the production and vending of juices. Statistically significant ($p < 0.05$) vending practices were observed for the following manufacturing practices namely; fruit vegetable and juice storage; sanitation of equipment, transportation of fresh produce and level of

education within the food establishments. Great need in the use of good manufacturing practices by all juice vendors should be promoted and encouraged by the government and all concerned regulatory bodies in Kampala.

Keywords: - Fresh juice, preparation, practices, storage, vending

iCB-2019-19

Impact of processing methods on microbial load of reared and wild-caught edible crickets (*Scapsipedus icipe* and *Gryllus bimaculatus*) in Kenya

J.W. Gatheru, F.M. Khamis, F.L.O. Ombura, J. Nonoh , C.M. Tanga , J. Maina , S.A. Mohamed , S. Subramanian , S. Ekesi , and K.K.M. Fiaboe, 2019. *Journal of Insects as Food and Feed*. pp.1 - 14 <https://doi.org/10.3920/JIFF2018.0042>

Abstract

The microbial composition of farmed and wild *Scapsipedus icipe* and *Gryllus bimaculatus* is presented. The aim of this study is to determine the microbial load of the two cricket species and evaluate the efficiency of processing methods (boiling, sun-drying, freeze-drying, snap-freezing and deep-frying) in reducing microbial counts. Farmed and wild species were compared based on microbial diversity. Fresh crickets had high microbial counts, bacterial and fungal populations ranged from 4.26-4.58 log cfu/g and 3.48-4.48 log cfu/g fresh weight, respectively. Upon processing, microbial counts reduced, bacterial counts ranged from 1.00-2.08 log cfu/g dry weight (boiled) and 2.70-3.34 log cfu/g dry weight (sun-dried). Fungal counts ranged from 1.85-1.95 log cfu/g dry weight (boiled) and 2.95-3.51 log cfu/g dry weight (sun-dried). Deep-frying, freeze-drying and snap-freezing emerged as the best processing methods. Although there is no alarm in consuming fresh crickets, a processing method is advisable to minimize any possible risks.

Keywords: microbial counts, wild, farmed, microbial-diversity

iCB-2019-20

Sugar Content and Physical Characterization of Four Selected African Nightshade (*Solanum nigrum*) Edible Berries

Elijah H. Kamau, Julius M. Mathara, and Glaston M. Kenji, 2019. *EJFOOD, European Journal of Agriculture and Food Sciences*. 2(3).

Abstract

Fruits constitute a major part of the diet in many parts of the world, highly recommended for the nutritional value derived from them. Fruit maturity is an important determinant of the quality as it affects the appearance, an aspect of quality considered by most consumers. Sugar content, colour, size and firmness are some of the quality indicators associated with maturity. While the ripening and maturity indicators are well documented for climacteric fruits, non-climacteric fruits such as berries lag behind. African nightshade (*Solanum nigrum* L.) edible berries are among them. This study evaluated the quality parameters of the edible berries of four varieties of African nightshade and found out that they accumulate glucose and fructose as they ripen with glucose being the most abundant sugar. Sucrose is only present during the senescence stage. Size remained relatively constant within each variety while firmness decreased progressively after veraison. Black NS differed with the others in colour besides fructose and sucrose content at 29.35 and 388.40 mg/100g, respectively. Giant NS recorded the highest glucose content at 172.44 mg/100g when ripe. Conclusively, the African nightshade berries are characteristically similar to other non-climacteric fruits adopted as part of the normal diet and should be considered as a valuable addition to the diet.

Keywords: Berries, African nightshade, Ripening, Firmness, Colour.

iCB-2019-21

Chemical composition of the seed and ‘milk’ of three common bean (*Phaseolus vulgaris* L.) varieties

Calvince Anino, Arnold N. Onyango, Samuel Imathiu, Julius Maina, Faith Onyangore, 2019. *Journal of Food Measurement and Characterization* 13, pp. 1242-1249. doi: 10.1007/s11694-019-00039-1

Abstract

Beans are a good source of nutrients and a variety of phytochemicals such as flavonoids, tannins and phytates. On the one hand, these non-nutrient phytochemicals reduce nutrient bio availability, but on the other hand they have some health benefits including reducing the risks for aging-related diseases. This study investigated the content of nutrients and non-nutrient phytochemicals in three varieties of common beans, namely red haricot, pinto and yellow kidney beans, and their corresponding milk extracts. Carbohydrates were the most abundant nutrient in the beans (63–66%), followed by proteins (21–24%), crude fiber (5–7%), crude ash (4–5%), and crude fat (2–3%). The beans were also rich in non-nutrient phytochemicals. The protein, carbohydrate and fat contents of the milk (18–26%, 63–67%, and 3–4%, respectively) did not differ much from the beans. Unlike the beans, the milk lacked crude fiber, and had greatly reduced ash (2%) and phytochemicals. Consistent with the reduction in ash, there was a reduction in minerals; calcium, iron, zinc and magnesium in the milk. The reduction in minerals was less than the reduction of phytates, indicating that the milk may have higher bioavailability of minerals than the beans. The milk also had higher protein digestibility. Thus, consumption of bean milk may be encouraged as an alternative way of bean consumption, especially by individuals whose greater needs are for nutrients rather than phytochemicals. The bean varieties had significant differences in the retention of nutrients and phytochemicals, and such differences should be considered during bean milk production.

Keywords: Common beans, Bean milk, Anti-nutrients

iCB-2019-22

Characteristics of Type 2 Diabetes Patients and Their Association with the Metabolic Syndrome and Cardiovascular Risk Factors at Thika Level Five Hospital in Kenya.

Thuita Ann Watetu, Kiage Nyanchama Beatrice, Onyango Arnold N & Makokha Anselimo, 2019. *International Journal of Diabetes and Endocrinology*. 4(2), 35-48. doi: 10.11648/j.ijde.20190402.11

Abstract

Type 2 diabetes mellitus is a public health problem and one of the most common life threatening conditions globally, due to its related complications that are usually very costly to treat, with increasing number of people being diagnosed with this condition each year. Presence of the metabolic syndrome (MetS) and cardiovascular risks in Type 2 diabetes mellitus patients increases the risk to complications. The objective of this study was to determine characteristics of Type 2 diabetes mellitus patients and their association with MetS and associated cardiovascular risk. The study employed a cross section design method. Subjects with Type 2 diabetes mellitus were recruited for the study from Thika Level Five Hospital in Kenya. Socio-demographic, clinical and lifestyle data were obtained using questionnaires. The nutrition status was determined by anthropometry. Other laboratory parameters that were determined included total cholesterol (TC), high density cholesterol (HDL-c) and low density cholesterol (LDL-c), triglyceride (TG), fasting blood glucose (FBG), glycated haemoglobin (HbA1C), and blood pressure (BP). Overall 153 (40.5% men and 59.5% women) Type 2 diabetic mellitus patients aged 20-79 years were included in the study. The overall mean age of patients was 56.07 years. The prevalence of the metabolic syndrome was 86.3% as per WHO criteria. The MetS components were elevated waist circumference (WC, 90.8%), increased waist hip ratio (WHR, 86.9%), elevated blood pressure (65.7% & 72.5%) and elevated triglycerides (64.8%). The prevalence of occurrence of the

components of the MetS was not significantly different among male and female patients except for WC, BMI and reduced serum HDL-C where women were at a significantly higher risk than men ($P \leq 0.00$). The current study showed that income was associated with elevated diastolic blood pressure (BP), secondary education and years lived with diabetes were associated with elevated TG, while occupation showed some association with high WHR. Additionally, Gender, marital status and type of residence were associated with elevated HDL while education, family history of diabetes and alcohol intake was associated with obesity. The prevalence of the MetS and associated cardiovascular risk among Type 2 Diabetes patients was high and similar among males and females. Enhanced surveillance on MetS and associated cardiovascular risk in Type 2 Diabetes in addition to application of preventive measures are critical in order to reduce the risk of macrovascular complications as well as increased cardiovascular risks in Type 2 Diabetes patients.

Keywords: Metabolic Syndrome, Type 2 Diabetes, Cardiovascular Risk and Patient Characteristic

iCB-2019-23

The Relationship between Patient Characteristics and Glycemic Control (HbA1c) in Type 2 Diabetes Patients Attending Thika Level Five Hospital, Kenya.

Thuita Ann Watetu, Kiage Beatrice Nyanchama, Onyango Anorld N and Anselimo O Makokha, 2019. *African Journal of Food Agriculture and Nutrition Development*. 19(4): 115041-15059. DOI: 10.18697/ajfand.87.18420

Abstract

Type 2 Diabetes Mellitus is a metabolic disorder characterized by hyperglycemia due to relative insulin secretion deficiency and insulin resistance. It is a global public health concern with increasing prevalence each year. Social demographic, lifestyle and metabolic characteristic, play a crucial role in development and progression of Type 2 diabetes mellitus. Poor glycemic control worsens the condition, leading to complications that are very costly to treat. This calls for a need to explore the relationship between patient characteristics and glycemic control (HbA1c). One hundred and fifty-three (153) participants with Type 2 diabetes mellitus aged 20-79 years and attending the Thika Level Five Hospital were enrolled in the study. Socio-demographic, clinical and lifestyle data were obtained using questionnaires. The nutrition status was determined by anthropometry. Lipid profile that included total cholesterol, (TC); high density lipoprotein-cholesterol, (HDL-c); low density lipoprotein cholesterol, (LDL-c) and triglyceride, (TG,) were determined by enzymatic method while glycated hemoglobin (HbA1c) and fasting blood sugar (FBS) were determined using high-performance liquid chromatography (HPLC) and glucose oxidase methods, respectively. Blood pressure of the patients was also determined. Overall sample size was 153 (40.5% men and 59.5% women). The overall mean age of patients was 56.07years, and the mean age of patients with poor glycemic control (HbA1c>7%) was 56.79years. The prevalence of the poor glycemic control (HbA1c>7%) was 77.8%. Participants with HbA1c > 7% showed statistically significant higher means for FBG, TC, and LDL-c than their counterparts with good glycemic control [11.71±3.11mmol/l vs. 8.54±3.19; 5.11±1.21mmol/l vs. 4.48±1.16 and 2.66±1.07 mmol/l vs. 2.22±1.04, respectively, ($P < 0.005$; 0.000, 0.008 and 0.034, respectively)]. The study showed a significant strong positive correlation between HbA1c and FBG ($r = 0.679$, $p < 0.01$); family history of diabetes, (FHD) ($r = 0.165$, $p < 0.05$); systolic blood pressure, (SBP) moderated with FHD ($r = 0.168$, $p < 0.05$); and diastolic blood pressure (DBP) moderated with FHD ($r = 0.181$, $p < 0.05$). In conclusion, poor glycemic control is associated with high/ blood pressure, high blood glucose and dyslipidemia, which are risk factors for macrovascular, microvascular and cardiovascular complications.

Keywords: Type 2 Diabetes Mellitus, glycemic control, cardiovascular risk, Patient characteristics

iCB-2019-24

Use of Peroxide Value and Moisture Content as a Measure of Quality for Amaranth-Sorghum Grains Based Complementary Food.

Gichau, A.W, Okoth, J.K, Makokha, A, Wanjala, G.W., 2019. *Nutrition Food Technology Open Access* 5(2): dx.doi.org/10.16966/2470-6086.162

Abstract

Amaranth sorghum grains complementary food is a nutrient dense dry food product for infants and young children. It is prone to moisture absorption from the environment and fat oxidation depending on packaging and storage condition due to its low moisture content and high level of unsaturated fat. In this study, amaranth sorghum grains complementary food was stored in three types of packaging material namely, kraft paper, kraft paper with polyethylene lining and aluminium pouch being the commonly used packaging materials for dry complementary foods in Kenya. These packaged samples were stored at ambient, 25°C, 60% relative humidity and 35°C, 75% relative humidity for 180 days. The moisture content of the product and the peroxide value of the oil extracted from the product were determined using the standard methods at an interval of 45 days for 180 days. The initial peroxide value of the product at day zero was 0.48 meq O₂ Kg⁻¹ while its moisture content was 3.7% on dry weight basis. Over the 180 days of storage, aluminium pouch was the most effective package in controlling increase in moisture content and peroxide value in comparison to the other two packages. Samples stored at 35°C, 75% RH had a shorter shelf life compared to those stored at 25°C, 60% RH and ambient conditions. It is recommended that the product should be stored below 25°C and packaged in aluminium pouch to achieve a longer shelf life.

Keywords: Peroxide value; Moisture content; Quality; Complementary food

iCB-2019-25

Moisture sorption isotherm and shelf life prediction of complementary food based on amaranth–sorghum grains.

Gichau, W. A., Okoth, J.K and Makokha, A., 2019. *Journal of Food Science and Technology*, 57(3), pp. 962-970..

.Doi:10.1007/s13197-019-04129-2

Abstract

The quantity and quality of complementary foods is one of the contributing factors to childhood under nutrition. Complementary food based on amaranth and sorghum grains was formulated. It was deemed to be superior nutritionally to the commonly used complementary foods in Kenya. Knowledge on storage and packaging is important for a long shelf life of the product to be achieved. Water activity and moisture content are key indicators of the stability of dried foods. To establish the proper storage conditions of the product, moisture sorption isotherms at 25 °C, 30 °C and 35 °C were determined over water activity range of 0.11-0.97 and data fitted with six sorption models. Water vapour permeability of common packaging materials was also determined at 25 °C and 35 °C and the data was used to predict the product's shelf life. The product exhibited type two sorption isotherm according to Brunner classification an indication of monolayer-multilayer sorption behavior. The critical storage moisture content of the complementary food corresponding to 0.6 water activity a point of microbiological stability was found to be 7.5%. Based on Heiss-Eichner model, a shelf life of 1423 days at 25 °C can be achieved with product initial moisture content of 5 g/100 g and packaged in 110 µm thick aluminum pouch. The shelf life of the product was shortened two to three fold at 35 °C in comparison to storage at 25 °C.

Keywords: Amaranth: Complementary food; Shelf life; Sorghum; Sorption isotherm; Water activity.

iCB-2019-26

Effect of Fortification with Snail Meat Powder on Physicochemical Properties and Shelf-life of Sorghum-Wheat Buns.

Agengo, F. B., Onyango, N.A., Serrem, A. C and Okoth, J., 2019. *Current Nutrition and Food Science*, 16(5), pp.749-756Doi: 10.2174/1573401315666190719162012.

Abstract

Formulation of composite flours from wheat and non-wheat flours has been proposed as the most desirable way to improve the nutritional quality in diets, promote food security and lower cost of baked products. This study evaluated the effect of fortification with snail meat powder on physicochemical properties and shelf life of sorghum-wheat buns. Buns were prepared by replacing part of sorghum-wheat flour with 5, 10, 15, 20, and 25% snail meat powder. Physical properties of volume, density, baking loss, yield, weight, hardness and colour, the proximate analyses including moisture, crude protein, crude fat, crude fibre and ash and mineral composition of iron, zinc, calcium, magnesium and copper were analyzed for the buns. In vitro protein digestibility was determined by pepsin digestion. Plate count agar and potato dextrose agar were respectively used for enumeration of bacterial and fungal flora, in the buns during storage. Shelf life determination was based number of days before the production of off flavours and fungal infestation. Compositing sorghum-wheat flour with snail meat powder progressively improved the buns density, baking loss, yield, weight and texture. Protein, fat, ash, energy, iron, zinc, calcium, magnesium and copper contents also increased. Fortification of buns at 5% and 25% with SMP improved in vitro protein digestibility by 16% and 22% respectively. Maximum bacterial count in buns was below the International Microbiological Standards recommended units for dry and ready to eat foods of 10³ cfu/g. Buns composited with snail meat powder have considerable potential to be used as protein rich foods in preventing Protein Energy Malnutrition among young children.

Keywords: Buns, digestibility, nutrient imbalance, protein energy malnutrition, protein rich foods, snail meat powder, sorghum- wheat.

iCB-2019-27

Status of commercial maize milling industry and flour fortification in Kenya.

S. Khamila S., Ndaka, D. S., A. Makokha, A., Kyallo, F., Kinyanjui, P.K., Kanensi, OJ and Mwai, J. 2019. *African Journal of Food Science*, 13(3) pp. 65-82.Doi: 10.5897/AJFS2018.1782.

Abstract

Maize is the most widely consumed staple food by the Kenyan population. Its wide consumption and centralized processing make it an appropriate fortification vehicle to supply essential micronutrients to the population. The legislation was enacted in 2012 that makes it mandatory for all commercial maize mills in Kenya to fortify the maize flour with specified micronutrients as a public health effort to reduce the prevalence of micronutrient deficiencies. However, there is limited information on the current status of maize milling and implementation of the flour fortification programme by these mills. A cross-sectional study was therefore carried out to characterize the commercial maize mills and determine the status of flour fortification in Kenya. Questionnaires were used to collect data. Information was obtained from 22 large-scale, 25 medium-scale and 31 small-scale mills. These mills had an installed capacity of 6084 metric tons/day of flour using roller and hammer mills. While all the large-scale mills implemented the recommended statutory flour fortification programs, only 45.8% of the medium and 24.1% of small-scale mills did so. There was evidence of weak quality management systems for fortified maize flour and most companies did not have trained mill operators. Regulatory monitoring was mainly done by the Kenya Bureau of Standards and the Ministry of Health. There is a need to enhance industry capacity in food fortification practices and fortification compliance.

Keywords: Fortification, maize flour, maize mills, mill characteristics.

iCB-2019-28

Nutritional Composition and Qualitative Phytochemical Analysis of Chia Seeds (*Salvia hispanica L.*) Grown in East Africa.

Mihafu, M. F., Kiage, N.B., Okoth, J. K. and Nyerere, A.K, 2019. *Current Nutrition and Food Science* 16(6), pp. 988-995. Doi: 10.2174/1573401315666191125105433

Abstract

Background Chia seed (*Salvia hispanica L.*) is becoming one of the most popular plant-based foods that contains the greatest amount of nutrients particularly omega-3 fatty acid, α -linolenic acid. Therefore, it is considered a functional food with pronounced health benefits. Objective: The purpose of this study was to determine the proximate composition, minerals, fatty acid profiles and phytochemical contents of chia seeds grown in East Africa (Kenya and Uganda). Methods Official methods of analysis, 2005 were adopted, minerals determined by Atomic absorption spectrophotometer, phytochemicals were determined by standard methods and fatty acid profiles were analyzed by Gas chromatography. Results Proximate composition indicated high contents of protein, fat and fiber. The fatty acid profiles revealed great amounts of α -linolenic acid (45.29-56.99 %) followed by linoleic acid (15.9-20.28%) and oleic acid (6.88-11.58%). However, the difference in content of α -linolenic acid between samples was not significant ($p = 0.7391$). Mineral determination (mg/100g) showed high contents of potassium (492.96-862.98), phosphorous (486.45-569.45), calcium (297.47- 429.09) and magnesium (192.22-202.97) while considerable amount was observed for iron, zinc, manganese and copper. There was a significant difference ($p = 0.0001$) in mineral content between black chia Molo and white chia Bukembo with exception of phosphorous. Conclusion Both black and white chia seeds grown in East Africa, observed to have high amounts of α -linolenic acid, proteins, fats, fiber and minerals. These findings support the evidence that chia is rich in nutrients that are beneficial to human health. Therefore, we suggest its incorporation in diets as a healthy food ingredient.

Keywords: Nutritional composition, chia seeds, phytochemical analysis

iCB-2019-29

Genome-wide genetic diversity, population structure and admixture analysis in Eritrean indigenous cattle.

Goitom S., Gicheha M. G., Francis K. N. & N'geno K., 2019. *South Africa Journal of Animal Science*, 49(6), pp. 1083 – 1092. Doi: 10.4314/sajas.v49i6.12

Abstract

Indigenous cattle play a vital role in subsistence and livelihood of pastoral producers in Eritrea. In order to optimally utilize and conserve these valuable indigenous cattle genetic resources, the need to carry out an inventory of their genetic diversity was recognized. This study assessed the genetic variability, population structure and admixture of the indigenous cattle populations (ICPs) of Eritrea using a genotype by sequencing (GBS) approach. The authors genotyped 188 animals, which were sampled from 27 cattle populations in three diverse agro-ecological zones (western lowlands, highlands and eastern lowlands). The genome-wide analysis results from this study revealed genetic diversity, population structure and admixture among the ICPs. Averages of the minor allele frequency (AF), observed heterozygosity (HO), expected heterozygosity (HE), and inbreeding coefficient (FIS) were 0.157, 0.255, 0.218, and -0.089, respectively. Nei's genetic distance (Ds) between populations ranged from 0.24 to 0.27. Mean population differentiation (FST) ranged from 0.01 to 0.30. Analysis of molecular variance revealed high genetic variation between the populations. Principal component analysis and the distance-based unweighted pair group method and arithmetic mean analyses revealed weak substructure among the populations, separating them into three genetic clusters. However, multi-locus clustering had the lowest cross-validation error when two genetically distinct groups were modelled. This information about genetic diversity and population structure of Eritrean ICPs provided a basis for establishing their conservation and genetic improvement programmes.

Keywords: genetic variability; molecular characterization; population differentiation.

iCB-2019-30

Morphological Characterisation of Indigenous Cattle Breeds in Eritrea.

Goitom S., Gicheha M.G. Ng'eno, K., Njonge, F.K., 2019. *Advances in Animal and Veterinary Sciences*. 7: 848-857. <http://dx.doi.org/10.17582/journal.aavs/2019/7.10.848.857>

Abstract

Cattle production plays important socio-economic roles at household and national levels in Eritrea. The grazed cattle sector dominates the agricultural production occurring mainly in pastoral and agro-pastoral systems. Indigenous cattle breeds are almost exclusively reared in the two production systems. The breeds have notable physical differences but no scientific research has been carried out to determine the extent of the morphological diversity. We hypothesized that there exist morphological differences that can distinguish the indigenous cattle population (ICPs) into distinct groups using the guidelines on morphological characterisation of different livestock species provided by Food and Agriculture Organisation (FAO). A total of 4617 data were collected for analysis. This included data from 13 morphometric and physical characteristics measurements from 243 head of indigenous cattle spread in 27 populations in the three agro ecological zones of Eritrea. The measurements were equally shared between production and reproduction traits. Homogenous groups were formed from cluster analysis based on single-linkage agglomerative hierarchical and non-overlapping (SAHN) technique while discriminant function analysis was performed to ascertain the accuracy of the classification. The Eritrean ICPs clustered around two groups. These were the Highland and East Coast cluster (Arado) and the Western lowland cluster (Barka). Individuals from cluster Arado had low mean linear measurements for the wither height (114.4 ± 0.8), body length (111.75 ± 2.1), and heart girth (134.65 ± 0.9) than those in cluster Barka whose respective values were 125.3 ± 0.6 , 126.8 ± 0.7 , and 156.4 ± 0.7 . Analysis of the data obtained from this study indicated the existence of a wide variation in morphological characteristics within and between cattle populations reared in Eritrea. This information is useful in design of a breeding program that utilizes the available within and between breed variation in enhancing productivity and profitability of indigenous cattle populations in Eritrea.

Keywords: Eritrea, Barka, Arado, Classification, Morphometric

iCB-2019-31

Effects of yeast and yeast cell wall polysaccharides supplementation on beef cattle growth performance, rumen microbial populations and lipopolysaccharides production.

Peng Quan-hui, Cheng Long, Kan Kun, Gang Tian, Gicheha Mathew, Xue Bai, Wang Lizhi, Zou Hua-wei, Al-Mamun Mohamud, Wang Zhi-sheng, 2019. *Journal of Integrative Agriculture*, 19(3), pp. 810-819. Doi: 10.1016/S2095-3119(19)62708-5

Abstract

This experiment was conducted to investigate the effects of live yeast and yeast cell wall polysaccharides on growth performance, rumen function and plasma lipopolysaccharides (LPS) content and immunity parameters of beef cattle. Forty Qinchuan cattle were randomly assigned to one of four treatments with 10 replicates in each treatment. The dietary treatments were: control diet (CTR), CTR supplemented with 1 g live yeast (2×10^{10} live cell g^{-1} per cattle per day (YST1), CTR supplemented with 2 g live yeast per cattle per day (YST2) and CTR supplemented with 20 g of yeast cell wall polysaccharides ($30.0\% \leq \beta$ -glucan $\leq 35.0\%$, and $28.0\% \leq$ mannanoligosaccharide $\leq 32.0\%$) per cattle per day (YCW). The average daily gain was higher ($P=0.023$) and feed conversion ratio was lower ($P=0.042$) for the YST2 than the CTR. The digestibility of neutral detergent fiber ($P=0.039$) and acid detergent fiber ($P=0.016$) were higher in yeast supplemented groups. The acetic acid: propionic acid of the YST2 was lower compared with the CTR ($P=0.033$). Plasma LPS ($P=0.032$), acute phase protein haptoglobin ($P=0.033$), plasma amyloid A ($P=0.015$) and histamine ($P=0.038$) were lower in the YST2 compared with the CTR.

The copies of fibrolytic microbial populations such as *Fibrobacter succinogenes* S85, *Ruminococcus albus* 7 and *Ruminococcus flavefaciens* FD-1 of the YST2 were higher ($P < 0.001$), while the copies of typical lactate producing bacteria *Streptococcus bovis* JB1 was lower ($P < 0.001$) compared with the CTR. Little differences were observed between the CTR, YST1 and YCW in growth performance, ruminal fermentation characteristics, microbial populations, immunity indices and total tract nutrient digestibility. It is concluded that the YST2 could promote fibrolytic microbial populations, decrease starch-utilizing bacteria, reduce LPS production in the rumen and LPS absorption into plasma and decrease inflammatory parameters, which can lead to an improvement in growth performance in beef cattle.

Keywords: live yeast; fiber degradability; rumen fermentation; immunity indices

iCB-2019-32

Effect of locally produced complementary foods on fat-free mass, linear growth, and iron status among Kenyan infants: A randomized controlled trial.

Konyole, S. O., Omollo, S. A., Kinyuru, J., Skau, J. K., Owuor, B. O., Estambale, B. B., Filteau, S. M., Michaelsen, K. F., Friis, H., Roos, N., & Owino, V. O., 2019. *Maternal & child nutrition*, 15 (4), pg. 1-12. Doi: 10.1111/mcn.12836

Abstract

The impact of quality complementary food products on infant growth and body composition has not been adequately investigated. This study evaluated the effect on fat-free mass (FFM) accrual, linear growth, and iron status of locally produced complementary food products comparing to a standard product. In a randomized, double-blind trial, 499 infants at 6 months received nine monthly rations of (a) WinFood Classic (WFC) comprising germinated amaranth (71%), maize (10.4%), small fish (3%), and edible termites (10%); (b) WinFood Lite (WFL) comprising germinated amaranth (82.5%), maize (10.2%), and multimicronutrient premix; or (c) fortified corn–soy blend plus (CSB+). Primary outcomes were changes in FFM, length, and plasma ferritin and transferrin receptors (TfR). FFM was determined using deuterium dilution. Analysis was by intention to treat, based on available cases. Compared with CSB+, there were no differences in change from 6 to 15 months in FFM for WFC 0.0 kg (95% CI [−0.30, 0.29]) and WFL 0.03 kg (95% CI [−0.25, 0.32]) and length change for WFC −0.3 cm (95% CI [−0.9, 0.4]) and WFL −0.3 cm (95% CI [−0.9, 0.3]). TfR increased in WFC group 3.3 mg L^{−1} (95% CI [1.7, 4.9]) and WFL group 1.7 mg L^{−1} (95% CI [0.1, 3.4]) compared with CSB+. Compared with the increase in Hb in CSB+ group, there was a reduction in Hb in WFC of −0.9 g dl^{−1} (95% CI [−1.3, −0.5]) and a lower increase in WFL −0.4 g dl^{−1} (95% CI [−0.8, 0.0]). In conclusion, the tested WinFoods had the same effect on FFM and length as CSB+, whereas Hb and iron status decreased, suggesting inhibited iron bioavailability from the amaranth-based WinFoods.

Keywords: animal-source foods, body composition, complementary feeding, deuterium dilution technique, edible termites, iron status

iCB-2019-33

Effects of NaCl and pH on the functional properties of edible crickets (*Acheta domesticus*) protein concentrate.

Ndiritu, A. K., Kinyuru, J., Gichuhi, P. N., & Kenji, G. M., 2019. *Journal of Food Measurement and Characterization*, 13, pp. 1788–1796 Doi: <https://doi.org/10.1007/s11694-019-00097-5>

Abstract

For a long time whole edible insects have been consumed in developing countries as part of food. With the aim of promoting food and nutrition security there is a focus on the industrial value addition of edible insects. The industrial utilization is hampered by limited information regarding the functionality of cricket proteins in food matrixes. Therefore this study aims at determining the NaCl and pH at which the functional properties of edible crickets' protein concentrates is optimum. Reared edible crickets were acquired from JKUAT farm in Kenya, freeze dried and ground to

powder. Two methods were used to extract the proteins namely; hexane and aqueous extraction. The protein solubility, water holding capacity, emulsion capacity and stability, foaming capacity and stability and least gelation concentration of the protein concentrates were determined separately using NaCl at concentrations of 2%, 4%, 6%, 8% and 12% and pH regimes of 2, 4, 6, 8 and 12 respectively. Protein solubility of the protein concentrates decreased from pH 2 to pH 8 followed by a significant increase at pH 12. Increase of NaCl concentration to 4% increased the water holding capacity followed by a decline towards 12%. pH had significant effect on the water holding capacity of the protein concentrates ($p = 0.0246$). Emulsion capacity decreased with increase in NaCl concentration up to 6% followed by an increase with continuous increase in NaCl concentration. NaCl and pH considerably influenced the foaming capacity of the protein concentrates. The least gelation concentration of the protein concentrates was 30%.

Keywords: Edible cricket · Hexane extract · Emulsion capacity · Protein concentrate · Protein solubility

iCB-2019-34

The Use of Insects as Food Ingredient.

Kinyuru, J., & Ng'ang'a, J., 2019. *Food Safety Magazine*, 9, pp. 1-6.

Abstract

Edible insects are a well-appreciated food source (entomophagy) in many regions of Africa, Asia, and the Americas. In Western countries, the use of insects as food and feed is gaining attention as consumers learn of the nutritional and environmental benefits associated with them. Globally, over 2,000 species are known to be edible and consumed by approximately 2 billion people. According to a global estimation, the most commonly consumed insects by humans are beetles (31%), caterpillars (18%), and bees, wasps, and ants (14%). In addition, consumption of grasshoppers, locusts, and crickets is about 13 percent, followed by cicadas, leafhoppers, plant hoppers, scale insects, and true bugs (10%), termites (3%), dragonflies (3%), flies (2%), and others (5%). Insect consumption is usually promoted for three major reasons: nutritional value, environmental benefits, and livelihood improvement (social and economic factors). The nutritional value (relative amount of proteins, fat, vitamins, and calories) compares favorably with that of meat and fish and can reduce nutrient deficiencies in populations consuming them. Furthermore, edible insects can be used in fortified blended foods in countries with food insecurity mainly because of their high protein and micronutrient content and the high bioavailability of nutrients. In terms of environmental benefits, insects emit less greenhouse gas and ammonia as they are mostly omnivorous and therefore could be raised on various organic waste/agricultural side streams. Edible insects have also been reported to contribute significantly to food security and livelihoods in most African countries where they are consumed. For instance, some communities trade the harvested insects to nearby markets, generating income to improve their livelihood.

iCB-2019-35

Microbial quality of edible grasshoppers *Ruspolia differens* (Orthoptera: Tettigoniidae): From wild harvesting to fork in the Kagera Region, Tanzania.

Ng'ang'a, J., Imathiu, S., Fombong, F., Ayieko, M., Vanden Broeck, J., & Kinyuru, J., 2019. *Journal of Food Safety*, 39(1), Pg. 574

Abstract

In Tanzania, edible *Ruspolia differens* are still harvested from the natural environments. In this perspective, little is known about the microbiological quality of wild harvested *R. differens*. This study was conducted to assess the microbiological quality of wild harvested *R. differens* and evaluate the efficacy of conventional processing methods in reducing microbial load. Two districts (Bukoba rural and Muleba) within the Kagera region were purposively selected for the study. Sampling was done from the same batches along the *R. differens* food chain as follows: (1) at harvest points in the villages, (2) after transportation to the market and plucking of wings and legs,

(3) after rinsing with potable tap water and (4) after processing using conventional methods. Generally, high microbial counts, i.e., total viable aerobic count (TVC), Enterobacteriaceae, lactic acid bacteria (LAB), bacterial endospores, and yeasts and moulds were observed in raw *R. differens* samples. A significant increase in microbial counts after transportation and plucking was only observed for TVC, bacterial endospores, and yeasts and moulds. A statistically significant reduction in all types of counts, with the exception of bacterial endospores, was observed after processing. All processed samples analyzed were devoid of salmonellae, *Listeria monocytogenes*, and *Escherichia coli*. Practical applications: Although commonly used processing methods of *R. differens* were effective in reducing microbial load, bacterial endospores were hardly eliminated and could pose a health hazard to consumers; thus, improved handling of *R. differens* along the food chain could reduce such risks.

Keywords: entomophagy, microbial counts, processing methods, bacterial endospores, handling

iCB-2019-36

Adoption of ‘Push -Pull’ Biological Control of Striga (*Striga hermonthica*) Weeds, Among Smallholder Maize Farmers in Homa Bay, Kenya.

D. Wanda, J. Ateka, and R. Mbeche, 2019. *Journal of Agriculture Science and Technology* 19(1) pp. 1-12

Abstract

Maize is the most important staple food for 96 percent of Kenya’s population. However, maize productivity in Kenya is low averaging 1800kg/ha compared to a yield potential of over 6000kg/ha. Weed management has been attributed as one of the key factors affecting Maize yields. Among the weeds, *Striga (Striga hermonthica)* is perhaps the most critical due to its ability to retard maize growth by competing for its nutrients with farmers reporting yield losses of up to 80 percent in infested fields. In recent times, the ‘push-pull’ biological method of striga weed control has been developed. The innovation controls *Striga* and stem borers by using repellent (push) and traps (pull) plants. Although there is evidence showing that this method is effective and environmentally friendly, few farmers have adopted it in striga infested areas of Homa Bay, in Kenya. This article assesses factors that influence farmers’ choice towards adoption of this push-pull innovation. A random sample of 96 smallholder farmers from Mbita and Homa Bay sub-counties were interviewed. Data analysis involved descriptive statistics, and probit regression model. Results show that the probability of adopting push -pull biological control increases with access to extension services ($p<0.01$); household size ($p<0.05$); returns from maize but decreases with limited access to markets ($p<0.05$). The findings suggest that addressing labour sourcing arrangements, enhancing the profitability of maize farming and putting in place the right institutional arrangements for extension and access to markets would enhance the adoption of the push-pull innovation.

Keywords: Adoption, push-pull innovations, biological weed control, *Striga* weed, maize yields, probit, Kenya

iCB-2019-37

Factors influencing crop commercialization among soybeans smallholder farmers in chipata district, eastern Zambia

Z. Kahenge, K. Muendo, and N. Nhamo., 2019. *Cogent Food & Agriculture*, 6(1), pg. 1797260..

Abstract

This study examined the socio-economic factors influencing household crop commercialization among soybeans smallholder farmers in Chipata District of Zambia. Purposive sampling was used to select four agricultural blocks. One agricultural camp was picked from each one of them based on the highest yields of the major crops. Farmer registers were used to develop a sampling frame in each camp. Then, random sampling procedure was used to select a total of 85 households. A semi-structured questionnaire was administered to the sample to collect the study data. Analysis

used the Tobit model and focused on the four major crops produced in the area that included maize, soybeans, groundnuts and sunflower. The output Household Commercialization Index (HCI) was used to measure the level of orientation towards market-led crop production. Results showed that all households' crop activities were commercialized to an extent. Maize, soybeans, groundnuts and sunflower had 50, 89, 9, 7 percent commercialization indices respectively. Tobit model results revealed that ownership to livestock was very important for effective crop commercialization ($p < 0.01$). Other factors included gender, land size, access to credit, household size, off-farm income and distance to markets which was significant at $p < 0.05$. Although the influence was weak, membership to farmer's organizations was also significant in explaining crop commercialization. The study recommended policies and efforts to promote better understanding of gender roles in agriculture and improved access to labour saving technologies such as simple machinery for production, harvesting and processing. Other recommendations include development of policies to reduce transaction costs to enhance access to affordable credit services for smallholder farmers. There is also need to encourage establishment of new farmer organizations and to strengthen the existing ones to ensure that they operate efficiently

Keywords: Crop Commercialization, Maize, Soybeans, Sunflower, Groundnuts, household, Zambia

iCB-2019-38

Determinants of intensity of utilization of Baobab products in Kenya

Collins Kiprotich, M. Muendo Kavoi & Dagmar Mithöfer, 2019. *Cogent Food & Agriculture*, 5(1), pg.1704163, <https://doi.org/10.1080/23311932.2019.1704163>

Abstract

Baobab tree is central to livelihoods of majority of rural communities living in marginal areas of Kenya in the wake of climate change, low agriculture productivity and falling food security. This study examined factors influencing intensity of utilization of baobab products in Kenya. Data on socio-economic, demographic characteristics, and attitude toward baobab pulp were collected from 353 consumers in rural and urban markets. Descriptive were used to describe consumer characteristics. Zero-truncated Poisson regression was used to analyze factors influencing intensity of utilization of baobab products. Exploratory factor analysis was used to assess the attitudes of consumers toward baobab pulp. The model results revealed that education level ($p < 0.01$) and household size ($p < 0.01$) negatively influenced the intensity of utilization, while years of product usage ($p < 0.01$), and awareness level ($p < 0.01$) had a positive influence. Exploratory factor analysis generated four factors that explained 61.16% of the total explained variance. "Availability, affordability, and income value" factor had the highest factor loading in the analysis, while "Trust and nutritive value" factor had the second highest loading. The study findings recommend strategies that could promote baobab utilization. This include; ensuring that baobab products are available, accessible, and affordable. Likewise, sustained product packaging, certification, and labeling are essential. Other promotional approaches include community nutritional training and information dissemination through both formal and informal education.

Keywords: Baobab products; intensity of utilization; attitudes; Zero truncated Poisson; rural; urban

iCB-2019-39

Factors affecting commercialization of African indigenous vegetables: A case study of Githunguri constituency of Kiambu County, Kenya.

Boro Paul & Majiwa Eucabeth, 2019. *Research Journal of Agriculture*, 6(8), pp. 1-9.

Abstract

African indigenous vegetables (AIVs) remain an important source of diet and income for many African households. However, its production still remains on a subsistence level. The study aimed at assessing the factors affecting commercialization of AIVs in Kenya using Githunguri

constituency as a case study. Data was collected from 80 randomly selected AIV farmers using questionnaires and interview schedule. Data analysis was done using descriptive statistics and regression analysis to determine the level of commercialization and its determinants. The results found that on average the commercialization index was 55% which implies that there was potential to increase production by 45%. Of the 80 farmers interviewed only 35% planted the AIVs purely for commercial purposes while the rest (65%) planted for subsistence and partly for commercial purposes. The results indicated that social-economic-factors had a significant impact on AIV commercialization. Such factors included access credit and agricultural extension services, market availability, land size, packaging and adoption of improved varieties had a positive influence on AIVs commercialization. On the other hand, age of the farmer, gender of the farmer, and market distance had a negative influence on the commercial production of AIVs. The level of education of the AIV farmers' as well as household income however were found to have no significant effect on commercialization of AIVs. The challenges faced by AIV farmers included pests and diseases, weather, yield variation between species, poor access to extension services, lack of reliable market and differences in consumer preferences for AIVs. Therefore, the study recommended that there is a need to increase farmers' access to credit and extension services. The study also recommended training of farmers on commercial production of AIVs. Further, there was need to address the challenges that affect the marketing of AIVs.

iCB-2019-40

'Does participation in farmer field school extension program improve crop yields? Evidence from smallholder tea production systems in Kenya'

Ateka, J.M., Onono- Okelo, P.A., & Etyang, M., 2019. *International Journal of Agricultural Management and Development*, 9(4), pp. 409-423

Abstract

Agricultural Extension services are among the most important rural services in developing countries. The services are considered to be a key driver of technological change and productivity growth in agriculture. In Kenya, like in the rest of the developing economies, agricultural extension has largely been delivered through supply-driven approaches. Due to perceived low impact of agricultural extension, the country is implementing the National Extension Policy (NEP) which advocates for demand-driven extension and participation of other players. Using the case of the smallholder tea sub-sector, this paper examines the effects the FFS extension on tea crop yields in Kenya. The FFS system uses participatory approaches including the demonstration of best sustainable practices in the farms and farmers learn by doing. Data for the study was collected from a sample of 525 farm households in Western Kenya using a multi stage random sampling procedure and analyzed using the propensity score matching (PSM) model which controls for self-selection endogeneity. The results show that participation in FFS extension increases annual tea yields by an average of 471.70 kgs per acre ($P = 0.009$) while the farmer-funded train and visit system has no influence on crop yields. A part from showing the contribution of FFS to crop yields, the paper demonstrates that the supply-driven extension models including T&V are necessary to stimulate demand in the initial stages of implementing the FFS models. Based on the findings, investments to enhance FFS access among smallholder farmers are recommended.

Keywords: FFS extension, train and visit, tea productivity, demand-driven extension services, propensity score matching, self-selection endogeneity

iCB-2019-41

Smallholder Dairy Farming Characterization, Typologies and Determinants in Nakuru and Nyandarua Counties, Kenya

Geoffrey Ochieng Otieno, Kavoi Muendo & Robert Mbeche

Abstract

Kenya's dairy industry is the largest and one of the most successful in Africa. Private sector dominates the sector and milk production is majorly from small-scale farms. Despite the policies in place for the dairy subsector, smallholder dairy farmers in Kenya still exhibit poor economic status mostly attributed to inefficiencies and inadequacies in production and commercialization that differs from farmer to farmer. This study established the smallholder dairy farming typologies and their underlying determinants. The study obtained data from a cross section survey of farmers in Nyandarua and Nakuru counties of Kenya where dairy activities are predominant. Data was collected from 380-smallholder dairy farmers identified using stratified random sampling. Data analysis was by Principal Components Analysis and Cluster Analysis. Results of Principal Component Analysis showed that the smallholders' dairy farming differed because of output, land, household assets and infrastructure components. Cluster Analysis results indicated three significantly different smallholder dairy farming typologies i.e. Low resource endowed and lower market oriented, Moderate resource endowed and moderate market oriented and high resource endowed and high market oriented. The determinants of smallholder dairy typologies were land factors, years of dairy farming, stock of dairy animals kept, labor engaged, household income, farming assets, dairy output and consumption levels and costs of production. The study recommended policies that would increase access to land through land reform processes, financial accessibility and adequate infrastructure needed by the smallholder dairy farmers.

Keywords: Smallholder Dairy, Principal Components Analysis, Cluster Analysis, Characterization, Farming Typologies, Kenya

iCB-2019-42

Effect of Board Size on the Financial Performance of Supermarkets in Kenya: A Case of Nairobi County

Micah Kipkirui Cheruiyot & Antony Sije, 2019. *International Journal of Social Science and Humanities Research*, 7(1), pp. 311-319.

Abstract

The main objective of this study was to assess the effect of the board composition on the financial performance of supermarkets in Kenya. The study used descriptive research design. The total target population was 30 supermarkets in Nairobi County selected based on monthly sales of Ksh.150, 000 and above and with a minimum of two branches. This study collected primary data by use of semi-structured questionnaires. Purposive sampling technique was used to pick respondents from the management of these supermarkets as they were deemed to be the ones with crucial information for this study. Validity and reliability of the instruments for research was tested through a pre-test. Cronbach alpha test was utilized to test for reliability of this paper. The analysis of Multiple Regression (Standard), Descriptive Statistics and Inferential statistics was used to analyze data. SPSS software (version 21.0) was adopted to assist in data analysis and presentation. The study used tables and charts to present the findings. The study found out that board size and financial performance are negatively related and significant and therefore the study concluded that a shrink in board size means an increase in supermarkets' financial performance and an increase in board size means a decrease in supermarkets' financial performance.

Keywords: Board Size, Financial Performance, Supermarkets, Corporate Governance.

iCB-2019-43

Influence of Organizational Culture on Performance Contracting in Public Secondary Schools in Kenya, a Case of Muranga County

Georgina Wanjiru Mathangani & Antony Sije, 2019. *International Journal of Social Science and Humanities Research*, 7(2), 974-983.

Abstract

The general objective of the study was to assess the influence of organizational culture on performance contracting in public secondary schools in Kenya focusing majorly on Muranga

County. The study concentrated on all Public Secondary Schools in Kandara Sub County. The field studies covered all public secondary schools in the five zones in the sub county which are Ithiru, Githumu, Gaichanjiru, Muruka and Kagundu zones. The theoretical framework in this study was; Geert Hofstede Culture theory, Max Weber Bureaucratic theory and Situated Learning or Cognition theory. The study employed descriptive and inferential statistics. In this study, the targeted population were 55 secondary school head teachers and 55 deputy head teachers in Kandara Sub County, Murang'a County a total of 110. Since the population size is too small the study involved a census survey where all the 55 secondary heads and 55 deputies were issued with questionnaires. Primary data was collected through the use of questionnaires with the pilot study conducted in Gatanga Sub County on 38 respondents. Data analysis involved both quantitative and qualitative procedures with descriptive and inferential statistics procedures in application. The statistical package for social sciences (SPSS) Computer software Version 22 was used in data analysis. The data was presented in form of tables, percentage bar graphs and pie charts. The study found out that organization culture was significant in predicting performance contracting. The study therefore concluded that key policy makers and policies emanate from the political wing of the government. Politicians rather than professional policy makers are the ones wielding the power to chart the future direction and performance of public entities.

Keywords: Organizational Culture, Performance contracting, Public Secondary Schools.

iCB-2019-44

Influence of Corporate Governance on Competitiveness among Retail Supermarkets in Kenya

Peace Tusasirwe & Antony Sije, 2019. *International Journal of Social Science and Humanities Research*, 7(2), pp. 829-836.

Abstract

The Main objective of this study was to determine the influence of corporate governance on competitiveness among the retail supermarkets in Nairobi, Kenya. Census survey was used to collect data from the respondents. Census was used as the target population of middle level managers; junior level managers and senior level managers. The total target population was 90. A total of 71 respondents were used as the sample size for the study. Primary and secondary data were used. While self-administered questionnaires and interview guides were used to collect primary data, the study reviewed the previous evaluation reports to seek the secondary data on competitiveness. The study used two regression models. The results of this study are to benefit policy makers, managers, administrators, entrepreneurs, consultants, scholars and trainers involved in strategic management. This study tested the null hypotheses that corporate governance has no significant influence on the competitiveness of retail supermarkets in Nairobi Kenya. The questionnaire was tested for validity and reliability. Quantitative and qualitative techniques were used to analyze the collected data with the assistance of Statistical Package for Social Sciences (SPSS) software. The study findings suggest that corporate government significantly contributes to supermarket competitiveness in Kenya. The study recommends that supermarkets should seek to increase geographical expansion as it holds significant benefits in competitive advantages; the government and other supermarket developmental organizations should formulate corporate governance standards and principles that are exclusive to supermarkets in order to improve compliance.

Keywords: Corporate Governance, Competitiveness, Competitive Advantage, Retail Supermarkets.

iCB-2019-45

Influence of Organizational Culture on Implementation of Smart Home Technologies at Safaricom in Kenya

Elaine Ngina Kyalo & Antony Sije, 2019. *International Journal of Social Science and Humanities Research*, 7(2) pp. 758-765.

Abstract

The general objective of the study was to investigate the influence of organizational culture on strategy implementation in Safaricom's Smart Home Technology. The research study applied descriptive research design. The target population of this study was 120 top, middle and low level management staffs of Safaricom's Smart Home Technology department. A sample of 92 was selected from within each group in proportions that each group bears to the study population using Israel method sampling technique. The study used questionnaires as data collection instruments for the research distributed through drop and pick later method. Data collected was purely quantitative and was analyzed by descriptive analysis. Statistical Package for Social Sciences (SPSS) and MS Excel helped the researcher to describe the data and determine the extent used. The study found out that number of respondents noted that organizational culture has high influence on the implementation of Smart Technologies at Safaricom PLC in Kenya. Majority also recognized that understanding the existing culture in an organization enables one identify the aspects that will aid the strategy implementation while also predicting the effects that these cultural components will have in the execution process.

Keywords: Organizational Culture, Smart Home Technologies, Strategy Implementation.

iCB-2019-46

Morphological Characterisation of Indigenous Cattle Breeds in Eritrea.

Goitom S., Gicheha M.G. Ng'eno, K., Njonge, F.K. 2019. *Advances in Animal and Veterinary Sciences*. 7, pp. 848-857. <http://dx.doi.org/10.17582/journal.aavs/2019/7.10.848.857>

Abstract

Cattle production plays important socio-economic roles at household and national levels in Eritrea. The grazed cattle sector dominates the agricultural production occurring mainly in pastoral and agro-pastoral systems. Indigenous cattle breeds are almost exclusively reared in the two production systems. The breeds have notable physical differences but no scientific research has been carried out to determine the extent of the morphological diversity. We hypothesized that there exist morphological differences that can distinguish the indigenous cattle population (ICPs) into distinct groups using the guidelines on morphological characterization of different livestock species provided by Food and Agriculture Organisation (FAO). A total of 4617 data were collected for analysis. This included data from 13 morphometric and physical characteristics measurements from 243 head of indigenous cattle spread in 27 populations in the three agro ecological zones of Eritrea. The measurements were equally shared between production and reproduction traits. Homogenous groups were formed from cluster analysis based on single-linkage agglomerative hierarchical and non-overlapping (SAHN) technique while discriminant function analysis was performed to ascertain the accuracy of the classification. The Eritrean ICPs clustered around two groups. These were the Highland and East Coast cluster (Arado) and the Western lowland cluster (Barka). Individuals from cluster Arado had low mean linear measurements for the wither height (114.4 ± 0.8), body length (111.75 ± 2.1), and heart girth (134.65 ± 0.9) than those in cluster Barka whose respective values were 125.3 ± 0.6 , 126.8 ± 0.7 , and 156.4 ± 0.7 . Analysis of the data obtained from this study indicated the existence of a wide variation in morphological characteristics within and between cattle populations reared in Eritrea. This information is useful in design of a breeding program that utilizes the available within and between breed variation in enhancing productivity and profitability of indigenous cattle populations in Eritrea.

Keywords: Eritrea, Barka, Arado, Classification, Morphometric

iCB-2019-47

Effects of yeast and yeast cell wall polysaccharides supplementation on beef cattle growth performance, rumen microbial populations and lipopolysaccharides production.

Peng Quan-hui, Cheng Long, Kan Kun, Gang Tian, Gicheha Mathew, Xue Bai, Wang Lizhi, Zou Hua-wei1, Al-Mamun Mohamud, Wang Zhi-sheng. 2019. *Journal of Integrative Agriculture*. 18, pp. 2–11

Abstract

This experiment was conducted to investigate the effects of live yeast and yeast cell wall polysaccharides on growth performance, rumen function and plasma lipopolysaccharides (LPS) content and immunity parameters of beef cattle. Forty Qinchuan cattle were randomly assigned to one of four treatments with 10 replicates in each treatment. The dietary treatments were: control diet (CTR), CTR supplemented with 1 g live yeast (2×10^{10} live cell g^{-1} per cattle per day (YST1), CTR supplemented with 2 g live yeast per cattle per day (YST2) and CTR supplemented with 20 g of yeast cell wall polysaccharides ($30.0\% \leq \beta\text{-glucan} \leq 35.0\%$, and $28.0\% \leq \text{mannan oligosaccharide} \leq 32.0\%$) per cattle per day (YCW). The average daily gain was higher ($P=0.023$) and feed conversion ratio was lower ($P=0.042$) for the YST2 than the CTR. The digestibility of neutral detergent fiber ($P=0.039$) and acid detergent fiber ($P=0.016$) were higher in yeast supplemented groups. The acetic acid: propionic acid of the YST2 was lower compared with the CTR ($P=0.033$). Plasma LPS ($P=0.032$), acute phase protein haptoglobin ($P=0.033$), plasma amyloid A ($P=0.015$) and histamine ($P=0.038$) were lower in the YST2 compared with the CTR. The copies of fibrolytic microbial populations such as *Fibrobacter succinogenes* S85, *Ruminococcus albus* 7 and *Ruminococcus flavefaciens* FD-1 of the YST2 were higher ($P<0.001$), while the copies of typical lactate producing bacteria *Streptococcus bovis* JB1 was lower ($P<0.001$) compared with the CTR. Little differences were observed between the CTR, YST1 and YCW in growth performance, ruminal fermentation characteristics, microbial populations, immunity indices and total tract nutrient digestibility. It is concluded that the YST2 could promote fibrolytic microbial populations, decrease starch-utilizing bacteria, reduce LPS production in the rumen and LPS absorption into plasma and decrease inflammatory parameters, which can lead to an improvement in growth performance in beef cattle.

Keywords: live yeast; fiber degradability; rumen fermentation; immunity indices

iCB-2019-48

Organ Pathology and Associated IFN- γ Variations in Mice Infected with *Toxoplasma gondii* isolate from Kenya.

Mose, J. M., Kamau, D. M., Kagira, J. M., Maina, N., Ngotho, M., Mutharia, L., & Karanja, S. M., 2019. In *Parasites and Parasitic Diseases*. IntechOpen. pp. 58-62. ISBN: 978-1-83880-128-1: Print ISBN: 978-1-83880-127-4.

Abstract

Toxoplasma gondii is an important foodborne opportunistic pathogen that causes a severe disease in immunocompromised patients. The pathology and immune responses associated with the ensuing disease have not been well described in strains from different parts of the world. The aim of the present study is to determine the IFN- γ and IL-10 variations and organ pathology in immunocompetent and immunocompromised mice infected with *T. gondii* isolated from a Kenyan chicken. Two groups of BALB/c mice were infected with *T. gondii* cysts and administered with dexamethasone (DXM) in drinking water. Other two groups: infected untreated and uninfected mice were kept as controls. The mice were euthanized at various time points: blood collected for serum and assayed for IFN- γ and IL-10 variations. After infection, significant ($p<0.05$) elevated levels of IFN- γ and IL-10 were observed. A significant decline in IFN- γ and IL-10 levels ($p<0.05$) was observed after dexamethasone treatment. Histological sections in the liver, heart, and spleen of the mice administered with DXM revealed various degrees of inflammation characterized by

infiltration of inflammatory cells. The dexamethasone-treated mice presented with progressively increased ($p < 0.001$) inflammatory responses is compared with the infected untreated mice.

iCB-2019-49

Toxicity and anthelmintic efficacy of chitosan encapsulated bromelain against gastrointestinal strongyles in Small East African goats in Kenya.

Wasso W., Naomi Maina and John Kagira, 2019. *Veterinary World*, 13(1), pp. 177-183.

Abstract

Background and Aim: The development of resistance to anthelmintic drugs has prompted research into alternative methods of controlling intestinal nematodes in ruminants. This study aimed at evaluating the in vitro and in vivo anthelmintic efficacy and toxicity of chitosan encapsulated bromelain in Small East African goats in Kenya. **Materials and Methods:** Adult mortality assay was performed using live *Haemonchus contortus* worms treated with encapsulated bromelain solution ranging from 0.125 mg/ml to 2 mg/ml. Percentage mortality of worms was calculated after 24 h and the lethal concentration 50% (LC50) determined. For the in vivo study, 18 healthy male indigenous goats were divided into six groups of three goats each. The encapsulated bromelain was orally administered in increasing dosages (3-30 mg/kg) once daily, for 14 days. The packed cell volume (PCV), aspartate aminotransferase (AST), alanine aminotransferase (ALT), urea, creatinine, and fecal egg count (FEC) were determined on a weekly basis. At the end of the study, the goats were sacrificed and gross pathology and histopathology of main organs assessed. **Results:** Albendazole had the highest ($p < 0.05$) anthelmintic effect on the worms. An LC50 of 0.05 mg/ml, 0.445 mg/ml, and 0.155 mg/ml was observed for albendazole, plain bromelain, and encapsulated bromelain, respectively. The PCV of treated and untreated goats did not show any significant difference ($p > 0.05$), varied from 29.3% to 35.1%, and was within the normal range of the animal. Likewise, no significant differences ($p > 0.05$) were observed between the AST, ALT, urea, and creatinine levels of treated and the control (non-treated) goats. No adverse clinical symptoms, toxicity of the main organs, and mortality in goats were associated with the chitosan encapsulated bromelain after administration of dose up to 30 mg/kg for 14 days. Therefore, the lethal dose 50 of encapsulated bromelain may be considered to be > 30 mg/kg. On day 28 posttreatment, the encapsulated bromelain showed a higher in vivo FEC reduction (68.8%) as compared to the plain bromelain (32.4%). **Conclusion:** Our results show that bromelain encapsulated in chitosan may be safe and effective in reducing the burden of gastrointestinal tract strongyle nematodes in goats. However, there is a need for further studies to establish the dosage of the encapsulated bromelain to be administered in a single dose for the treatment of goats against gastrointestinal strongyles. In addition, species-specific studies on the efficacy of encapsulated bromelain on strongyles are necessary to evaluate its effectiveness against the entire Strongyloidea family.

iCB-2019-50

Prevalence and monetary loss due to cystic echinococcosis in slaughter house livestock: A case study of Migori County, Kenya.

Kere O.J., E. Joeph, B.L. Jessika, B.L., Kagira J.M., 2019. *Parasite Epidemiology and Control*, 5(3), pp. 1-8. <https://doi.org/10.1016/j.parepi.2019.e00105>

Abstract

Cystic Echinococcosis (CE) is a parasitic zoonotic disease of public health importance that causes considerable economic loss worldwide. The aim of this study was to assess the prevalence and monetary loss of CE in livestock slaughtered in Migori County, Kenya. The study was conducted by retrieving and analyzing secondary data over a ten year period (2007-2016) and; these were annual meat inspection reports from the sub county veterinary offices within Migori County, Kenya. The data included species of slaughter animals, number of each species slaughtered and number of animal organs condemned due to presence of hydatid cysts recorded. The results

showed CE prevalence was highest in cattle (5.3%) followed by goats (2.0%) and the least affected were sheep (0.1%). The overall direct monetary loss of \$152,003/year. The study results confirms occurrence of CE in Migori County and demonstrates emerging new foci of the zoonosis in other non-endemic regions of Kenya with a significant direct monetary loss, a phenomenon that require serious attention to prevent and control the zoonosis in Kenya.

iCB-2019-51

Probiotics and Poultry Gut Microflora.

Kibrnesh Tegenaw Tsega, John Kagira Maina and Nega Berhane Tesema, 2019. *Journal of World Poultry Research* 9(4) pp. 217-223

Abstract

Poultry production is presently the most effective animal production industry and provides an excellent source of protein production worldwide. The poultry gastrointestinal microbiota includes commensal, mutualistic and pathogenic microbes. The relationship between host and gut microbiota can affect the balance of mutualism and pathogenicity. The imbalanced gut microflora caused by the incidence of disease, hygiene conditions, diet, management practices, and environmental stress affects the survival and productivity of chicken. Maintenance of the gut microbial composition is possible through the regulation of the gastrointestinal microbiota by suppressing the growth of pathogens. For many years, antibiotic growth promoters have been used to manage these problems. Nowadays, because of the emergence of antibiotic-resistant bacteria, other alternatives are being sought. Supplementation of probiotics as feed additives is considered to enhance chicken productivity and to protect the gut from pathogen colonization and help to tolerate environmental stress. The goal of the present article was to review the poultry gastrointestinal microflora and probiotics role in the health and growth of poultry. In addition, this article focused on probiotic microorganisms and their potential characteristics

iCB-2019-52

Zoonotic Hemoparasites of Baboons (*Papio Anubis*) at the Human-Wildlife Interface in Kenya.

Maloba F., Mwangi D., Kagira J. M, Kivai S., Ndeereh D., Ngotho J., Gicheru M., Mbaruk S., Akinyi M., 2019. *International Journal of Zoology and Animal Biology*, 2 (5), pp. 1-9. Doi: 10.23880/izab-16000172

Abstract

In Kenya, the encroachment of baboon habitats has led to increased interaction between humans and non-human primates (NHP). This increases the chance of zoonotic transmission between wildlife and humans. The current study investigated the protozoan hemoparasites of olive baboons (*Papio anubis*) at the human–baboon interface in Tsavo West National Park (TWNP) and Tana River Primate Reserve (TRPR) where wildlife, especially baboons, freely roam and share habitats with humans. One hundred and six (106) baboons were trapped, anaesthetized, physically examined, and sampled for blood and ectoparasites. Thin blood smears were prepared and examined for differential leucocyte counts and hemoparasites. EDTA blood was used for determining total hematological counts and species of hemoparasites using Polymerase Chain Reaction (PCR). Lymphadenopathy was observed in all (100%) baboons from Tsavo and 66.7% in Tana. When blood smears were used, the prevalence of hemoparasites in TWNP and TRPR baboons were *Hepaticystis kochi* (70%, 64.4%), *Entopolypoides macaci* (0%, 4.4%), *Babesia microti* (0%, 4.4%), and *Plasmodium* spp. (1.7%, 0%) respectively. When PCR was used, the prevalence of hemoparasites in TWNP and TRPR baboons were *Hepaticystis kochi* (87%, 90%), *Babesia* (10.8%, 16.7%) and *Entopolypoides* (8.7%, 5%) respectively. There was a significant difference ($P<0.05$) in the prevalences of *Entopolypoides macaci* and *Babesia microti* between the two sites. The prevalence of ticks observed in TWNP and TRPR baboons was 28% and 23.3%, respectively. The species of ticks included *Rhipicephalus simus*, *Rhipicephalus pulchellus* and

Hyalomma truncatum. The study showed that the baboons were infected with a variety of parasites of which *Entopolypoides macaci* and *Babesia microti* are of zoonotic significance. The relevant authorities should put in place measures aiming to reduce human-baboon interactions hence chances of zoonotic transmission from the animals

iCB-2019-53

Effects of *Mondia Whitei* ‘Mukombero’ on Sperm Parameters in Male Albino Rats.

Mabonga C., D. Kamau, J. Kagira, F. Alkizim and Nandwa A., 2019. *Africa Environmental Review Journal* 3 (2) pp. 58-69.

Abstract

Infertility affects about 8 to 12% of the world’s population and, in about half of cases, men are either the single cause or contribute to the couple’s infertility. Many indigenous plants have been reported to be effective in male fertility regulation. *Mondia whitei* is a widely used medicinal plant across Africa for treatment of sexual dysfunction yet minimal empirical data exists to support its therapeutic value. The aim of this study was to evaluate the effects of aqueous extract of *Mondia whitei* on sperm characteristics in male albino rats following oral administration. 36 albino male rats weighing between 200mg-400mg were divided into 4 groups, each of nine rats. Group I comprised untreated controls while Groups II, III, and IV were treated with 100, 200 and 400mg/kg body weight respectively using the aqueous extract of *Mondia whitei* via oral gavage. At the end of experiment, rats were humanely sacrificed using Carbon dioxide, the testes and epididymis, dissected for sperm collection. Sperm count, total motility, vitality and morphology were determined using a microscope and a Neubauer’s chamber. Data was analyzed using Statistical Package for Social Sciences (SPSS) -Version 20.0). Kruskal wallis test was employed in the analysis. $P < 0.05$ was considered statistically significant. The median (IQR) sperm count of group I, II, III and IV at 10th day were 100.03 (100.03, 100.04) 10398 (98, 101), 96.66 (96.65, 96.68) and 100.98 (100.88, 101.47) cells/ml respectively. The difference was statistically significant ($\chi^2=8.157$, $p=0.043$). Trend analysis indicated that within the groups, sperm count decreased significantly with increase in time (all $p < 0.05$). The median (IQR) total sperm motility (percentage) of group I, II, III and IV at 10th day were 91 (90, 92) 84 (81, 85), 86 (84, 88) and 88 (84, 89) respectively and the difference was statistically significant ($\chi^2=7.686$, $p=0.049$). The median (IQR) sperm vitality in percentage of group I, II, III and IV at 10th day were 91 (90, 91), 85 (82, 86), 87 (85, 89) and 89 (86, 90) respectively. The difference was statistically significant ($\chi^2=8.286$, $p=0.040$). Though trend analysis indicated that it did not vary significantly within the groups (all $p > 0.05$). Normal morphology percentage declined in different test groups as compared to the control groups. A statistically significant decline in normal morphology was observed within the groups with respect to time interval ($p=0.027$). Trend analysis indicated that within the groups, normal morphology decreased significantly with time (all $p < 0.05$) while abnormal head morphology and tail increased with time $p=0.05$. This study concludes that *Mondia whitei* may alter male fertility by affecting sperm quality; it causes a decline in sperm count, morphology, motility and vitality. This shows that *M. whitei* might be cytotoxic and can result in hypogonadotropic hypogonadism and oligoasthenoteratozoospermia.

iCB-2019-54

Effect of Dietary Replacement of Fishmeal by Insect Meal on Growth Performance, Blood Profiles and Economics of Growing Pigs in Kenya.

Chia S. Y., C. M. Tanga, I. M. Osuga, A. O. Alaru, D. M. Mwangi, M. Githinji, S. Subramanian, K. K. M. Fiaboe, S. Ekesi, J. J.A. van Loon and M. Dicke, 2019. *Animals*, 9(10), pg. 705. <https://doi.org/10.3390/ani9100705>.

Abstract

Pig production is one of the fastest growing livestock sectors. Development of this sector is hampered by rapidly increasing costs of fishmeal (FM), which is a common protein source in

animal feeds. Here, we explored the potential of substituting FM with black soldier fly larval meal (BSFLM) on growth and blood parameters of pigs as well as economic aspects. At weaning, 40 hybrid pigs, i.e., crossbreeds of purebred Large White and Landrace were randomly assigned to five iso-nitrogenous and iso-energetic dietary treatments: Control (0% BSFLM and 100% FM (T0)), and FM replaced at 25% (T25), 50% (T50), and 75% (T75) and 100% (T100) with BSFLM. Average daily feed intake (ADFI), average daily gain (ADG), body weight gain (BWG) and feed conversion ratio (FCR) were calculated for the whole trial. Hematological and serum biochemical parameters, the cost–benefit ratio (CBR) and return on investment (RoI) were evaluated. No significant effect of diet type was observed on feed intake and daily weight gain. Red or white blood cell indices did not differ among diets. Pigs fed T25, T75 and T100, had lower platelet counts compared to T0 and T50. Dietary inclusion of BSFLM did not affect blood total cholesterol, triglycerides, low-density lipoprotein and high-density lipoprotein. CBR and RoI were similar for the various diets. In conclusion, BSFLM is a suitable and cost-effective alternative to fishmeal in feed for growing pigs.

iCB-2019-55

The nutritive value of black soldier fly larvae reared on common organic waste streams in Kenya.

Marwa S., I. M. Osga, F. M. Khamis, C. M. Tanga, K. K. M. Fiaboe, S. Subramanian, S. Ekesi, A. Huis and C. Borgemeister, 2019. *Scientific Reports*, 9, pg. 101110. .
<https://doi:10.1038/s41598-019-46603-z>

Abstract

In Africa, livestock production currently accounts for about 30% of the gross value of agricultural production. However, production is struggling to keep up with the demands of expanding human populations, the rise in urbanization and the associated shifts in diet habits. High costs of feed prevent the livestock sector from thriving and to meet the rising demand. Insects have been identified as potential alternatives to the conventionally used protein sources in livestock feed due to their rich nutrients content and the fact that they can be reared on organic side streams. Substrates derived from organic by-products are suitable for industrial large-scale production of insect meal. Thus, a holistic comparison of the nutritive value of Black Soldier Fly larvae (BSFL) reared on three different organic substrates, i.e. chicken manure (CM), brewers' spent grain (SG) and kitchen waste (KW), was conducted. BSFL samples reared on every substrate were collected for chemical analysis after the feeding process. Five-hundred (500) neonatal BSFL were placed in 23 × 15 cm metallic trays on the respective substrates for a period of 3–4 weeks at 28 ± 2 °C and 65 ± 5% relative humidity. The larvae were harvested when the prepupal stage was reached using a 5 mm mesh size sieve. A sample of 200 grams prepupae was taken from each replicate and pooled for every substrate and then frozen at –20 °C for chemical analysis. Samples of BSFL and substrates were analyzed for dry matter (DM), crude protein (CP), ether extracts (EE), ash, acid detergent fibre (ADF), neutral detergent fibre (NDF), amino acids (AA), fatty acids (FA), vitamins, flavonoids, minerals and aflatoxins. The data were then subjected to analysis of variance (ANOVA) using general linear model procedure. BSFL differed in terms of nutrient composition depending on the organic substrates they were reared on. CP, EE, minerals, amino acids, ADF and NDF but not vitamins were affected by the different rearing substrates. BSFL fed on different substrates exhibited different accumulation patterns of minerals, with CM resulting in the largest turnover of minerals. Low concentrations of heavy metals (cadmium and lead) were detected in the BSFL, but no traces of aflatoxins were found. In conclusion, it is possible to take advantage of the readily available organic waste streams in Kenya to produce nutrient-rich BSFL-derived feed.

iCB-2019-56

Experimental feeding studies with crickets and locusts on the use of feed mixtures composed of storable feed materials commonly used in livestock production.

Straub P., C. M. Tanga, I. Osuga, W. Windisch and S. Subramanian, 2019. *Animal Feed Science and Technology*, 255, pg.114215. <https://doi.org/10.1016/j.anifeedsci.2019.114215>

Abstract

Insects such as the Mediterranean field cricket, *Gryllus bimaculatus* and the Desert locust, *Schistocerca gregaria*, are emerging as potential sources of human food and feed for livestock. High nutritive value and efficient feed conversion make them attractive for commercial production as novel livestock, but these properties strongly vary with the insects' diet. Current mass rearing protocols are based on fresh, non-storable feed materials. This requires constant supply and makes the systems sensitive to fluctuations regarding nutritional quality and safety. Hence there is a need to find storable, readily available feeds. Therefore, experimental diets were composed from the five different feed materials, corn meal; soya extracts; dried cowpea leave; corn stover; dried carrot; and a vitamin supplement. The diets were formulated such as to vary in macro-nutrient and vitamin content. Effects of these diets on consumption, biomass gain, feed conversion and nutritional composition of the insects were assessed. Crickets were fed a combination of corn meal and cowpea leave ("Starch") and a combination of soya extract and corn stover ("Protein/fiber"). Locusts were fed "Starch" and "Protein/fiber" and variations of these, supplemented with vitamins and carrot ("Protein/fiber/carrot" and "Starch/carrot"). Additionally, a combination of cowpea leaves and soya extract, supplemented with vitamins and carrot ("Protein/carrot"), was tested on locusts. Crickets grew and gained biomass relatively well when fed "Starch" but struggled with digestion of the high-fiber diet "Protein/fiber". Locusts fed "Starch" and "Protein/fiber" failed to gain biomass or performed poorly. When supplementing these diets with vitamins and carrot, locusts on "Starch/carrot" failed to grow while locusts fed "Protein/fiber/carrot" could gain biomass and showed excellent feed conversion. Accordingly, vitamin supplementation of this diet had a positive impact. Locusts fed "Protein/carrot" showed the best results regarding feeding efficiency and production figures. All tested feed materials were accepted by the insects. Therefore, these feed materials may replace fresh feed materials and may thus improve efficiency and safety of insect production systems. Indeed, certain diet formulations revealed nutritional limitations. They might serve as model diets to derive nutritional requirements of insects e.g. for protein, amino acids or vitamins.

iCB-2019-57

Repellent activity of *Cymbopogon citratus* and *Tagetes minuta* and their specific volatiles against *Megalurothrips sjostedti*

Diabate, S., Martin, T., Murungi, L. K., Fiaboe, K. K., Subramanian, S., Wesonga, J., & Deletre, E., 2019. *Journal of Applied Entomology*, 143(8), pp. 855-866. <https://doi.org/10.1111/jen.12651>

Abstract

Cowpea is an important source of protein for people in Africa. However, the crop suffers major damage and yield losses due to bean flower thrips, *Megalurothrips sjostedti* Trybom (Thysanoptera: Thripidae). Although companion plants are known to reduce the damage caused by insect pests, the role of their volatiles in repelling pests from target plants has been the subject of few investigations. Here, we used the Y-tube olfactometer experiments and chemical analyses to investigate the effect of volatiles from cowpea flowers and two companion plants; lemongrass, *Cymbopogon citratus* and Mexican marigold, *Tagetes minuta* on the olfactory responses of *M. sjostedti*. The results revealed that *M. sjostedti* males and females were repelled by the volatiles from freshly cut leaves of *C. citratus*. The combination of freshly cut leaves of *C. citratus* and cowpea flower was repellent to females but not to males. The female thrips, but not males, were repelled by the volatiles from the vegetative stage of *T. minuta*. Fifty-four compounds were identified in the volatiles from two herbal plants. Among the major compounds, citral and a 4-

component blend comprised of dihydrotageton, (Z) -3-hexenyl acetate, limonene and (Z) - β -ocimene repelled females but dihydrotageton alone attracted females. While myrcene combined with cowpea flower volatiles enhanced the attraction of females *M. sjostedti*, when tested alone was not attractive. These results highlight the potential of volatiles from *C. citratus* and *T. minuta* to repel *M. sjostedti* females. The use of these plants as companion plants in a cowpea cropping system could reduce *M. sjostedti* infestation.

iCB-2019-58

Diversity and abundance of insect pollinators and their effect on yield and quality of cowpea and cucumber in Makueni, Kenya.

Njeri, S., Murungi, L.K., Kioko, E., 2019. *African Journal of Horticultural Sciences*. 16, pp. 43-54 <http://hakenya.net/ajhs/index.php/ajhs/article/view/228>

Abstract

Inadequate pollination is one of the key limitations in crop yield and quality of key vegetable crops. Cowpea and cucumber are crops of economic importance in Makueni county-Kenya. A study of insect pollinators and their role on yield and quality of cowpea and cucumber was conducted during the short and long rain seasons in 2017 and 2018 respectively in Kikome, Makueni- Eastern Kenya. The experiment was laid out as a split plot in a randomized complete block design with three replications and involved bagged and unbagged treatments. Eight insect pollinator species (4 orders, 7 families) were recorded on cowpea flowers and 10 species (4 orders, 8 families) on cucumber flowers. In cowpea, the abundance of Hymenoptera was maximum (5 species) while the orders Coleoptera, Lepidoptera and Hemiptera were each represented by a single insect pollinator. *Apis mellifera* was the most abundant of all insect pollinators observed (96.58% and 52.44% during the short and long rain seasons respectively). The peak foraging activity of *Apis mellifera* was recorded between 8:00am to 9:00am and 7:00am-8:00am during the short and long rain seasons respectively. In cucumber, abundance of Hemiptera was maximum (5 species) followed by Hymenoptera (3 species) and Lepidoptera (2 species), while Coleoptera and Diptera were each represented by a single species. *Apis mellifera* was the most abundant of all insect pollinators observed (96.50% and 64.29% during the short and long rain seasons respectively). The peak foraging activity of *Apis mellifera* was recorded between 8:00am to 9:00am and 9:00am -10:00am during the short and long rain seasons respectively. Unbagged treatments had significantly higher yield and germination percentage than the bagged treatments in both test crops ($p < 0.05$). This study highlights the importance of insect pollination as an additional input in enhancing the yield and quality of cowpea and cucumber in Makueni-Eastern Kenya.

Keywords: Insect pollinators, Diversity, Cowpea, Cucumber, Insect, Yield, Makueni

iCB-2019-59

Behavioural response of alate *Aphis craccivora* Koch (Homoptera: Aphididae) to volatiles from different cowpea cultivars

Diabate, S., Deletre, E., Murungi, L. K., Fiaboe, K. K., Wesonga, J., & Martin, T., 2019. *Journal of Applied Entomology*, 143(6), pp. 659-669. <https://doi.org/10.1111/jen.12633>

Abstract

The cowpea aphid, *Aphis craccivora*, is a major insect pest of cowpea in Africa. Volatile organic compounds (VOCs) mediate plant–arthropod interactions that could be used in the management of insect pests. In this study, we established the VOC profile involved in the interaction between *A. craccivora* and four cowpea cultivars, namely Ex-Luanda, Katumani 80, Machakos 66 and Ken Kunde 1. Behavioural assays were conducted to study host preference and gas chromatography-mass spectrometry (GC/MS) for chemical analysis of volatiles. In preference assays, alate *A. craccivora* had no significant preference for any of the four cowpea cultivars tested. However, in the olfactometer assays, the aphids showed a significant preference for odours from

cultivar Ex-Luanda compared to Katumani 80. Machakos 66 and Ken Kunde 1 elicited neutral responses. In pairwise comparisons, alate *A. craccivora* did not distinguish between odours of respective cowpea cultivars. GC/MS analysis identified 23 compounds in the volatiles of the four cowpea cultivars. Not all compounds were detected in all cowpea cultivars, and the detected compounds amounts varied in each cultivar. Of these, only four compounds (hexanal, (E)-2-hexenal, 1-octen-3-ol and p-xylene) were emitted in significantly different quantities in the four cultivars. A blend of hexanal and (E)-2-hexenal added to cowpea cultivar Ex-Luanda decreased its attractiveness to *A. craccivora* compared to the control. Our findings showed differential attractiveness of VOCs of cowpea cultivars to *A. craccivora*, suggesting that VOCs could be used in the management of *A. craccivora*.

iCB-2019-60

Behavioural responses of bean flower thrips (*Megalurothrips sjostedti*) to vegetative and floral volatiles from different cowpea cultivars

Diabate, S., Deletre, E., Murungi, L. K., Fiaboe, K. K., Subramanian, S., Wesonga, J., & Martin, T., 2019. *Chemoecology*, 29(2), 73-88. DOI: 10.1007/s00049-019-00278-0

Abstract

Bean flower thrips (*Megalurothrips sjostedti*) is a key pest of cowpea (*Vigna unguiculata*) in Africa. To better understand the interaction of *M. sjostedti* to cowpea cultivars to improve management efforts, we investigated the repellent properties of volatiles of four cowpea cultivars, namely Ex-Luanda, Machakos, Ken Kunde 1 and Katumani 80 at different phenological stages. Bioassays were conducted to study host preference and gas chromatography–mass spectrometry for chemical analysis of volatiles. Our results showed no significant preference of females *M. sjostedti* for any cowpea cultivars tested in preference assays. However, in olfactometer, the volatiles emitted during the vegetative stage of only Ex-Luanda, Machakos and Katumani 80 cultivars were repellent to females, while only Ken Kunde 1 was repellent to males. Volatiles from flowers of Ken Kunde 1 were attractive to females, whereas volatiles from the flowers of Katumani 80 were repellent, respectively. Ex-Luanda and Machakos elicited neutral response. Flowers of Machakos 66 and Ex-Luanda cultivars were repellent to males, while Katumani 80 and Ken Kunde 1 were neutral. The volatile analysis showed that (E)- β -ocimene and 1-octen-3-ol were unique to the volatile profile of Katumani 80 flowers. Previous study showed that (E)-2-hexenal and hexanal were only abundant in the vegetative stage of Katumani 80. (E)-2-hexenal was repellent to the females at a concentration of 0.01% but not at 1%. Hexanal, (E)- β -ocimene and 1-octen-3-ol elicited a neutral response from females at 0.01% and 1%. Our study indicates that (E)-2-hexenal could be useful in the development of semiochemical-based repellent tools for *M. sjostedti* management.

iCB-2019-61

Behavioral response of the small hive beetle, *Aethina tumida* (Coleoptera: Nitidulidae) to volatiles of Apicure®, a plant-based extract.

Komen, E., Murungi, L. K., & Irungu, J., 2019. *African Academy of Sciences Open Research*, 2(9), pg. 9. DOI: 10.12688/aasopenres.12946.1

Abstract

The small hive beetle (SHB), *Aethina tumida* is an invasive pest of the honey bee. Although no previous methods have led to its successful management, yeast inoculated pollen baited-traps have showed promise as quick monitoring tools. In this study, we evaluated the role of olfaction in SHB response to Apicure®, an essential oil-based biopesticide that has shown potential for the management of honey bee pests and diseases. Volatiles from Apicure® were collected using super Q adsorbent traps. Subsequent analysis was done using Gas chromatography- mass spectrophotometry (GC-MS) to ascertain the components of Apicure®. The selectivity and sensitivity of antennal receptors of *A. tumida* adults to the volatile compounds were determined

using behavioral assays and Gas Chromatography-Electroantennodetection (GC-EAD). GC-MS analysis showed that Apicure® consists of 40 compounds. GC-EAD analysis isolated 11 compounds that elicited antennal response with the SHB. Of these, linalool, camphor, geraniol and α -terpineol were confirmed to be strongly repellent, while limonene was attractive to SHB in dual-choice olfactometer assays. Our results demonstrate that the major components in Apicure® are mainly repellents thus prospective in disrupting the host recognition by the SHB. The product therefore can be up-scaled for the management of SHB.

Keywords: *Aethina tumida*, Apicure®, electroantennography, hive pests, honey bee, monoterpenes, olfaction, repellents, sesquiterpenes

iCB-2019-62

Soil chemical properties influence abundance of nematode trophic groups and *Ralstonia solanacearum* in high tunnel tomato production

Ngeno, D. C., Murungi, L. K., Fundi, D. I., Wekesa, V., Haukeland, S., & Mbaka, J., 2019. *African Academy of Sciences Open Research*, 2(3), pg. 3. DOI: 10.12688/aasopenres.12932.1

Abstract

Plant parasitic nematodes (PPNs) and bacterial wilt (*Ralstonia solanacearum*) are serious soil-borne pests in tomato (*Solanum lycopersicon* L) production in high tunnels. This study was undertaken to determine effects of soil chemical properties on their abundance. Soil samples were collected from 32 high tunnels in the sub-counties: Gatundu North, Gatundu South, Juja, Thika, Ruiru and Kiambu, Kenya, from January to November 2016. Nematode genera, *R. solanacearum* and soil chemical properties were evaluated from composite soil samples collected from the high tunnels. The soil pH and N, P, K, Ca, Mg, Na and Cu varied across sub-counties. Twenty-four nematode genera including 14 PPNs, 5 bacterivores, 3 fungivores and 2 predators were recovered from soil samples. The genera *Meloidogyne*, *Alaimus*, *Aporcelaimus* and *Mononchus* were the most abundant PPNs, bacterivores, fungivores and predators, respectively, and differed across sub-counties. The abundance of *Meloidogyne* spp. and *R. solanacearum* was higher in Gatundu North than in the other sub-counties. There was a strong, positive correlation between *Meloidogyne* spp. (second stage juveniles counts) population and *R. solanacearum* (cfu·mL⁻¹) with soil N and P, and a weak negative correlation with soil pH, EC, Zn and Cu. Fungal feeders exhibited a strong negative correlation with soil pH and Ca; predators, bacterial feeders, and PPNs had similar correlations with N, P and Ca, respectively. Soil chemical properties affect abundance of beneficial and phytoparasitic nematodes and *R. solanacearum*, which varies with location.

Keywords: *Solanum lycopersicum*, bacterial wilt, plant parasitic nematodes, small holder farmers

iCB-2019-63

Drivers of small holder farmers' decision to adopt agroforestry in Rulindo District, Rwanda

Rwaburindi Jean Claude, Rimberia Fredah K., Mulyungi Patrick and Olumeh Dennis., 2019. *International Journal of Social Sciences and Information Technology* 4 (11), pp. 1-12.

Abstract

The main objective of this study was to investigate the drivers of small holder farmers' decision to plant trees on farms in Rulindo District. This study used data from a survey of 270 smallholder farmers selected using a two stage sampling technique and interviewed using semi-structured questionnaires. Descriptive statistics and a probit model were applied in data analysis. Probit model analysis showed that size of the land, livestock husbandry and additional labor in household influence adoption of agroforestry, while Gender and farmers occupation had an inverse relationship. Inadequate knowledge and skills on Agroforestry is a limitation on the farmers' decision to plant more trees on their farms. These findings provide useful insight into the factors that need to be targeted to stimulate more adoption of Agroforestry on small holder farms in Rulindo District. Strengthening extension services and capacity building of local actors in

agroforestry should be targeted. Government should invest in informing and sensitization on womens' roles and responsibilities in decision making, emphasizing uses and benefits of agroforestry products.

Keywords: Agroforestry, Adoption, Probit model, small holder farmers

iCB-2019-64

Fruit morphological diversity and productivity of baobab (*Adansoniadigitata L.*) in coastal and lower eastern Kenya

Monica Omondi, Fredah Karambu Rimberia, Cornelius Mbathi Wainaina, John Bosco Njoroge Mukundi, Justine Orina, Jens Gebauer & Katja Kehlenbeck., 2019. *Forests, Trees and Livelihoods*, 28(4), pp. 266-280. DOI: 10.1080/14728028.2019.1659861

Abstract

Baobab (*Adansonia digitata L.*) is an indigenous fruit tree of great importance in African drylands. In Kenya, the species' potential is not fully utilized and domestication could help in increasing its usage. This study aimed at assessing the variability in morphological fruit traits and productivity of baobab trees in two regions of Kenya in order to select superior mother trees for domestication. Data were collected from 71 fruiting baobab trees in the coastal area of Kilifi County and the inland regions of Kitui and Makueni Counties. All fruits per tree were counted and 10 fruits harvested for morphological characterisation. Productivity per tree was calculated and correlation analysis between selected fruit traits performed. Most (60%) of the 71 studied trees had ellipsoid fruit shapes. Median productivity in weight of fruits per tree was significantly higher in accessions from the coast (87.7 kg/tree) than from the inland region (29.5 kg/tree; $p < 0.001$). Median fruit length and weight were significantly higher in the coastal as compared to the inland region (22.1 versus 14.2 cm and 376 versus 155 g, respectively; $p < 0.001$ for both). Similarly, median pulp weight was significantly higher in samples from the coast than from the inland region (61.3 versus 27.2 g; $p < 0.001$), while pulp proportion was similar between the regions (median 16.9% of the whole fruit weight, range 13-23%). Fruit weight correlated significantly with pulp weight ($r = 0.948$; $p < 0.001$), but not with pulp proportion. Two superior mother trees with high fruit weight, high pulp proportion and intermediate or sweet tasting fruit pulp were selected each in the two research regions. Further studies including genetic characterization should be done to identify the causes of variation among the trees in Kenya. Our findings may contribute to the domestication and increased utilization of this important indigenous fruit tree in Kenya and beyond.

Keywords: Domestication, fruit traits, indigenous fruit tree, pulp proportion, superior mother tree

iCB-2019-65

Evaluation of the morphological and quality characteristics of new papaya hybrid lines in Kenya

Gaudence Nishimwe, Janet Chepng'etich Kosgei, Everlyn Musenya Okoth, George Ochieng' Asudi and Fredah Karambu Rimberia, 2019. *African Journal of Biotechnology* 18 (2), pp. 58 – 67.

Abstract

Papaya (*Carica papaya L.*) is an important fruit crop for both fresh and processed products. Papaya fruits are rich in carbohydrates, vitamins and minerals. The papaya industry in Kenya relies on imported varieties or farmer selected seed whose quality is not known. Researchers at Jomo Kenyatta University of Agriculture and Technology (JKUAT) have developed papaya hybrids that are tolerant to viral diseases and are locally adapted. However, their fruit quality characteristics have not been reported. The objective was to evaluate the physical and quality characteristic of the new papaya hybrids fruits. Mature fruits of 8 papaya hybrids and Sunrise solo (control) at colour break stage were used for the study. The fruit characterization was done using papaya descriptors (IBPGR and UPOV) and 2015 Royal Horticultural society colour Chart. The result were analyzed using GenStat software 14th edition followed by Duncan's test for mean separation at 5% probability. There was significance difference in size among the new papaya hybrids and the

control. Line 4 had the longest and heaviest means of 21.2 cm and 1246.6g respectively. Fruits of the control, lines 2, 3, 7 and 8 ranged from small to medium in size, while those of lines 4 and 6 were large. Line 7 had the longest shelf life of 11 days, while Line 1 had the shortest shelf life of 4 days. The total soluble solids varied from 7.4 for line 8 to 12.3% for line 5 and line 7. The study revealed that the physical and quality characteristics of the new papaya hybrids compare favorably or even exceed that of local and imported papaya varieties in Kenya. The quality of the new papaya hybrids was found to be suitable for both local and export markets. Besides, they are locally adapted and will serve to reduce the cost of imported seeds.

Keywords: *Carica papaya* L., new papaya hybrids, morphological characteristics, shelf life, fruit quality.

iCB-2019-66

Evaluation of physicochemical, nutritional and sensory quality characteristics of new papaya hybrids fruits developed in JKUAT

Gaudence Nishimwe, Everlyn Musenya Okoth and Fredah Karambu Rimberia, 2019. *Journal of Food Research* 8(1) pp. 12-20.

Abstract

The world is faced with a lot of challenges including lack of sustainable development and inability to feed its growing population leading to malnutrition. The issue of accessing high quality nutritious foods such as fruits has become a major challenge for many African people. Papaya (*Carica papaya* L.) is among the most popular fruits grown in Kenya and excellent in nutritional content. However, its potential has remained unexploited due to inadequate quality planting materials, high post-harvest losses and prevalence of pests and diseases. Researchers at Jomo Kenyatta University of Agriculture and Technology developed promising papaya hybrids whose physicochemical, nutritional content and sensory characteristics have not been evaluated. Thus, the aim of this study was to determine the physicochemical, nutritional content and sensory quality characteristics of the new papaya hybrids and their control, Sunrise Solo. The physicochemical attributes evaluated included; total soluble solids, total titratable acid, pH and total soluble solid/total titratable acid ratio. While the nutritional content evaluated included (Vitamin C and β -carotene content) and sensory quality characteristics were evaluated. The standard AOAC methods was used to determine nutritional content and an effective analysis with 9-point hedonic scale was used on sensory evaluation. There was significant difference ($P < 0.05$) in nutritional content of new hybrids papaya fruits and Sunrise solo. The maximum and minimum Vitamin C content of 131.63 mg/100g and 52mg/100g were exhibited by line 6 and 8 respectively. β -carotene content ranged between 1.69 and 3.39 mg/100g as exhibited by line 1 and lines 2 and 8 respectively. The findings of this study revealed that the nutritional content of the new papaya hybrids exceeded the one of Sunrise Solo while their sensory quality characteristics compared favourably to the one of Sunrise Solo. Based on these findings, lines 1, 2, 5, 6, 7 can be recommended for commercialization.

Keywords: Hybrids, papaya fruits, sensory, Vitamins

iCB-2019-67

Evaluation of morphological diversity of tamarind (*Tamarindus indica*) accessions from Eastern parts of Kenya

Mercy Liharaka Kidaha, Wariara Kariuki, Fredah K. Rimberia and Remmy Kasili Wekesa, 2019. *Journal of Horticulture and Forestry* 11(1), pp. 1-7.

Abstract

Tamarind is native to tropical parts of Africa and Asia. It shows considerable phenotypic variation in morphological and horticultural traits that can be utilized in its genetic improvement. In Kenya, there exists a wide range of tamarind germplasm that has not been characterized. Initial characterization is based on morphological descriptors. The objective of this study is to evaluate morphological diversity of tamarind germplasm from Eastern parts of Kenya. Tamarind

germplasms were collected from Kitui, Mwingi, Masinga, Embu and Kibwezi and then characterized using morphological descriptors based on seed, fruit and stem. Morphological characters were recorded and data from eighty-nine accessions were submitted to principal component and hierarchic ascendant analysis (HAC) and Euclidian average distance. Accessions from Kibwezi, Embu and Kitui showed the greatest diversity while accessions from Masinga and Mwingi had the least diversity. Trunk diameter at ground, pod weight, number of seeds/pod, height to the first branch and pod width showed greatest variation in principal component analysis. High morphological diversity obtained in these regions can be used to initiate new breeding and conservation programmes in tamarind for improved fruit and tree crop.

Keywords: Tamarind, morphology, diversity, accessions, principle component.

iCB-2019-68

Phenotype characterization and diversity assessment of mango (*Mangifera indica L.*) cultivars in Ethiopia

Tewodros B. Neguse, Fredah K. Rimberia Wanzala, Wassu Mohammed Ali, Githiri Stephen Mwangi and Willis O. Owino, 2019. *Journal of Plant Breeding and Crop Science* 11 (2), pp. 55-67.

Abstract

Little efforts have been made on mango genetic resource assessment in Ethiopia though it is one of the major fruit crops. This study was conducted to assess the diversity of 69 mango cultivars of different growing regions of the country based on 44 phenotypic descriptors. The results of both univariate and multivariate analysis of variance computed for quantitative data, and results from descriptive statistics for qualitative characters indicated the presence of phenotypic variation among the cultivars. Further analysis of Principal Component Analysis (PCA) indicated the first four components explained more than 75% of the total variation in which most fruit, seed and leaf characters contributed much to the observed variation. The cultivars were grouped into 13 clusters by Unweighted Pair Group Method with Arithmetic Means clustering method from the Euclidean distances estimated from phenotypic characters. The three clusters (II, X, and XIII) constructed each by one cultivar while others encompass more than one irrespective of their geographic regions. This indicated the presence of diversity among cultivars in Ethiopia which can be exploited for further improvement, use, and conservation of mango genetic resources.

Keywords: Cluster, Euclidean distances, genetic resources, principal component.

iCB-2019-69

Production practices and constraints in major production regions of Ethiopia.

Tewodros B. Neguse, Fredah K.R. Wanzala, Wassu M. Ali, Willis O. Owino and Githiri S. Mwangi, 2019. *African Journal of Agricultural Research* 14 (4), pp. 185 – 196.

Abstract

Mango (*Mangifera indica L.*) is the second among fruit crops in Ethiopia in its production coverage and economical importance. However, compared to the countries' potential, it is at the infant stage. This study was conducted to identify the main mango cultivars, production practices and constraints in east and western Ethiopia in 2016. Study areas were selected purposively based on their extensive mango production. Thirty-one cultivars of unknown origin were identified based on farmers' characterization criteria. The majority of the farmers were found not to apply fertilizers (63.7%), supplementary irrigation (87.6%), nor prune their mangos (50%). About 50% of growers revealed fruit yield of 100-200 kg/tree and harvest fully ripe. Packaging and transportation of mangos were entirely below the standard. Availability of agricultural inputs such as fertilizers and pesticides, pest, knowledge and skill gap, and availability of improved varieties were the major constraints. Assessment of similarities in terms of farming system, mango production practices, harvest, post-harvest handling, marketing, and their constraints indicated that 76.9% of growers were similar. Therefore, improvement of the pre and postproduction practices, utilization and/or

conservation of the identified cultivars, and addressing the constraints will be crucial to improving the mango sector in Ethiopia.

Keywords: Interview, mango cultivars, tropical fruit, biodiversity.

iCB-2020-01

Effect of Defoliation on Blossom-end Rot Incidence and Calcium Transport into Fruit of Tomato Cultivars under Moderate Water Stress

Annah Khatenje Indече, Yuichi Yoshida, Tanjuro Goto, Ken-ichiro Yasuba and Yoshiyuki Tanaka, 2020. *The Horticulture Journal* 89 (1), pp. 22–29. <https://doi.org/10.2503/hortj.UTD-079>

Abstract

The translocation of calcium (Ca) within the tomato plant and the causes of Ca deficiency, a factor associated with blossom-end rot (BER) in fruit, are still a matter of conjecture. The objective of this study was to determine the effect of defoliation on BER incidence and Ca transport into different size tomato fruit cultivars. Four experiments were conducted. The start and end dates for each experiment were; 14 March–2 May, 22 July–23 August, 30 August–7 October 2017, and 20 May–25 June 2018, for experiments 1, 2, 3, and 4, respectively. Five tomato cultivars including one large ('Momotaro fight (MF)', ≥ 200 g), three medium ('Lui 60 (L60)', 'Tio cook (TC)', and 'Cindy sweet (CS)', 30–80 g), and one small ('Pepe (PP)', ≤ 20 g) fruit cultivars, respectively, were grown under moderate water stress controlled by a combination of root zone restriction and solar mediated fertigation. Leaf area of plants was reduced by 20–30% by removing alternate leaflets on all leaves. Defoliation significantly reduced BER in all experiments. In experiment 4, no BER was observed in defoliated plants of L60 and PP, and in MF and TC, BER incidence decreased to a quarter of the control. Defoliation increased the fruit growth rate (FGR) in experiment 1, in which the temperature was the lowest, by a ratio of 1.42 and by 1.39 in experiment 4, in which the radiation was strongest and day length longest. Defoliation increased the rate of daily Ca transport into fruit (CTR) in MF, L60, TC, CS, and PP by average ratios of 1.64, 1.55, 1.35, 1.30, and 1.13, respectively. The increase in CTR in defoliated plants was highest in experiment 4 with a ratio of 1.68 followed by 1.37, 1.33, and 1.28 in experiments 1, 3, and 2, respectively. Defoliation increased both FGR and CTR and there were significant linear relationships between them. However, the degree of increase was larger in CTR than that in FGR, especially in the BER-sensitive large fruit cultivar MF, and defoliation increased the total Ca concentration in fruit accordingly. We conclude that under moderate water stress by root zone restriction and certain other BER inductive conditions, defoliation could be a promising approach to reduce BER incidence by improving Ca nutrition in susceptible large fruit cultivars.

Keywords: Ca deficiency, Ca transport rate, environmental conditions, fruit size, root zone restriction.

iCB-2020-02

Defoliating to 12-15 leaves increases calcium concentration and decreases blossom-end rot incidence in fruit of tomato plant grown under moderate water stress

Indече, A. K., Yoshida, Y., Miyaji, D., Goto, T., Yasuba, K. I., & Tanaka, Y., 2020. *Scientific Reports of the Faculty of Agriculture, Okayama University*, 109, pp. 21-27.

Abstract

The objectives of this study were to (i) determine the optimum number of whole leaves to retain on a tomato plant for effective blossom-end rot (BER) management and (ii) explore the relationship between shoot calcium (Ca) and fruit Ca in non-defoliated plants in two different sized fruit cultivars, a largefruited cultivar 'Momotaro fight' and a medium-fruited cultivar 'Cindy sweet'. Treatments involved maintaining 18, 15 and 12 leaves on a plant. All lateral shoots were removed regularly throughout the growing period except the shoot closest to the flowering truss in the 18-leaf treatment. At the length of 10 cm, these shoots were sampled for real time Ca determination using a hand held Ca²⁺ meter. In the plants defoliated to 18 leaves, BER was higher

in ‘Momotaro fight’ at 10% compared to 2% in ‘Cindy sweet’. Fruit growth rate was significantly increased by defoliation in ‘Momotaro fight’, however no significant difference was observed among treatments in ‘Cindy sweet’. Defoliating to 12 leaves increased daily Ca transport rate by 59% and 37% in ‘Momotaro fight’ and ‘Cindy sweet’, respectively. Defoliating to 12 leaves increased the water-soluble Ca concentration in the distal part of fruit by 34% and 14% in ‘Momotaro fight’ and ‘Cindy sweet’, respectively. In the plants defoliated to 18 leaves where only old yellowish leaves were removed, a significant steady decrease was observed in the concentration of water soluble Ca in the distal part of fruit with increase in truss order. There was a significant linear relationship between water-soluble Ca concentration in the distal part of the fruit and Ca concentration in the lateral shoot of plants defoliated to 18 leaves. We conclude that under moderate water stress by root zone restriction and also certain other BER inductive conditions, defoliation to 12–15 leaves on a tomato plant should be a promising approach for decreasing BER incidence in susceptible large fruit cultivars.

Keywords: BER management, defoliation, water-soluble Ca, lateral shoot Ca, root zone restriction

iCB-2020-03

Resistance of *Amaranthus Spp.* to the Green Peach Aphid (Hemiptera: Aphididae).

Nampeera, E. L., Blodgett, S., O’Neal, M. E., Nonnecke, G. R., Murungi, L. K., Abukutsa-Onyango, M. O., & Wesonga, J. M., 2020. *Journal of Economic Entomology*, 113(3), pp. 1299-1306.

Abstract

The green peach aphid [*Myzus persicae* (Sulzer)] is an important pest of amaranth grown for leaf consumption (i.e., leafy amaranth) in the tropics. Aphids reduce the amount of fresh leaf yield of amaranth and the value of leafy amaranth as aphid-infested leaves are not marketable. Our objective was to evaluate *Amaranthus* species selected by a breeding program in East Africa to develop cultivars for leaf consumption with resistance to *M. persicae*. We focused on antibiosis to determine whether varieties of *Amaranthus* spp. could be grown without producing an aphid population. Artificial infestations of aphids were placed on multiple selections of three species of *Amaranthus*: two selections of *A. blitum*, four selections of *A. hybridus* and one selection of *A. hypochondriacus*. Aphid populations were assessed over a 5-wk period. Evaluations of vegetative yield, leaf damage symptoms, and specific leaf area (SLA) were made of the seven selections at the end of this experiment. Aphid populations assessed 49 d after planting differed significantly ($P \leq 0.001$) among the amaranth species and within selections of the same species. The selections of *A. blitum* had the lowest aphid populations, and *A. hybridus* had the highest populations. Selections of *A. hybridus* produced the most marketable leaves (i.e., aphid free). The fresh weight of *A. blitum* were the lowest of the seven selections, whereas *A. hybridus* had the greatest fresh leaf weight. Implications of these findings for further promotion of amaranth breeding are discussed related to pest management for leaf production.

Keywords: leafy amaranth, African vegetable, Hemiptera (Aphididae), leaf yield, aphid population

iCB-2020-04

Managing Phosphate Rock to Improve Nutrient Uptake, Phosphorus Use Efficiency, and Carrot Yields.

Edwin Mwangi, Catherine Ngamau, John Wesonga, Edward Karanja, Martha Musyoka, Felix Matheri, Komi Fiaboe, David Bautze & Noah Adamtey, 2020. *Journal of Soil Science and Plant Nutrition*. 20(3), pp. 1350-1365. DOI: <https://doi.org/10.1007/s42729-020-00217-x>

Abstract

The objectives of this study were to assess (a) the efficiency of lemon and pineapple juices and the concentration and time needed to release more than 50% of available phosphorus from phosphate rock (PR), and (b) the effect of different types of PR management on carrot yields, nutrient uptake,

and phosphorus use efficiency. Field trials were set up at two sites with humic andosols and orthic acrisols over two seasons in Kenya. In a randomized complete block design, replicated three times, the following treatments were compared: (i) composted dissolved PR in lemon juice; (ii) powdered PR composted; (iii) dissolved PR in lemon juice added to compost; (iv) powdered PR and compost; (v) triple superphosphate and compost; (vi) compost alone; (vii) triple superphosphate and Tithonia diversifoliamulch; with (viii) un-amended soil as a control. Lemon juice was effective in solubilizing PR, releasing 63% of the total phosphorus applied into available phosphorus, compared to 11% for pineapple juice and 6% for water. The combined application of compost and PR dissolved in lemon juice at planting significantly increased phosphorus and potassium uptake, phosphorus use efficiency, and carrot yields that was comparable to the use of triple superphosphate and compost. The study concludes that the dissolution of phosphate rock with lemon juice at a ratio of 1:5 phosphate rock to lemon juice and its combined application (immediately after dissolution) with compost at planting improves nutrient uptake, phosphorus use efficiency, and crop yields. We recommend further studies to explore the possibility of using citrus peels or other acidic organic materials to enhance the solubility of phosphate rock, and to assess their practical feasibility and the economic advantage(s) in the large-scale production of high value crops.

Keywords: Phosphorus management, Phosphate rock dissolution. Organic juices, phosphorus uptake, Phosphorus recovery, Compost

iCB-2020-05

Spatio-Temporal Variability of Simulated 2 m Air Temperature for Nairobi City, Kenya.

Ochola, Emmanuel & Langer, Ines & Ochieng Adimo, Aggrey & Mukundi, John & Wesonga, John, 2020. *Current Urban Studies*, 8 (02). pp. 205-221. Doi:10.4236/cus.2020.82011.

Abstract

Nairobi city in Kenya is an example of the many cities in Africa experiencing rapid growth and too many environmental impacts, including the urban heat islands (UHI) phenomenon. UHI develops and escalates under outrageous hot periods, such as during heatwave, which can affect outdoor microclimate, human thermal comfort, and health and also increase the energy demand for cooling. This study used the MUKLIMO_3 model to reveal the spatial heterogeneity and temporal variability of 2 m air temperature fields and thermally sensitive areas within Nairobi city. The model reproduced the potential summer day conditions through idealized simulations of temperature, wind, and relative humidity based on the urban topography and local climate zones (LCZs) data at a spatial resolution of 200 m. The aim was to expand knowledge of urban climate change based on the accompanying extensive modification of land use and land cover that are critical for the local-scale atmospheric circulation. The model results revealed intricate spatiotemporal patterns of 2 m air temperature fields, which accrued from terrain-induced flows and land surface heterogeneity as described by the LCZ parameters. The variation in canopy layer UHI was a joined impact of the unfavorable location of the town and urbanization process, which added to the formation of excessive urban heat load. The study concluded that the enhancement of urban heat load in Nairobi city could be linked to the concept of rapid urbanization process and its historical development. Therefore, urban planning strategies such as optimization of mixed building heights and the introduction of green & blue infrastructure were critical to mitigating heat-stress across Nairobi City.

iCB-2020-06

Meta-analysis of 3R Kenya findings about the transformation of the aquaculture, dairy and horticulture sectors; Recommendations to support the transition from aid to inclusive aid and trade

Jan Joost Kessler, Ingrid Coninx, Catherine Kilelu, Simone van Vugt, Irene Koomen, Bockline Bebe, Katrine Soma, Asaah Ndambi, Joyce Gema, Benson Obwanga, Eugene Rurangwa, Indira

Moreno Echeverri, Gonne Beekman, Jessica Wangui Koge, Jan van der Lee, Annabelle Daburon, John Wesonga, Ruerd Ruben, 2020. *Wageningen Centre for Development Innovation, Wageningen University & Research Report* WCDI-20-116. <https://doi.org/10.18174/524002>

Abstract

Like many other countries, Kenya is becoming more developed and its bilateral relations are changing accordingly. The 3R Kenya project's objective was to support the ambition of the Dutch government to transition from aid to inclusive aid and trade and investment approaches in its bilateral engagement with Kenya. 3R Kenya, as an applied research and learning project, examined programmes and investment that promote private sector and market-led approaches to agrifood sector development, including those supported under the food and nutrition security programmes of the Embassy of the Kingdom of the Netherlands (EKN) in Kenya. These programmes, run in the periods 2012–2015 and 2014–2017, mainly aimed to support private sector development and transformation in the aquaculture, dairy and horticulture sectors by creating an enabling environment and level playing field for Dutch investors and businesses. The aid support in these programmes was considered investment funding rather than donor funding and aimed to leverage more private investment. The transition of the Dutch government was informed by assumptions about how Kenya's agrifood and related socioeconomic systems were transforming as it become a low-middle-income country. 3R Kenya investigated some of these assumptions and unravelled the different drivers of sector transformation with a focus on the aquaculture, dairy and horticulture sectors in Kenya. Funded by the EKN, the project began in 2016 and ended in March 2020. It was implemented by Wageningen University & Research in the Netherlands and African Centre for Technology Studies in Kenya, in collaboration with Egerton University, Jomo Kenyatta University of Agriculture and Technology, Tradecare Africa Ltd., Climate Adaptation Services and Aid environment. Within the 3R Kenya project, we have collected evidence mainly about market-led and policy interventions. This report aims to consolidate the insights via a meta-analysis; that is, we have analysed and compared each of the three sectors similarly, through the perspective of a food system that is in continuous transformation. This enabled us to compare sectors, elucidate trends and sector changes and generate insights that inform policy and practice in addressing challenges and responding to opportunities in the transition from aid to inclusive aid and trade.

The leading questions were:

1. To what extent do we observe sector transformation, interpreted as a change towards a sector that is more competitive, while also being sustainable and inclusive?
2. What are the main drivers of sector transformation? Do we see a move towards better institutional governance in sectors, better supply chain coordination and stronger innovation systems? What are the systemic issues that currently affect sector transformation?
3. What do we recommend will make the transformation to more robust (better supply chain coordination), resilient (stronger innovation) and reliable (better governance) agrifood systems in Kenya?

This report brings together results of the many 3R Kenya studies. We did this via the method of meta analysis which is described in chapter 2. This chapter explains the methodology of the meta-analysis, adopting a systems approach that was developed and tailored to the 3R Kenya project. Chapter 3 contains insights and conclusions about systemic issues in relation to sector transformation. These were obtained from the cross-sectoral analysis of the study results of each of the three sectors, which can be found in Appendix 1. We have used the insights and conclusions on systemic issues to define some overall recommendations in Chapter 4 for investment and further engagement to foster sector transformation. Specific sector analyses are presented in Appendix 1, supported with the references to 3R Kenya and other studies. This data was analysed by applying the sector assessment framework (Appendix 2) and the scores were summarized in an easy overview of each sector via spiderweb diagrams in Appendix 3.

iCB-2020-07**Effect of Boiling and Wet Frying on Nutritional and Antinutrients Content of Traditional Vegetables Commonly Consumed in Malawi**

Joseph Y Issa, Arnold Onyango, Anselimo O Makokha, Judith Okoth, 2020. *Journal of Food Research*. 9, pp. 19-33.

Abstract

This study was carried out to evaluate the effects of boiling and wet frying on nutritional and antinutrients content of Amaranth hybridus, Moringa oleifera, Bidens pilosa (black jack), Corchorus olitorius (Jute mallow) and Ipomea batatas (sweet potato) leaves. The edible portions of the vegetables were either boiled or wet fried for ten minutes then dried alongside the raw vegetables under the shade. Crude fats, minerals, vitamins and antinutrients were determined in the dried materials. Wet frying increased the oil content of the vegetables by a range of 15.49% to 28.40% and was hence associated with lower% ash and mineral contents. Wet frying significantly reduced ($P \leq 0.05$) beta-carotene in all the vegetables except in jute mallow. Boiling had no significant effect on beta-carotene in most of the vegetables. Boiling significantly reduced ($P \leq 0.05$) ascorbic acid in all the vegetables while wet frying preserved ascorbic acid in all the vegetables. Both boiling and wet frying significantly reduced ($P \leq 0.05$) oxalates in all the vegetables except in black jack. Both boiling and wet frying significantly ($P \leq 0.05$) reduced the concentration of phytates in most of the vegetables. However, boiling was more effective in reducing the amount of phytates. Boiling reduced higher concentrations of tannins in all the vegetables as compared to wet frying. Boiling was associated with better retention of minerals and beta-carotene, and greater reduction of antinutrients in most of the vegetables. Wet frying was more advantageous in retaining vitamin C. The different species showed differences in retention of various minerals and vitamins.

Key words: Vitamins, minerals, anti-nutrients, boiling, wet frying, traditional vegetables, Malawi.

iCB-2020-08**Empowering women through probiotic fermented food in East Africa**

Gregor Reid, Wilbert Sybesma, William Matovu, Arnold Onyango, Nieke Westerik, and Remco Kort, 2020. *Journal of Global Health*. 10 (1), 010330. Doi: 10.7189/jogh.10.010330

Abstract

The role of women in society has evolved in the developed world, but in many developing countries it still revolves around food production and preparation and caring for children in a gender inequitable environment. Many females are exposed to violence, and in poverty-stricken areas with rampant malnutrition, women's dependency on males for shelter and access to farmland can restrict their personal growth. Confounding factors include lack of education, societal traditions that favour males, malnutrition and insufficient local food production, unemployment especially amongst youth, poor transportation, high rates of infant mortality, and poor access to clean water, electricity, housing and heat. Women in such impoverished settings find it difficult to become empowered and able to establish an independent means of generating revenue. No single intervention can solve all these issues, but we would propose that utilization of beneficial microorganisms (probiotics) can make a significant impact. This project has shown how 'western' science and local ingenuity can impact vulnerable populations in rural East Africa. It has the potential to improve a number of important health and economic markers in regions challenged by poverty, infectious diseases, malnutrition and unemployment.

Keywords: Probiotics; Fermented foods, Empowerment

iCB-2020-09

Efficacy of compositing with snail meat powder on protein nutritional quality of sorghum–wheat buns using a rat bioassay

Fredrick B Agengo, Arnold N Onyango, Charlotte A Serrem, Judith Okoth, 2020. *Journal of the Science of Food and Agriculture*. 100 (7), pp. 2963-2970.

Abstract

Protein energy malnutrition (PEM) is an important health burden in most developing countries mainly in sub-Saharan Africa, where it contributes to high rates of child morbidity and mortality. This study evaluated the efficacy of compositing with snail meat powder (SMP) on protein nutritional quality of sorghum–wheat buns using a rat bioassay. Nine diets –seven isonitrogenous diets, based on six variations of buns and a reference diet made using skimmed milk powder, in addition to the basal diet meant to estimate the endogenous nitrogen excretion and a 16% protein rehabilitation diet – were fed to male weanling albino rats. Protein efficiency ratio (PER), and food efficiency ratio (FER), net protein retention ratio (NPRR), apparent protein digestibility (APD), and true protein digestibility (TPD), protein digestibility corrected amino acid score (PDCAAS), and digestible indispensable amino acid score (DIAAS) indices of protein quality were determined. Fortification with SMP significantly ($P < 0.05$) enhanced PER from 0.21% to 2.70%, FER from 0.02% to 0.27%, APD from 81.17% to 88.28%, and TPD from 87.48% to 95.38%. PDCAAS and DIAAS increased from 45% to 78% and 44% to 69% respectively in unfortified buns to buns fortified with 25% SMP. Complementary diets fortified with SMP promote growth and rehabilitate emaciated rats, whereas unfortified diet did not support weight gain. Thus, supplementation of buns with SMP might enhance a faster recovery in children affected by PEM.

Keywords: digestibility; fortification; growth; malnutrition; protein.

iCB-2020-10

Lysine Reacts with Cholesterol Hydroperoxide to Form Secosterol Aldehydes and Lysine-Secosterol Aldehyde Adducts

G., W. Wanjala, A. N., Onyango, D., R., Abuga, J.K., Muchuna, C. Onyango, M. Makayoto, 2020. *Journal of Chemistry*. Article ID: 5862645. Doi: <https://doi.org/10.1155/2020/5862645>

Abstract

Two cholesterol secosterol aldehydes, namely, 3β -hydroxy-5-oxo-5,6-secocholestan-6-al (secosterol A) and its aldolization product 3β -hydroxy-5 β -hydroxy-B-norcholestane-6 β -carboxyaldehyde (secosterol B), are highly bioactive compounds which have been detected in human tissues and potentially contribute to the development of physiological dysfunctions such as atherosclerosis, Alzheimer's disease, diabetes, and cancer. They were originally considered to be exclusive products of cholesterol ozonolysis and thus to be evidence for endogenous ozone formation. However, it was recently postulated that primary amines such as lysine may catalyse their formation from cholesterol-5 α -hydroperoxide (Ch-5 α -OOH), the main product of the oxidation of cholesterol with singlet oxygen. This involves cyclization of Ch-5 α -OOH to an unstable dioxetane intermediate, which decomposes to form secosterol aldehydes with triplet carbonyl groups, whose return to the singlet state is at least partly coupled to the conversion of triplet molecular oxygen to singlet oxygen. Here, we subjected cholesterol to photosensitized oxidation, which predominantly produces Ch-5 α -OOH and minor amounts of the 6 α - and 6 β -hydroperoxides, exposed the hydroperoxide mixture to lysine in the presence of the antioxidant 2,6-ditertiary-butyl-4-hydroxytoluene (BHT), and analysed the reaction mixture by liquid chromatography-electrospray ionization-mass spectrometry. Consistent with the postulated lysine-catalysed formation of secosterol aldehydes, we detected formation of the latter and several types of their lysine adducts, including carbinolamines, Schiff's bases, and amide-type adducts. We propose that the amide type adducts, which are major biomarkers of lipid oxidation, are mainly formed by singlet oxygen-mediated oxidation of the carbinolamine adducts.

Keywords: Lipid oxidation; secosterol aldehydes; singlet oxygen; amide-type advanced lipoxidation end products

iCB-2020-11

Evaluation of Five Essential Oils by Gas Chromatography-Mass Spectrometry and their Effect on Fungal Growth Inhibition and Sensory Acceptability of Soymilk

Marguerite Niyibituronsa, Arnold Nola Onyango, Svetlana Gaidashova, Samuel Imathiu, Zhang Ming, Yang Ruinan, Zhang Weiqi, Wang XiuPin, Zhang Qi, Zhang Zhaowei, Li Peiwu, 2020. *Journal of Food Research*. 9, pp. 36-47, doi:10.5539/jfr.v9n2p36

Abstract

Essential oils are widely used in the food industry as natural food preservatives to extend product shelf life and as flavoring agents. However, not much has been done on their use in soymilk. The aim of the study is to determine the compounds of five essential oils by GC-MS and their effect on fungal growth inhibition and sensory acceptability of soymilk. The components of the essential oils of five spices, namely citronella, basil, cinnamon, eucalyptus and mint were analysed by gas chromatography-mass spectrometry (GC-MS). The minimum inhibitory concentration (MIC) of the essential oils was tested on the fungus *Aspergillus flavus* 3.4408 on PDA (agar dilution method). Sensory evaluation of soymilk flavored with the essential oils of citronella, basil and mint at different concentrations was done by ten member panelists using a 9-point hedonic scale. The main compound for basil was eugenol 83.26%. Cinnamon contained cinnamaldehyde (97.3%). The main compounds in citronella (*Cymbopogon nardus*) were limonene (38.51%), citronellal (30.29%). Eucalyptus (*Eucalyptus globulus*) essential oil mainly contained eucalyptol/cineole (76.70%), and Mint (*Mentha arvensis*): Menthol 42.72%, Menthone 25.72%. The MICs of citronella, basil, cinnamon, eucalyptus and mint were 5-10 $\mu\text{l/ml}$, 0.5-1 $\mu\text{l/ml}$, $\leq 0.1 \mu\text{l/ml}$, $\gg 10 \mu\text{l/ml}$ and 10-20 $\mu\text{l/ml}$, respectively. Thus, cinnamon was the most effective in inhibiting fungal growth, while eucalyptus was the least effective. These essential oils improved the soymilk flavor. Mint was the most preferred flavor, followed by citronella and basil. Thus, essential oils especially mint and citronella can be used for acceptability of soymilk at low concentration.

Keywords: basil, CFU, citronella, cinnamon, eucalyptus, mint, sensory attributes, soybean

iCB-2020-12

Partial substitution of soy protein isolates with cricket flour during extrusion affects firmness and in vitro protein digestibility.

Kiiru, S.M.¹; Kinyuru, J.N.¹; Kiage, B.N.¹; Marel, A.K.², 2020. *Journal of Insects as Food and Feed*. 6(2), pp. 169-177(9). DOI: <https://doi.org/10.3920/JIFF2019.0024>

Abstract

The rapid increase in global population and the unsustainable conventional meat production have created demand for alternative animal-derived protein. Traditionally, soy has been utilised in structuring meat analogues. Currently, edible insects are researched as a potential alternative source of proteins and a valuable ingredient in development of meat analogues. High moisture extrusion was applied to a mixture of soy protein isolate (SPI) and full or low-fat cricket flour (CF) and the impact of cricket inclusion levels as well as extruder barrel temperature on the firmness and in vitro protein digestibility was evaluated. The SPI flour was substituted at 0 (control), 15, 30 and 45% and extruded on a laboratory co-rotating twin-screw extruder with a throughput of 1 kg/h at 150 rpm screw speed. Cooking temperature was varied at 120, 140 and 160 °C and water flowrate set to 10 ml/min. Texture as evaluated on all the treatments by texture profile analysis while the in vitro crude protein digestibility (CPD) was done on raw flours and extrudates with 15 and 45% CF inclusion and at 120 and 160 °C. The extrusion temperature had a negative correlation ($r=-0.49$) with the CPD but the CF inclusion had a correlation; $r=0.71$ (120 °C) and -0.28 (160 °C). The highest CPD (50%) was recorded from 45% full-fat CF extruded blend at 120 °C. Firmness was positively influenced ($r=0.56$) by temperature but negatively influenced ($r\approx-0.57$) by CF

inclusions at selected temperatures. Overall the low-fat CF blends had lower firmness values compared to their full-fat counterparts and control samples. The findings from this research demonstrated to be relevant for processing of high-protein and insect-based meat alternatives for food dependencies.

Keywords: Acheta domesticus; edible insects; full and low-fat; meat analogue

iCB-2020-13

Extrusion texturization of cricket flour and soy protein isolate: Influence of insect content, extrusion temperature, and moisture-level variation on textural properties

Kiiru, S. M., Kinyuru, J. N., Kiage, B. N., Martin, A., Marel, A. K., & Osen, R., 2020. *Food Science & Nutrition*, 8(8), pp. 4112-4120. <https://doi.org/10.1002/fsn3.1700>

Abstract

Due to the increasing global population and unsustainable meat production, the future supply of animal-derived protein is predicted to be insufficient. Currently, edible insects are considered as a potential and “novel” source of protein in the development of palatable meat analogues. This research used high moisture extrusion cooking (HMEC), at a screw speed of 150 rpm, to produce meat analogues using full- or low-fat cricket flours (CF) and soy protein isolate (SPI). Effects of water flow rate (WFR), cooking temperature (9 and 10 ml/min; 120, 140, and 160°C, respectively), and CF inclusions levels of 0, 15, 30, and 45% were analyzed. Cooking temperature and CF inclusion had a significant effect ($p < .05$) on both tensile stress in parallel and perpendicular directions, while WFR had no significant effect ($p = .3357$ and 0.7700), respectively. The tensile stress increased with temperature but decreased with CF inclusion at both WFRs. Comparatively, the tensile stress was stronger at WFR of 9 ml/min than at 10 ml/min; however, the tensile stress in parallel was mostly greater than tensile stress in perpendicular directions. Fibrous meat analogues with high anisotropic indices (AIs) of up to 2.80 were obtained, particularly at WFR of 10 ml/min and at inclusions of 30% low-fat CF. By controlling HMEC conditions, full-/low-fat cricket flours at 15% and 30% inclusions can offer an opportunity to partially substitute SPI in manufacturing of fibrous meat analogues.

iCB-2020-14

Can Improved Legume Varieties Optimize Iron Status in Low- and Middle-Income Countries? A Systematic Review

Mutwiri, L. N., Kyallo, F., Kiage, B., Van der Schueren, B., & Matthys, C., 2020. *Advances in Nutrition*, 11(5), pp. 1315–1324. Doi: <https://doi.org/10.1093/advances/nmaa038>

Abstract

Iron and zinc deficiencies are some of the most widespread micronutrient deficiencies in low- and middle-income countries (LMIC). Dietary diversification, food fortification, nutrition education, and supplementation can be used to control micronutrient deficiencies. Legumes are important staple foods in most households in LMIC. Legumes are highly nutritious (good sources of essential minerals, fiber, and low glycemic index) and offer potential benefits in addressing nutrition insecurity in LMIC. Several efforts have been made to increase micronutrient intake by use of improved legumes. Improved legumes have a higher nutrient bioavailability, lower phytate, or reduced hard-to-cook (HTC) defect. We hypothesize that consumption of improved legumes leads to optimization of zinc and iron status and associated health outcomes. Therefore, the objective of this review is to examine the evidence on the efficacy of interventions using improved legumes. Nine relevant studies are included in the review. Consumption of improved legumes resulted in a ≥ 1.5 -fold increase in iron intake. Several studies noted modest improvements in biomarkers of iron status [hemoglobin (Hb), serum ferritin (SF), and transferrin receptor] associated with consumption of improved legumes. Currently, no efficacy studies assessing the relation between consumption of improved legumes and zinc status are available in the literature. Evidence shows that, in addition to repletion of biomarkers of iron status, consumption of improved legumes is

associated with both clinical and functional outcomes. The prevalence of iron deficiency (ID) decreases with consumption of improved legumes, with increases of ≤ 3.0 g/L in Hb concentrations. Improvement in cognition and brain function in women has been reported as well. However, further research is necessary in more at-risk groups and also to show if the reported improvements in status markers translate to improved health outcomes. Evidence from the included studies shows potential from consumption of improved legumes suggesting them to be a sustainable solution to improve iron status.

Keywords: low- and middle-income countries, micronutrients, iron, legumes, common bean, nutritional status

iCB-2020-15

Nutritional Composition and Qualitative Phytochemical Analysis of Chia Seeds (*Salvia hispanica L.*) Grown in East Africa

Fabian D. Mihafu*, Beatrice N. Kiage, Judith K. Okoth, Andrew K. Nyerere, 2020. *Journal of Current Nutrition & Food Science*. 16(6), pp. 988-995. Doi: 10.2174/1573401315666191125105433

Abstract

Chia seed (*Salvia hispanica L.*) is becoming one of the most popular plant-based foods that contain the greatest amount of nutrients particularly omega-3 fatty acid, α -linolenic acid. It is therefore considered a functional food with pronounced health benefits. The purpose of this study was to determine the proximate composition, minerals, fatty acid profiles and phytochemical contents of chia seeds grown in East Africa (Kenya and Uganda). Official methods of analysis, 2005 were adopted, minerals determined by Atomic absorption spectrophotometer, phytochemicals were determined by standard methods and fatty acid profiles were analyzed by Gas chromatography. Proximate composition indicated high contents of protein, fat and fiber. The fatty acid profiles revealed great amounts of α -linolenic acid (45.29-56.99%) followed by linoleic acid (15.9-20.28%) and oleic acid (6.88-11.58%). However, the difference in the content of α -linolenic acid between samples was not significant ($p = 0.7391$). Mineral determination (mg/100g) showed high contents of potassium (492.96-862.98), phosphorous (486.45-569.45), calcium (297.47-429.09) and magnesium (192.22-202.97) while considerable amount was observed for iron, zinc, manganese, and copper. There was a significant difference ($p = 0.0001$) in mineral content between black chia Molo and white chia Bukembo with the exception of phosphorus. Both black and white chia seeds grown in East Africa, observed to have high amounts of α -linolenic acid, proteins, fats, fiber, and minerals. These findings support the evidence that chia is rich in nutrients that are beneficial to human health. Therefore, we suggest its incorporation in diets as a healthy food ingredient.

Keywords: Fatty acids, functional food, minerals, phytochemicals, proximate composition, vitamins.

iCB-2020-16

Effect of a nutrition education programme on the metabolic syndrome in type 2 diabetes mellitus at a Level 5 Hospital in Kenya: “a randomized controlled trial”

Thuita, A. W., Kiage, B. N., Onyango, A. N., & Makokha, A. O., 2020. *BMC nutrition*, 6(1), pp. 1-14. <https://doi.org/10.21203/rs.2.18287/>

Abstract

Type 2 diabetes mellitus (T2D), is a life-threatening condition of global public health concern. It worsens in the presence of the metabolic syndrome (MetS), a complex disorder characterized by co-occurrence of at least three of such factors as hypertension, obesity, dyslipidemia and insulin resistance. However, lifestyle interventions reduce the risk of both MetS and T2D, and nutrition education can empower individuals on the appropriate lifestyle changes. The aim of the current study was to evaluate the effect of a nutrition education programme, with and without inclusion of

peer to peer support, on MetS in T2D patients. This was a randomized controlled trial with two intervention groups and one control. One of the intervention groups involved a nutrition education programme with peer-to-peer support (NEP); the other involved only the education program, while the control received standard care. Each group had 51 participants. The nutrition education programme was conducted for 2h per week for 8 weeks. In addition, the NEP had weekly peer-to-peer interactions for 8 weeks. All groups had follow-up sessions for 6 months. Data on MetS risk factors as well as food intake patterns and physical activity levels were taken at baseline and at different time points during the study. Analysis of Co-variance and regression were used in the analysis. The MetS prevalence improved in the NEP (90% to 52%) and NE (86% to 69%), while it worsened in C (88% to 91%). There was improvement in the mean values of the anthropometric parameters in the NEP and NE which worsened in the control group. There was a general improvement in mean values of blood lipids, fasting blood glucose and HbA1c in all the groups, with NEP showing the greatest improvements, followed by NE, except for triglycerides and HDL where the control group had better improvement than the NE. Changes in the anthropometric and metabolic indicators mirrored the changes in food intake patterns and physical activity, where the greatest improvements occurred in the NEP. Nutrition education with inclusion of peer to peer support was of clinical benefit in improving metabolic outcomes and reducing MetS in T2D patients.

Keywords: Metabolic Syndrome, Type 2 Diabetes mellitus and cardiovascular risk

iCB-2020-17

Benefits and food safety concerns associated with consumption of edible insects – Review article.

Imathiu, S., 2020. *Nutrition and Food Science Journal*, 18, pp. 1-11. Doi: <https://doi.org/10.1016/j.nfs.2019.11.002>

Abstract

Many types of edible insects in raw and processed forms have been consumed by many cultures globally since time immemorial, particularly in developing countries where they are mostly traditionally viewed as a delicacy besides provision of nutrition. As a food type, they are consumed in two main forms; whole insects or incorporated in various food products as an ingredient, the choice of which is consumer preference driven. Recently, there has been a lot of research interest in edible insects farming, processing and consumption mainly in an effort to eradicate food insecurities prevalent in many developing countries and boost nutrition. Inclusion of edible insects in human diets has been shown to improve the nutritional quality of foods due to their high micro- and macronutrient levels comparable and sometimes higher than those of animal-derived foods. It is in this regard that they can actually be used in directly addressing the first three UN's Sustainable Development Goals (no poverty, zero hunger, and good health and well-being). Edible insect's production also helps in mitigating the negative effects of climate change and improve biodiversity both of which positively contributes to food security. Even with all these benefits, several challenges are encountered in the promotion of edible insects farming and consumption in developing and developed countries. Top in the list of these obstacles is the issue of food safety where, especially western consumers willing to consume edible insects and/or edible insects-derived foods are wary of the microbiological and chemical health risk they could pose. Based on the current literature, there is clearly a need to balance the food safety concerns and the nutritional benefits of edible insects. There is a necessity to promote food safety and hygiene practices in the entire edible insect value chain including during wild harvesting in order to ensure that this highly nutritious food that requires little resources to produce is availed to the consumers in a state that does not pose any health risks. Lack of regulations on edible insects' value chain which lacks in many countries, especially developing countries is also another problem that requires urgent attention as addressing this issue is likely to boost consumer confidence and ease trade of this commodity between countries.

Keywords: Edible insects, entomophagy, farmed insects, food safety, nutrition, wild insects

iCB-2020-18

Effects of traditional processing techniques on the nutritional and microbiological quality of four edible insect species used for food and feed in East Africa.

Nyangena, D. N., Mutungi, C., Imathiu, S., Kinyuru, J., Affognon, H., Ekese, S., Nakimbugwe, D., & Fiaboe, K. K., 2020. *Foods*, 9(5), 574. Doi: 10.3390/foods9050574.

Abstract

Edible insects are increasingly being considered as food and feed ingredients because of their rich nutrient content. Already, edible insect farming has taken-off in Africa, but quality and safety concerns call for simple, actionable hazard control mechanisms. We examined the effects of traditional processing techniques - boiling, toasting, solar-drying, oven-drying, boiling + oven-drying, boiling +solar-drying, toasting + oven-drying, toasting + solar-drying—on the proximate composition and microbiological quality of adult *Acheta domesticus* and *Ruspolia differens*, the prepupae of *Hermetia illucens* and 5th instar larvae of *Spodoptera littoralis*. Boiling, toasting, and drying decreased the dry matter crude fat by 0.8–51% in the order: toasting > boiling > oven-drying > solar-drying, whereas the protein contents increased by 1.2–22% following the same order. Boiling and toasting decreased aerobic mesophilic bacterial populations, lowered *Staphylococcus aureus*, and eliminated the yeasts and moulds, Lac⁺ enteric bacteria, and *Salmonella*. Oven-drying alone marginally lowered bacterial populations as well as yeast and moulds, whereas solar-drying alone had no effect on these parameters. Oven-drying of the boiled or toasted products increased the aerobic mesophilic bacteria counts but the products remained negative on Lac⁺ enteric bacteria and *Salmonella*. Traditional processing improves microbial safety but alters the nutritional value. Species- and treatment-specific patterns exist.

Keywords: Entomophagy, processing, traditional knowledge, food/feed safety, nutrition

iCB-2020-19

Can farm weeds improve the growth and microbiological quality of crickets (*Gryllus bimaculatus*)?

Ng'ang'a, J., Imathiu, S., Fombong, F., Borremans, A., Van Campenhout, L., Broeck, J. V., & Kinyuru, J., 2020. *Journal of Insects as Food and Feed*, 6(2), pp. 199-209. Doi: <https://doi.org/10.3920/JIFF2019.0051>.

Abstract

Farming of edible insects has been proposed as a means to reduce current practices of harvesting from the wild. While farming could relieve the pressure on wild populations, as well as on their natural habitats, and generate a continuous supply of edible insects to the consumers, the high cost of commercial chicken feeds is still a challenge to many farmers. The aim of this study was to investigate whether the partial replacement of commercial chicken feed with the farm weed, wandering Jew (*Commelina sinensis*), would have an impact on weight gain and microbial quality of farmed field crickets (*Gryllus bimaculatus*). Therefore, we have experimentally compared two types of feed: (1) starter commercial chicken feed only (SO); and (2) starter commercial chicken feed supplemented with fresh wandering Jew weeds (S+W). After a feeding period of thirty days, the final body weight differed significantly ($P=0.026$) between crickets fed with SO and with S+W, which averaged at 1.11 and 1.39 g, respectively. Generally, high counts of total aerobic, *Enterobacteriaceae*, lactic acid bacteria, bacterial endospores, yeasts and moulds were observed in both experimental groups. However, bacterial endospore counts of S+W fed crickets (2.7 log cfu/g) were significantly lower ($P=0.021$) than these of the SO fed ones (3.9 log cfu/g). Metagenetic analyses indicated that Proteobacteria, Firmicutes and Tenericutes were the most abundant phyla, while members of the family Coxiellaceae, and the genera *Lactobacillus*, and *Spiroplasma* were the most abundant operational taxonomic units (OTUs). Concerning the food safety, a few OTUs could be associated with potential food pathogens, such as *Clostridiaceae*,

Staphylococcus and *Enterobacteriaceae*. In summary, the inclusion of fresh wandering Jew weeds in commercial starter chicken feed produced crickets with increased body weight and improved microbial quality.

Keywords: Edible insects, food safety, microbial numbers, next-generation sequencing, weight gain

iCB-2020-20

Changes in chemical and microbiological quality of semi-processed black soldier fly (*Hermetia illucens* L.) larval meal during storage.

Kamau, E., Mutungi, C., Kinyuru, J., Imathiu, S., Affognon, H., Ekesi, S., & Fiaboe, K. K. M., 2020. *Journal of Insects as Food and Feed*, pp. 1-12. DOI: <https://doi.org/10.3920/JIFF2019.0043>.

Abstract

Edible insects are receiving attention as a protein source in the food and feed sector. However, successful commercialization requires mass production matched with appropriate processing and storage techniques. The quality of dried and pulverised black soldier fly larvae stored in woven polypropylene (PP) sacks, polyethylene (PE) bags and plastic containers with screw lid (PL) in ambient and refrigerated environments was monitored over six months. Chemical indicators (oxidation, fatty acid profile), microbiological parameters (total viable counts, yeast and moulds, *Enterobacteriaceae*, presumptive coliforms, *Salmonella*) and colour change were examined. Temperature and relative humidity of the storage environments were monitored. In the ambient environment (temperature: 23.6±2.7°C; relative humidity: 57.6±7.0%), chemical deterioration progressed 1.5 and 1.2 times faster in PP and PE, respectively, compared to PL. Refrigeration (temperature: 5.4±1.1°C; relative humidity: 97±5.7%) exacerbated spoilage in the PP due to permeation of moisture through the woven strands, but slowed chemical deterioration by factors of 3.3 (PL) and 2.8 (PE). Likewise, based on the average counts of *Enterobacteriaceae* and yeast and moulds, microbiological deterioration progressed 2.1 and 1.4 times faster in the PP and PE, respectively, while refrigeration retarded build-up of microbial loads by factors of 1.3-9.6. The presence of *Salmonella* spp. in the experimental product indicates that due attention must be given to adequacy of processing and handling procedures for dried black soldier fly meal.

Keywords: Edible insects, entomophagy, processing, packaging, shelf-life.

iCB-2020-21

Evaluation of five essential oils by gas chromatography-mass spectrometry and their effect on fungal growth inhibition and sensory acceptability of soymilk.

Marguerite Niyibituronsa, Arnold Nola Onyango, Svetlana Gaidashova, Samuel Imathiu, Zhang Ming, Yang Ruinan, Zhang Weiqi, Wang XiuPin, Zhang Qi, Zhang Zhaowei and Li Peiwu, 2020. *Journal of Food Research*, 9, 36-47. DOI: <https://doi.org/10.5539/jfr.v9n2p36>.

Abstract

Essential oils are widely used in the food industry as natural food preservatives to extend product shelf life and as flavoring agents. However, not much has been done on their use in soymilk. The aim of the study is to determine the compounds of five essential oils by GC-MS and their effect on fungal growth inhibition and sensory acceptability of soymilk. The components of the essential oils of five spices, namely citronella, basil, cinnamon, eucalyptus and mint were analysed by gas chromatography-mass spectrometry (GC-MS). The minimum inhibitory concentration (MIC) of the essential oils was tested on the fungus *Aspergillus flavus* 3.4408 on PDA (agar dilution method). Sensory evaluation of soymilk flavored with the essential oils of citronella, basil and mint at different concentrations was done by ten member panelists using a 9-point hedonic scale. The main compound for basil was eugenol 83.26%. Cinnamon contained cinnamaldehyde (97.3%). The main compounds in citronella (*Cymbopogon nardus*) were limonene (38.51%), citronellal (30.29%). Eucalyptus (*Eucalyptus globulus*) essential oil mainly contained eucalyptol/cineole

(76.70%), and Mint (*Mentha arvensis*): Menthol 42.72%, Menthone 25.72%. The MICs of citronella, basil, cinnamon, eucalyptus and mint were 5-10 µl/ml, 0.5-1 µl/ml, ≤0.1 µl/ml, >>10 µl/ml and 10-20 µl/ml, respectively. Thus, cinnamon was the most effective in inhibiting fungal growth, while eucalyptus was the least effective. These essential oils improved the soymilk flavor. Mint was the most preferred flavor, followed by citronella and basil. Thus, essential oils especially mint and citronella can be used for improving acceptability of soymilk at low concentration.

Keywords: Basil, CFU, citronella, cinnamon, eucalyptus, and mint, sensory attributes, soybean

iCB-2020-22

Developing and Nutritional Quality Evaluation of Complementary Diets Produced from Selected Cereals and Legumes Cultivated in Gondar province, Ethiopia.

Tsehayneh G. Y., Makokha, O. A., Okoth, J. K. and Tenagashaw, W. M., 2020. *Journal of Current Research in Nutrition and Food Science*, 8(1), pp. 291-302.

Abstract

Malnutrition is a great concern in developing countries which affects infants and young children in their early age. The objective of this study was to formulate low-cost complementary foods from selected cereals and legumes using household technologies and an attempt was made to evaluate nutritionally. Four complementary blends were formulated based on protein basis of the ingredients and their nutritional characteristics were compared with the commercial complementary food (Cerifam). Standard official procedures were used to determine the macronutrient composition of the developed diets and ingredients. High-performance liquid chromatography was used to quantify vitamins of the formulated diets, while minerals were analyzed using atomic absorption spectrophotometer. The crude protein values of cereal-legume based diets were ranged from 12.20-17.14% on dry matter basis. Mean separation using Least Significant Difference indicated that protein values to be significantly ($p < 0.05$) differed between the different composite flours. However, the crude protein content of all blended diets were statistically greater ($p < 0.05$) than the control value. Energy values of the blends were ranged from 394-560 kcal/100g and the values met the WHO recommendations of 0.8 -1.0 kcal/g from complementary foods. In general, the formulated diets were better than the reference diet and meet the recommended levels for protein, energy and problem nutrients like as zinc, iron and vitamin A based on an estimated daily intake of 65 g of weaning foods. Therefore, the formulated diets have a significant potential in poor rural and urban mothers for use in sub-Saharan Africa.

Keywords: Cereals; Complementary Foods; Legumes; Nutrient Requirement

iCB-2020-23

Food Fortification: The Level of Awareness among Kenyan Consumers.

Maya, A. L., Kyallo, F., Okoth, J. K., Kahenya, P., Makokha, A., Sila, D. and Mwai, J., 2020. *Journal of Nutrition and Metabolism*, Article: ID 8486129 <https://doi.org/10.1155/2020/8486129>

Abstract

More than half of the morbidity and mortality cases among children in Kenya are as a result of micronutrient deficiencies (MNDs). Food fortification is considered by the Government of Kenya as a feasible strategy for addressing MNDs. Worldwide, fortification has been proven to be effective since it does not require any change in dietary habits. Success of large-scale food fortification however may depend on consumer awareness of the fortification benefits. A cross-sectional study was conducted in 13 counties to collect information on fortification awareness using structured questionnaires. 1435 respondents were selected using the Lot Quality Assurance Sampling method. Data were analyzed using Stata version 14.0 and statistical significance $p < 0.05$. The study participants were described using descriptive statistics. The association of sociodemographic characteristics and awareness of fortification was performed using binary logistic regression analysis. The median age of the study participants was 35 years. Only 28% of the respondents were aware of the term “fortification.” Of the respondents, about 27% heard of

food fortification through radio. Vernacular radio emerged as the most preferred channel for communicating fortification information among 24.9% of the respondents. Although awareness of vitamins (32%) and minerals (1.5%) was limited, most (76%) respondents reported of existence of health risks for lacking micronutrients. Awareness of food fortification was significantly associated with respondents' occupation ($p < 0.001$), household size ($p = 0.012$), education levels ($p < 0.001$), and age ($p = 0.025$). There is need for a wider use of broadcast media sources to modify information and education materials to promote fortification awareness among Kenyan consumers.

Keywords: Food Fortification, Consumers Awareness

iCB-2020-24

Efficacy of compositing with snail meat powder on protein nutritional quality of sorghum–wheat buns using a rat bioassay.

Agengo, F. B., Onyango, N.A., Serrem, A. C and Okoth, J., 2020. *Journal of the Science of Food and Agriculture*, 100(7), pp. 2963-2970. Doi:10.1002/jsfa.10324

Abstract

Protein energy malnutrition (PEM) is an important health burden in most developing countries mainly in sub-Saharan Africa, where it contributes to high rates of child morbidity and mortality. This study evaluated the efficacy of compositing with snail meat powder (SMP) on protein nutritional quality of sorghum–wheat buns using a rat bioassay. Nine diets –seven isonitrogenous diets, based on six variations of buns and a reference diet made using skimmed milk powder, in addition to the basal diet meant to estimate the endogenous nitrogen excretion and a 16% protein rehabilitation diet – were fed to male weanling albino rats. Protein efficiency ratio (PER), and food efficiency ratio (FER), net protein retention ratio (NPRR), apparent protein digestibility (APD), and true protein digestibility (TPD), protein digestibility corrected amino acid score (PDCAAS), and digestible indispensable amino acid score (DIAAS) indices of protein quality were determined. Fortification with SMP significantly ($P < 0.05$) enhanced PER from 0.21% to 2.70%, FER from 0.02% to 0.27%, APD from 81.17% to 88.28%, and TPD from 87.48% to 95.38%. PDCAAS and DIAAS increased from 45% to 78% and 44% to 69% respectively in unfortified buns to buns fortified with 25% SMP. Complementary diets fortified with SMP promote growth and rehabilitate emaciated rats, whereas unfortified diet did not support weight gain. Thus, supplementation of buns with SMP might enhance a faster recovery in children affected by PEM.

Keywords: Protein Energy Malnutrition; Complementary Feeding; Snail Meat Powder

iCB-2020-25

Effect of Boiling and Wet Frying on Nutritional and Antinutrients Content of Traditional Vegetables Commonly Consumed in Malawi.

Issa Y. J., Onyango, A., Anselimo O. Makokha, O. A and Okoth, J., 2020. *Journal of Food Research*, 9(1), pp.19-33. doi:10.5539/jfr.v9n1p19

Abstract

This study was carried out to evaluate the effects of boiling and wet frying on nutritional and antinutrients content of *Amaranth hybridus*, *Moringa oleifera*, *Bidens pilosa* (black jack), *Corchorus olitorius* (Jute mallow) and *Ipomea batatas* (sweet potato) leaves. The edible portions of the vegetables were either boiled or wet fried for ten minutes then dried alongside the raw vegetables under the shade. Crude fats, minerals, vitamins and antinutrients were determined in the dried materials. Wet frying increased the oil content of the vegetables by a range of 15.49% to 28.40 % and was hence associated with lower % ash and mineral contents. Wet frying significantly reduced ($P \leq 0.05$) beta-carotene in all the vegetables except in jute mallow. Boiling had no significant effect on beta-carotene in most of the vegetables. Boiling significantly reduced ($P \leq 0.05$) ascorbic acid in all the vegetables while wet frying preserved ascorbic acid in all the vegetables. Both boiling and wet frying significantly reduced ($P \leq 0.05$) oxalates in all the

vegetables except in black jack. Both boiling and wet frying significantly ($P \leq 0.05$) reduced the concentration of phytates in most of the vegetables. However, boiling was more effective in reducing the amount of phytates. Boiling reduced higher concentrations of tannins in all the vegetables as compared to wet frying. Boiling was associated with better retention of minerals and beta-carotene, and greater reduction of antinutrients in most of the vegetables. Wet frying was more advantageous in retaining vitamin C. The different species showed differences in retention of various minerals and vitamins.

Keywords: Traditional Vegetables; Nutrients; Antinutrients; Cooking

iCB-2020-26

Effect of feed supplementation of *Dacryodes edulis* parts' powder as prebiotic on the growth traits, ceca microbiota and blood parameters of local chickens.

Tangomo A.N., Keambou C.T., Gicheha M.G. & Kagira J.M., 2020. *Translational Animal Science*, 4 (2), pp. 764-777. Doi: <https://doi.org/10.1093/tas/txaa069>

Abstract

This study aimed at testing the efficacy and safety of *Dacryodes edulis* plant parts in diets fed to chicken. The plant has potential for use as a natural prebiotic to substitute the conventionally used antibiotic growth promoters in poultry production. Phytochemical analyses of the plant leaves, stem, and bark combination (stembark) and seed powders from the *D. edulis* were carried out. The powder from the three *D. edulis* plant parts were used as supplement in formulating six experimental diets tested in this study. The diets were TL_{0Ed} (0.5% leaves powder), TL_{1Ed} (1.0% leaves powder), TB_{0Ed} (0.5% stembark powder), TB_{1Ed} (1.0% stembark powder), TS_{0Ed} (0.5% seeds powder), and TS_{1Ed} (1.0% seeds powder). Besides, a positive (T₊ positive control; 0.5-g oxytetracycline as recommended by the manufacturer) and a negative (T₋ negative control; having no commercial antibiotic and no plant supplement) diets were prepared for comparison purposes. The diets were fed to a total of 288 dual-purpose chicken for a period of 14 weeks. The chicken growth and body composition characteristics, blood chemistry, and microbiota count were collected and used as indicators of the plant parts efficacy and safety. The analysis of the *D. edulis* plant parts significantly differed ($P \leq 0.05$) in their phytochemical contents. The initial body weight and feed conversion efficiency ratios were not significantly different ($P \geq 0.05$) between and among treatment groups. However, significant differences ($P \leq 0.05$) were detected in the feed intake and body weight gain at eighth week. Live weight at eighth week was significantly different ($P \leq 0.05$) with its values ranging between 503.32 and 614.93 g for treatments TL_{1Ed} and T_{Neg-}, respectively. The dietary treatment of *D. edulis* leaves, stembark, and seed powder at the two inclusion levels significantly ($P \leq 0.05$) decreased the colonies forming unit of *Escherichia coli* and *Salmonella* sp. as compared with negative control treatment in the eighth week phase. The level of glucose, total cholesterol, triglycerides, aspartate aminotransferase, alanine amino transferase, alkaline phosphatase, and the packed cell volume did not differ significantly ($P \geq 0.05$) between and among dietary *D. edulis* treatments. The findings from this research provide crucial information on the efficacy and safety of *D. edulis* plant parts. This is an important step in testing the potential of the plant in use as a prebiotic in chicken feeds production.

Keywords: *Dacryodes edulis*; blood parameters; growth; microbiota; local chicken.

iCB-2020-27

Breeding dairy goats for disease resistance is profitable in smallholder production systems.

Amayi A.A., Okeno T.O., Gicheha M.G. & Kahi A.K., 2020. *Small Ruminant Research*

Abstract

We tested hypothesis that, inclusion of the disease resistance indicator traits in the breeding goal of the dairy goats would result to increased response to selection and consequently profitability of smallholder farmers. Using deterministic simulation, we compared response to selection realised in breeding schemes without (Scheme I) and with (Schemes II, III and IV) disease resistance in

the breeding goal. We used faecal egg count (FEC) and somatic cell score (SCS) as the indicator traits for helminthosis and mastitis in goats, respectively. We also investigated the effect of risk aversion among the smallholder farmers on response to selection. The breeding structure consisted of a two-tier closed nucleus system, with recording and genetic evaluations being undertaken in the nucleus. The breeding schemes, differed based on the number of traits in the selection criteria and number of records used to estimate their breeding values. For instance, in Scheme I, traits in the breeding goal included milk yield (MY), live weight (LW), average daily gain (ADG), doe mature weight (DMW), number of kids weaned (NKW) and survival rate (SR). Scheme II was similar to Scheme I, but included records of FEC and SCS measured immediately after weaning and during early lactation, respectively. Scheme III was similar to II, but with additional information on SCS recorded at mid-lactation, while Scheme IV was similar to III with more SCS information recorded in late-lactation. Our findings, indicate that, schemes that included disease resistance indicator traits in the selection criteria (Schemes II, III and IV) were 28, 24 and 19%, respectively, superior in profitability to Scheme I, which ignored the disease resistance in the breeding goal. Scheme II was the best as it realised additional 3.5 and 7.6% profitability compared to Schemes III and IV, respectively. The response to selection, was maximized when nucleus size consisted of 4-5% of the does' effective population size and 20% of them phenotyped for SCS. The breeding schemes, with high risk aversion realised low profitably compared to low risk aversion schemes. This demonstrates that, use of economic values obtained using low risk aversion models, could overestimate the economic worth of a breeding program especially in smallholder production systems, where farmers are risk averse.

Keywords: Breeding schemes; disease resistance; risk aversion; dairy goats; and smallholder systems.

iCB-2020-28

Production and fertility performance of Barka cattle breed in different agro-ecological zones of Eritrea.

Goitom S., Gicheha M.G. & Tsegay T. 2020. *African Journal of Rural development*. 4, pp. 212 – 216. www.afjrd.org/index.php/afjrd/article/download

Abstract

This study was carried out to determine the milk yield (MY), growth (Gp) and fertility (Fp) performances of Barka cattle breed reared in the two major agro-ecological zones (AEZs) in Eritrea. The breed which is indigenous to Eritrea is mainly kept in crop-livestock system in both zones implying similarity in production management. We thus hypothesized that the effect of agro-ecological zone would significantly impact on the production and reproduction performances of the Barka breed. Herds of 15 cows each were established and maintained at Halhale and Shambuko research stations from which MY, Gp and Fp data were obtained. The two sites are managed by the National Agricultural Research Institute (NARI) of Eritrea and represented the highland and lowland AEZs, respectively. General linear model (GLM) was used in the analysis with the age of a cow and calf sex being fitted as fixed effects in determination of MY, Gp and Fp performances over two lactations periods. The mean MY of cows for the two lactations period at Halhale and Shambuko were 3.93 ± 0.17 kg and 2.80 ± 0.13 kg, respectively. There was no significant difference in the average birth weight (BW) between the herds with male calves ranging between 22.19 kg in the first lactation and 23.03 kg in second lactation. There was no significant difference in weaning weight as well and the average weight irrespective of age of the dam which averaged 66.05 ± 11.75 kg. The services per conception (SPC) averaged 1.2 ± 0.43 while the average days open or post-partum anoestrus was 168 ± 87 days. The findings from this study provide valuable information useful in Barka breed utilization and conservation efforts.

Keywords: Age; Barka; cattle breed; Eritrea; lactation; reproduction, weaning

iCB-2020-29

Advancing Climate Smart Agriculture: Adoption Potential of Multiple On-Farm Dairy Production Strategies among Farmers in Murang'a County, Kenya.

Maindi N.C. Osuga I.M. & Gicheha M.G., 2020. *Livestock Research for Rural Development (LRRD)*, 32 (4). Accessible at: <http://www.lrrd.org/lrrd32/4/izzac32063.html>

Abstract

Improving uptake and intensification of farm-level utilisation of climate smart agriculture (CSA) strategies among farmers is essential to develop resilient livestock production systems for sustainable livelihoods and food security while addressing climate change adaptation and mitigation. However, empirical basis for sector-specific understanding of the adoption behaviour of the farmers to climate change is merely established, prompting the current study on adoption of CSA strategies among resource-constrained dairy farmers particularly in Sub Saharan Africa (SSA). The case study employed a joint analysis framework of both multivariate probit (MVP) and ordered probit models to analyse farmers' joint adoption decisions for four on-farm strategies namely: improved fodder, feed conservation, artificial insemination and manure management. The case study, involving 132 dairy farmers from a representative Murang'a County in Kenya revealed that adoption of CSA practices among farmers is widespread in the study area, with majority of the farmers (87%) adopting at least two of the four considered strategies. However, the specific adoption rates were relatively low, ranging from 27% for manure management to 66% for improved fodder and thus the need to target the less adopted strategies and incentivise the farmers to intensify their implementation. The findings show interdependence of the strategies with complementarity and substitutionality relationships among the practices. The interdependence can facilitate the tailoring of suitable packages of strategies which are interrelated to optimise their synergies. Capital, gender, water availability, market access and infrastructure and social networks were found to be the most important determinants of adoption decision as well as the intensity of adoption. These findings from dairy sector-specific data in Kenya are significant to provide tailored and targeted policies in scaling up adoption and intensification of CSA strategies to advance climate smart dairy production systems in SSA.

Keywords: climate change; mitigation; multivariate probit model; ordered probit model; sustainable dairying

iCB-2020-30

The promotion of amaranth value chains for livelihood enhancement in East Africa: A systems modelling approach

Dizyee K., Baker D., Herrero M., Burrow H., Mc Millan L., Sila D.N., Karl R., 2020. *African Journal of Agricultural and Resource Economics* 15(2), pp. 81-94.

Abstract

This paper conducts ex-ante impact assessments for policy interventions to promote amaranth value chains in Tanzania and Kenya. Amaranth is an underdeveloped, drought-resistant, and nutrition-rich crop used for human food, animal fodder, and ornamental purposes. Promoting amaranth value chains is a difficult task, given that amaranth is not a well-established commodity and has limited market outlets in the developing world at present. This paper provides a framework within which conduct scenario analysis of ways to promote amaranth value chains using system dynamics (SD). We constructed an integrated amaranth production and market model to evaluate the impact of producer adoption of improved production technologies (improved seed varieties), and changes in demand for amaranth products, on producer profits and planting behavior. The results of our model show that the profitably upgrading and commercializing of amaranth value chains require multifaceted and chain-level interventions that improve supply- and demand-side conditions. Interventions that target only the supply side serve to increase amaranth production, but generate minor economic gain for producers.

Keywords: Amaranth; East Africa; Tanzania; value chains; system dynamics

iCB-2020-31

Application of near-infrared spectroscopy to predict the cooking times of aged common beans (*Phaseolus vulgaris L.*)

Nakhungu, W. E., Njoki, W. I., Carolien, B., Nghia-Do-Trong, N., Kahenya, K. P., Wouter, S., Sila, D.N., ... & Marc, H., 2020. *Journal of Food Engineering*, 284, pg. 110056. Doi: <https://doi.org/10.1016/j.jfoodeng.2020.110056>

Abstract

The cooking time of beans is an important quality indicator which can change considerably during ageing. Therefore, this study investigated the potential of near-infrared spectroscopy to rapidly predict cooking times of aged common beans. Four bean varieties were aged under different storage conditions, resulting in a range of samples for each of these varieties. The cooking kinetics of the aged beans were determined by finger pressing and modelled using logistic regression to obtain the times it took to cook 95% of the beans. The cooking times obtained were predicted from the NIR spectra of milled raw bean samples. This was done using partial least squares regression, after carrying out wavelength selection. Model performance was improved up to an average prediction error of 8 min by de-hulling the beans and reducing the number of varieties included. In conclusion, NIR spectroscopy has high potential to predict the cooking times of aged beans.

Keywords: Common beans, Ageing, Logistic regression, Cooking time, Near infrared spectroscopy, Partial least squares regression

iCB-2020-32

Compliance status and stability of vitamins and minerals in Fortified Maize Flour in Kenya

Khamila, S., Sila, D. N., & Makokha, A., 2020. *Scientific African*, e00384, pp. 1-12. doi: <https://doi.org/10.1016/j.sciaf.2020.e00384>

Abstract

Fortification of staple foods is a cost-effective strategy that has been used to reduce the prevalence of micronutrient deficiency in the population. National mandatory maize flour fortification legislation was introduced in Kenya in 2012 to help address micronutrient deficiencies among the vulnerable groups of the population. This study aimed to quantify the amount of vitamin A, vitamin B2, B3, B9, iron and zinc in maize flour and premixes, relative to the national fortification standard, EAS 768 and determine the stability of micronutrients in fortified maize flour under normal storage conditions experienced in Kenya. A total of 27 maize flour brands and 2 brands of maize flour premixes were procured from the market and analyzed for compliance with the national standards for vitamin A, vitamin B2, vitamin B3, vitamin B9, iron, and zinc. Losses of micronutrients in fortified maize flour stored at 25°C/RH 60% and 35°C/RH 75% for six months were also quantified. Overall, the level of compliance of fortified maize flour to national standards was low with only 11.1% of the samples complying in the micronutrients analyzed. According to the Government of Kenya, compliance is accorded to brands that comply in at least three micronutrients. Only 48.1% of the samples had complied in three or more of the micronutrients analyzed. Compliance status for specific micronutrients to national standards varied greatly with minerals having higher compliance levels than vitamins. About a fifth (18%) of the samples from the market did not comply for any micronutrient analyzed. Some samples had folate and retinol levels below detectable limits. The retention of the vitamins analyzed was significantly affected by storage conditions (temperature and relative humidity). Low retention was observed for storage at 35°C/RH 75% compared to 25°C/RH 60%. In conclusion, fortification of maize flour is still low in Kenya and there is a need to strengthen efforts towards improved compliance.

Keywords: Compliance; stability; maize flour; premixes; fortification; vitamins; minerals

iCB-2020-33

Partial substitution of soy protein isolates with cricket flour during extrusion affects firmness and in vitro protein digestibility.

Kiiru, S. M., Kinyuru, J., Kiage, B. N., & Marel, A.-K., 2020. *Journal of Insects as Food and Feed*, 6(2), pp.169–177.

Abstract

The rapid increase in global population and the unsustainable conventional meat production have created demand for alternative animal-derived protein. Traditionally, soy has been utilised in structuring meat analogues. Currently, edible insects are researched as a potential alternative source of proteins and a valuable ingredient in development of meat analogues. High moisture extrusion was applied to a mixture of soy protein isolate (SPI) and full or low fat cricket flour (CF) and the impact of cricket inclusion levels as well as extruder barrel temperature on the firmness and in vitro protein digestibility was evaluated. The SPI flour was substituted at 0 (control), 15, 30 and 45% and extruded on a laboratory co-rotating twin-screw extruder with a throughput of 1 kg/h at 150 rpm screw speed. Cooking temperature was varied at 120, 140 and 160 °C and water flow rate set to 10 ml/min. Texture as evaluated on all the treatments by texture profile analysis while the in vitro crude protein digestibility (CPD) was done on raw flours and extrudates with 15 and 45% CF inclusion and at 120 and 160°C. The extrusion temperature had a negative correlation ($r = -0.49$) with the CPD but the CF inclusion had a correlation; $r = 0.71$ (120°C) and -0.28 (160°C). The highest CPD (50%) was recorded from 45% full-fat CF extruded blend at 120°C. Firmness was positively influenced ($r = 0.56$) by temperature but negatively influenced ($r \approx -0.57$) by CF inclusion. Overall the low-fat CF blends had lower firmness values compared to their full-fat counterparts and control samples. The findings from this research demonstrated to be relevant for processing of high-protein and insect-based meat alternatives for food dependencies.

Keywords: Edible insects, *Acheta domesticus*, full and low-fat, meat analogue

iCB-2020-34

Book review: African edible insects as alternative source of food, oil, protein and bioactive components.

Kinyuru, J., 2020. *Journal of Insects as Food and Feed*, 6(3), pp. 323–325. Doi <https://doi.org/10.3920/JIFF2020.x002>

Abstract

The book has a total of twenty-two chapters covering commonly consumed African edible insects and their nutritional composition, history and economic importance. The book is edited by a scientist and expert in food science and technology, oil chemistry, functional foods and bioactive compounds. To support the discussions in the chapters, the authors have used tables, figures and photos. The book delves directly into chapter one and lacks a preface by the editor introducing the contents of the book.

iCB-2020-35

Promoting edible insects in Kenya: historical, present and future perspectives towards establishment of a sustainable value chain.

Kinyuru, J. N., & Ndung'u, N. W., 2020. *Journal of Insects as Food and Feed*, 6(1), pp. 51–58. <https://doi.org/10.3920/JIFF2019.0016>

Abstract

This paper discusses the current state and priorities of Kenya-based research and innovations on insects as food and feed with a view to establishing a vibrant insects' value chain. The paper is

divided into sections that focus on historical insect consumption, farming, utilization and entrepreneurial priorities. The paper also introduces a new quadrat model for utilization of edible insects which shows an interrelationship between edible insects, crops, animals and humans. The paper attempts to identify attempts on identifying social and psychological barriers to insects' acceptance as food and feed since insects are intimately connected to strong cultural and regional values. We conclude with recommendations about the future priorities of edible insect field which include: tracking of production volumes, new innovations to support automation and industrial production, research on consumer attitudes and behaviour that is culturally sensitive, systematic, and large-scale; enactment of national and regional regulations to support the industry and unequivocal acknowledgment of the impacts of developments in the edible insect industry to national and regional development.

Keywords: entomophagy, farming systems, utilization model

iCB-2020-36

Supporting climate change adaptation using historical climate analysis

Peter Dorward, Henny Osbahr, Chloe Sutcliffe & Robert Mbeche, 2020. *Climate and Development*, 12(5), pp.469-480. DOI: 10.1080/17565529.2019.1642177

Abstract:

Climate change and variability presents a challenge for rural communities in developing countries. Bridging organizations help align stakeholder and local perspectives and mediate communication that shapes adaptation responses. We argue that a first step for adaptation projects is to determine the nature of the climate norms and how climate is changing. This paper explores the degree to which development organizations in Kenya, Uganda and Tanzania used analysis of local historical climate information in project aims, planning and design. This included 67 participants, managing 102 community-level climate-related agricultural projects, and three NGO case studies. Most focused on low-regret options. The majority of projects enhanced awareness of climate change and variability, but only 7% had used historical climate information during planning. Instead, projects relied on general knowledge or farmers' perceptions, which sometimes differ from analyzed historical climate information, potentially leading reinforcement of perceptions. It is vital that bridging organizations and policy makers value analyzed historical climate information when determining climate norms (including variability) and identify what data shows regarding how climate is changing. This is essential for planning with stakeholders the suitability of alternative crops and cultivars and ensuring other relevant environmental factors influencing agricultural production are considered.

Keywords: Adaptation; planning; perceptions; historical climate information; organizations

iCB-2020-37

Evaluation of technical efficiency of edible oil production: The case of canola production in Kieni West Constituency, Kenya.

Crispas Muiru Wambui & Majiwa Eucabeth, 2020. *Journal of Development and Agricultural Economics*, 12(1) pp. 59-66

Abstract

Globally, the vegetable oil demand is growing due to rising food consumption in emerging countries such as China and due to the high demand for biofuels. The current world vegetable production estimates stand at 187 million tons for the year 2016/2017. Of the estimated vegetable oil production, 70.3 million tons (37.6%) comes from palm and palm kernel, 55 million tons (30%) arise from soybean while the remaining 32.5% are supplied by canola, sunflower, peanut and cottonseed oils (USDA, 2017). Canola production is becoming an important crop in Kenya due to the high demand for edible oils, with the current production not meeting the current demand. This study evaluates canola production efficiency in Kieni West Constituency and its determinants using a stochastic production frontier approach and a sample of randomly selected 46 canola

farmers. The output and input variables measured included the total amount of canola produced, land size under canola production, quantity of canola seeds, labour quantity engaged, and fertilizer quantity. The total input costs and income from canola farming were also evaluated. The mean technical efficiency score was 0.97 with 50% of the farms being efficient. The determinants of canola production included gender of the farmer, age of the farmer, years of schooling of the farmer and number of household members. Canola production was found profitable with the farmers earning an average income of Kshs. 96532.61 (965.32 US\$) and a profit of Kshs. 76413.04 (764.13 US\$) per season. Thus the study recommends that there is need for policy makers to promote the crop as an alternative to other crops grown commonly in the area such as maize and coffee which have less returns than canola. Measures should specifically be put in place to popularize the crop especially among the younger canola farmers who were found to be more efficient than the older farmers. Seed is also not readily available in Kenya hence measures that would help farmers' access high quality canola seeds should be put in place.

iCB-2020-38

Smallholder Dairy Production, Motivations, Perceptions and Challenges in Nyandarua and Nakuru Counties, Kenya

Geoffrey Ochieng Otieno, Kavoi Muendo & Robert Mbeche, 2020. *Journal of Agriculture and Veterinary Science (IOSR-JAVS)*, 13(1), pp. 42-50

Abstract

Small-scale farmers dominate Kenya's dairy industry that is among the largest and one of the most successful in Africa. Despite the dairy policies in place, the smallholder dairy farmers are still subsistent and are yet to attain global competitiveness. This study explored socioeconomic characteristics, motivation, perceptions and challenges of smallholder dairy farmers in Kenya. The study used a mixed approach method of cross section survey and multistage sampling procedure to select a sample of 380 smallholder dairy farmers from Nakuru and Nyandarua counties. Structured questionnaires and Focus Group Discussion provided the data for analysis. The study results indicated that smallholder milk productivity was below the world leaders. Zero grazing was the most productive system while open grazing was the dominant production system. Land, income and market factors were core for smallholder dairy farming performance. Even though household dairy commercialization level for Nakuru and Nyandarua Counties were relatively low, Nyandarua County had higher level of smallholder dairy commercialization compared to Nakuru County. Majority of the dairy farmers were intending to continue with dairy production. Those planning to exit cited the venture as either being expensive, not profitable or risky. Challenges faced by the smallholder farmers related to productivity, infrastructure and institutions. To reduce productivity challenges, the study suggested review of land policies, improvement in animal feed, veterinary and insemination services. To reduce infrastructural impediments the study suggested improvement in roads network, rural electrification (and promotion of other sources of energy) storage facilities and exploration of alternative milk preservation methods. Institutional impediments need improvements in financial accessibility, extension services and customized research and technological innovations.

Keywords: Smallholder Dairy, Motivations, Perceptions and Challenges, Kenya

iCB-2020-39

Effect of feed supplementation of *Dacryodes edulis* parts' powder as prebiotic on the growth traits, ceca microbiota and blood parameters of local chickens.

A.N. Tangomo, C.T. Keambou, M.G. Gicheha, J.M. Kagira, 2020. *Translational Animal Science*, 4(2), pp. 764-777Doi: <https://doi.org/10.1093/tas/txaa069>

Abstract

This study aimed at testing the efficacy and safety of *Dacryodes edulis* plant parts in diets fed to chicken. The plant has potential for use as a natural prebiotic to substitute the conventionally used

antibiotic growth promoters in poultry production. Phytochemical analyses of the plant leaves, stem and bark combination (stembark) and seed powders from the *D. edulis* were carried out. The powder from the three *D. edulis* plant parts were used as supplement in formulating six experimental diets tested in this study. The diets were TL_{0Ed} (0.5% leaves powder), TL_{1Ed} (1.0% leaves powder), TB_{0Ed} (0.5% stembark powder), TB_{1Ed} (1.0% stembark powder), TS_{0Ed} (0.5% seeds powder) and TS_{1Ed} (1.0% seeds powder). Besides, a positive (T₊ positive control; 0.5g oxytetracycline as recommended by the manufacturer) and a negative (T₋ negative control; having no commercial antibiotic and no plant supplement) diets were prepared for comparison purposes. The diets were fed to a total of 288 dual-purpose chicken for a period of 14 weeks. The chicken growth and body composition characteristics, blood chemistry, and microbiota count were collected and used as indicators of the plant parts efficacy and safety. The analysis of the *D. edulis* plant parts significantly differed ($p \leq 0.05$) in their phytochemical contents. The initial body weight and feed conversion efficiency ratios were not significantly different ($p \geq 0.05$) between and among treatment groups. However, significant differences ($p \leq 0.05$) were detected in the feed intake and body weight gain at 8th week. Live weight at 8th week was significantly different ($p \leq 0.05$) with its values ranging between 503.32g and 614.93 g for treatments TL_{1Ed} and T_{Neg-}, respectively. The dietary treatment of *D. edulis* leaves, stembark and seed powder at the two inclusion levels significantly ($p \leq 0.05$) decreased the colonies forming unit of *Escherichia coli* and *Salmonella sp* as compared to negative control treatment in the 8th week phase. The level of glucose, total cholesterol, triglycerides, Aspartate aminotransferase (AST), Alanine amino transferase (ALT), alkaline phosphatase (ALP), and the packed cell volume (PCV) did not differ significantly ($p \geq 0.05$) between and among dietary *D. edulis* treatments. The findings from this research provide crucial information on the efficacy and safety of *D. edulis* plant parts. This is an important step in testing the potential of the plant in use as a prebiotic in chicken feeds production.

iCB-2020-40

Production and fertility performance of Barka cattle breed in different agro-ecological zones of Eritrea.

Goitom S., Gicheha M.G. & Tsegay T. 2020. *African Journal of Rural development*. 4, pp. 212 – 216. www.afjrd.org/index.php/afjrd/article/download

Abstract

This study was carried out to determine the milk yield (MY), growth (Gp) and fertility (Fp) performances of Barka cattle breed reared in the two major agro-ecological zones (AEZs) in Eritrea. The breed which is indigenous to Eritrea is mainly kept in crop-livestock system in both zones implying similarity in production management. We thus hypothesized that the effect of agro-ecological zone would significantly impact on the production and reproduction performances of the Barka breed. Herds of 15 cows each were established and maintained at Halhale and Shambuko research stations from which MY, Gp and Fp data were obtained. The two sites are managed by the National Agricultural Research Institute (NARI) of Eritrea and represented the highland and lowland AEZs, respectively. General linear model (GLM) was used in the analysis with the age of a cow and calf sex being fitted as fixed effects in determination of MY, Gp and Fp performances over two lactations periods. The mean MY of cows for the two lactations period at Halhale and Shambuko were 3.93 ± 0.17 kg and 2.80 ± 0.13 kg, respectively. There was no significant difference in the average birth weight (BW) between the herds with male calves ranging between 22.19 kg in the first lactation and 23.03 kg in second lactation. There was no significant difference in weaning weight as well and the average weight irrespective of age of the dam which averaged 66.05 ± 11.75 kg. The services per conception (SPC) averaged 1.2 ± 0.43 while the average days open or post-partum anoestrus was 168 ± 87 days. The findings from this study provide valuable information useful in Barka breed utilization and conservation efforts.

Keywords: Age; Barka; cattle breed; Eritrea; lactation; reproduction, weaning

iCB-2020-41

In-vitro Anthelmintic Activity of Chitosan Encapsulated Bromelain against eggs, larval and adult stages of *Haemonchus contortus*.

Hunduza A., John Kagira, Naomi Maina, Dickson Andala, Kipyegon Cheruiyot, Shadrack Kahiro, 2020. *Journal of Applied Life Sciences International* 23(3), pp. 28-38.

Abstract

The objective of this study was to evaluate in vitro ovicidal, larvicidal and adult mortality activity of bromelain encapsulated in chitosan nanocarriers against *H. contortus*. Bromelain was isolated from peels of ripe pineapple from Kiambu County, Kenya. Isolation of bromelain was conducted with several stages of fractionations with ammonia sulphate salt and dialysis. Encapsulation of bromelain was done by use of methyl cellulose-chitosan in order to control release and activity. The encapsulated chitosan nanocarriers were then subjected to in vitro ovicidal, larvicidal and adult mortality activity according to standard procedures. The results of the assays showed that encapsulated bromelain had an IC₅₀ of 0.249mg/ml, 0.251mg/ml and 0.140mg/ml on the egg hatch, larval and adult worm mortality assays, respectively. All these values showed better activity than bromelain although there was no significant difference ($p>0.05$) between activities of encapsulated bromelain and bromelain. There was also a significant difference ($p<0.05$), between Albendazole and the rest of the test drugs. In conclusion, this study has shown that encapsulated bromelain has anthelmintic activity on different developmental stages of *H. contortus* parasite and that it should be further investigated and developed as a novel anthelmintic drug for control of *H. contortus* and hence improve production of small ruminants.

iCB-2020-42

In vitro antibacterial activity of nanoencapsulated bromelain against bacteria isolated from milk of dairy goats with sub-clinical mastitis in Kenya.

Mahlangu Precious, Kagira John, Maina Naomi, 2020. *Asian Journal of Research in Animal and Veterinary Sciences* 5(3), pp. 33-40.

Abstract

Mastitis in dairy goats is managed by a variety of antibiotics. Due to the emergence of antibiotic resistance, there is need for development of new antimicrobial agents. In the current study, the *in vitro* activity of nanoencapsulated bromelain, using bromelain extracted from the pineapple fruit, *Annanus comosus* was investigated against bacteria isolated from milk of dairy goats with sub-clinical mastitis. Nanoencapsulation of bromelain was done using the ionic gelation method of chitosan nanoparticles with sodium tripolyphosphate as the cross linking agent. In this study, the agar well diffusion method was used to test for antimicrobial activity while the broth microdilution method was used to test for the Minimum Inhibitory Concentration (MIC). The isolates used were *Staphylococcus aureus*, Coagulase Negative *Staphylococci*, *Serratia* spp., *Klebsiella* spp., *Enterobacter* spp., *Citrobacter* spp. and *Escherichia coli* isolated from milk of dairy goats with sub-clinical mastitis in Thika East Sub-county, Kenya. The agar well diffusion method showed that bromelain and nanoencapsulated bromelain had antimicrobial activity. All of the tested bacteria were sensitive to extracted bromelain at 5mg/ml and less. The tested bacteria were less sensitive to commercial bromelain (57.1%) at 5mg/ml and less. The MIC of nanoencapsulated bromelain against *Enterobacter* spp., *Citrobacter* spp., *Serratia* spp. and Coagulase Negative *Staphylococci* was 25µg/ml, while that of *Escherichia coli* was 50µg/ml. The MIC of nanoencapsulated bromelain against *Klebsiella* spp. and *Staphylococcus aureus* was 200µg/ml. The low MICs recorded in this study shows that nanoencapsulated bromelain has high antimicrobial potential which warrants further *in vivo* studies in dairy goats to determine its efficacy against sub-clinical mastitis.

iCB-2020-43

Prevalence, Risk factors Associated with Brucellosis and Presence of Pathogenic Bacteria isolated from Camel Milk in Garissa County, Kenya.

Noor M., Rotich V., Kiarie J. W., Cheruiyot K. and J. M. Kagira, 2020. *South Asian Journal of Research in Microbiology*, 6 (4), pp. 42-52.

Abstract

Aim: The current study was undertaken to assess the prevalence, risk factors of brucellosis and presence of pathogenic bacteria isolated from camel milk in Garrisa County, Kenya.

Methodology: The study design was cross-sectional where questionnaires were administered to farmers to assess the risk factors associated with brucellosis. The experimental study was also employed to identify bacteria in milk samples which were collected from 104 camels. Fifty milk samples were obtained from local farms while 54 were from sales point at Garissa market. Further test for brucellosis using milk ring test was also carried out.

Results: The overall prevalence of brucellosis in camel milk was 8%. Most (12.5%) of the positive samples were from Dadaab Sub-county while the rest of the positive samples were from Fafi (5.9%) and Balambala (5.9%) sub-counties. All the 54 samples obtained from Garissa market were negative of brucellosis. Of the total (118) bacteria isolates, those from the farm level were 68.6% and from market were 31.2%. The bacteria isolated from the 104 milk samples were *Pseudomonas* spp. (32.2%), *Salmonella* spp. (30.5%), *Staphylococcus* spp (21.2%), *Escherichia coli* (8.5%) and *Shigella* spp. (7.6%). The risk factors that were significantly ($p < 0.05$) associated brucellosis were: age of lactating camels (higher in camels aged above 20 years), herd size (higher in camels from herd sizes of between 30-50 camels), and herding of camels with other livestock (higher in camels kept with other livestock).

Conclusion: In conclusion, a few milk samples from camels in Garissa County were found to have brucellosis and were heavily infected with bacteria which can cause mastitis. Considering that most people in the study area drank raw milk, spread of these bacteria to man is a high possibility and thus animal and public health officers should implement one health disease control strategies.

iCB-2020-44

Beta-Lactam Resistance in Bacteria Associated with Sub-Clinical Mastitis in Goats in Thika Sub-County, Kenya.

Okoko I.M., Maina N., Kiboi D., Kagira J., 2020. *Veterinary World* 13(6).

Abstract

Mastitis is an economically significant disease in livestock majorly caused by bacteria. In Kenya livestock contribute to gross domestic product and economic value. Mastitis manifests in two forms; clinical and sub-clinical forms. Treatment of mastitis is done using antibiotics. Limited studies exist on the bacteria causing mastitis and their susceptibility profiles to antibiotics. Using milk samples collected from goats with sub-clinical mastitis in Thika sub-county, Kenya, the study focused on two main aims; First, to determine resistance to antibiotics; Penicillin G, Cephalexin, Cefoxitin and Cefotaxime in bacteria isolated from the goat milk using agar disk diffusion method. Secondly, using a questionnaire, the study assessed the risk factors associated with the occurrence of resistance to the antibiotics. Of the 110 dairy goats sampled, 73% (80) were positive for subclinical mastitis by California Mastitis Test (CMT). Isolation and identification of the bacteria from the positive samples using standard biochemical tests yielded 149 bacteria isolates, among them *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter* spp., *Yersinia* spp., coagulase negative *Staphylococci* (CNS), *Escherichia coli*. Surprisingly, 76.5% (114) of the 149 bacteria isolates were resistant to at least one antibiotic tested. At least 56 (49%) bacteria isolates were resistant to all the four antibiotics tested while only one isolate was resistant to three antibiotics; Penicillin G, Cephalexin and Cefoxitin. Double disk synergy test using amoxicillin-clavulanic acid confirmed that none of the isolates possessed an extended-spectrum beta-lactamases (ESBLs). Pre- and post-milking practices ($p = 0.0336$) was found to be significantly associated with the

occurrence of antibiotic resistance. In conclusion, our results show that a large proportion of goat possessed beta lactam-resistant bacteria associated with sub-clinical mastitis. The identified bacteria are of zoonotic importance and, thus, further studies should be carried to determine transmission dynamics between humans and livestock and suggest novel intervention strategies.

iCB-2020-45

Nutritional composition of black soldier fly larvae feeding on agro-industrial by-products.

Chia, S. Y., Tanga, C. M., Osuga, I. M., Cheseto, X., Ekesi, S., Dicke, M., & van Loon, J. J., 2020. *Entomologia Experimentalis et Applicata*, 168(6-7), pp. 472-481. doi:10.1111/eea.12940

Abstract

Black soldier fly (BSF) larvae, *Hermetia illucens* L. (Diptera: Stratiomyidae), bio-convert organic side streams into high-quality biomass, the composition of which largely depends on the side stream used. In the present study, BSF larvae were reared on feed substrates composed of dried brewers' spent grains, each supplemented with either water, waste brewer's yeast, or a mixture of waste brewer's yeast and cane molasses to obtain 12 different substrates: barley/water, barley/yeast, barley/yeast/molasses, malted barley/water, malted barley/yeast, malted barley/yeast/molasses, malted corn/water, malted corn/yeast, malted corn/yeast/molasses, sorghum-barley/water, sorghum-barley/yeast, and sorghum-barley/yeast/molasses. The crude protein, fat, ash, and mineral contents of the BSF larvae fed each feed substrate were quantified by chemical analyses. The effect of substrate, supplementation, and their interaction on crude protein, fat, and ash contents of BSF larval body composition was significant. Calcium, phosphorus, and potassium were the most abundant macrominerals in the larvae and their concentrations differed significantly among substrates. These findings provide important information to support the use of BSF larval meal as potential new source of nutrient-rich and sustainable animal feed ingredients to substitute expensive and scarce protein sources such as fishmeal and soya bean meal.

iCB-2020-46

Nutritional and Technological Characteristics of New Cowpea (*Vigna unguiculata*) Lines and Varieties Grown in Eastern Kenya.

Biama, P. K., A. K. Faraj, C. M. Mutungi, I. M. Osuga and R. W. Kuruma. 2020. *Food and Nutrition Sciences*, 11(5), pp. 416-430. <https://doi.org/10.4236/fns.2020.115030>

Abstract

Protein sources in the diet of people living in semi-arid land of Kenya are lacking and if available it is costly to them. In terms of safe food and a healthy food supply, cowpeas (*Vigna unguiculata*) are a significant source of protein, carbohydrates, and minerals especially for poor populations in the Kenya, it is said to be poor man's meat. The aim of this study was to determine nutritional composition of newly bred ten cowpea lines and five varieties commonly grown in Eastern Kenya of Kitui, Machakos and Makueni counties to understand their potential utilization in curbing rising food and nutrition insecurity in arid and semi-arid lands ASALs and in any other food applications in Kenya. The experiment was arranged in Completely Randomized Design (CRD) whereby proximate composition and minerals were determined using standard AOAC and AACC methods and technological characteristics checked using modified methods used by other researchers. Collected data were subjected to Analysis of Variance (ANOVA) using SAS (2006) version 9.1, mean separation was done using Tukey's Honestly Significant Difference (HSD) method at 5% level of significance. Cowpeas composition ranged from 12.28% - 13.35% for moisture content, 49.37% - 55.74% for total carbohydrates, 2.99% - 3.34% for crude ash, 0.13% - 0.81% for crude lipids, 23.37% - 29.70% for crude protein and 1.40% - 4.34% for crude fibers. Cowpea samples recorded highest percentage of essential amino acids (60.71%) and non-essential amino acids (39.29%). Minerals ranged from 1.97 - 2.69 mg/100g for calcium, 3.23 - 3.90 mg/100g for magnesium, 205.53 - 223.30 mg/100g for sodium, 0.80 - 1.23 mg/100g for zinc, 1071.15 - 1152.62 mg/100g for potassium and 0.62 - 1.06 mg/100g for phosphorus. For technological properties,

lines absorbed water equivalent to their weights and they were comparable to varieties grown in the region. From the results it showed that cowpea line IT97K-1042-3, TEXAN PINKIYE, TX123, IT85F-867-5, IT82D-889-1 and IT82D-889 have desirable attributes such as high crude protein contents, good water absorption capacities and volumetric expansion. They compared well with existing K80 variety. These cowpea lines could possibly be bred and combined into a single cowpea line and further improved by breeders to have other good properties such as higher levels of water absorption during soaking hence reduced cooking times. Therefore, this work has shown that cowpea lines developed can be used as food security crop, industrial food applications and enriching foods of low protein like in complementary foods for healthy food supply in Eastern Kenya.

iCB-2020-47

The Nutritive Value and Palatability of Selected Browse Forages Mixtures from Arid and Semi-Arid Area of Kenya When Fed to Growing Small East African Goats.

Osuga I. M., D. G. Njeru, L. M. Musalia and S. A. Abdulrazak., 2020. *IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)*, 13(3), pp. 01-07. <http://www.iosrjournals.org/iosr-javs/papers/Vol13-issue3/Series-2/A1303020107.pdf>

Abstract

In this study the chemical composition, in vitro dry matter digestibility (IVDMD) and palatability of five browse forage mixtures were studied. The five forage mixtures were selected based on their nutritive value and IVDMD and from reported previous studies of single species. The species included *Acacia brevispica*, *Acacia mellifera*, *Acacia nilotica*, *Zizyphus mucronata* and *Berchemia discolor*. In vitro gas production technique was used to determine the rumen fermentation characteristics. Palatability of the browse forage mixtures was determined based on the mixture's voluntary intake by a cafeteria approach on growing small East African goats. The crude protein (CP) content ranged from 153.9 g/kg dry matter (DM) in *B. discolor* & *A. nilotica* forage mixture to 184.4 g/kg dry matter (DM) in *Z. mucronata* & *A. mellifera* forage mixture, while the total fibre content as measured by NDF ranged from 313.7 g/kg DM in *Z. mucronata* & *A. mellifera* forage mixture to 440.4 g/kg DM in the forage mixture containing *Z. mucronata*, *A. brevispica*, *A. mellifera* & *A. nilotica*. The IVDMD ranged from 57.1% in *B. discolor* & *A. nilotica* to 64.0 % in the browse mixture containing *Z. mucronata*, *A. brevispica*, *A. mellifera* & *A. nilotica*. Browse mixture containing *Z. mucronata*, *A. brevispica*, *A. mellifera*, *A. nilotica* and mixture containing *B. discolor*, *Z. mucronata*, *A. mellifera* and *A. nilotica* were the most preferred by the animals and had a coefficient of preference (CoP) of 1.51 and 1.02 respectively. The two browse forage mixtures also had the highest ($p < 0.05$) intakes (168.6 and 113.3 g DMI/6h respectively) by the goats. The results of this study indicates that browse forage mixtures are highly palatable and have great potential as supplements for poor-quality basal diets in the marginal areas of the tropics and can enhance performance of livestock especially the small ruminants.

iCB-2020-48

A method for evaluating cold tolerance in rice during reproductive growth stages under natural low-temperature conditions in tropical highlands in Kenya.

Hiroaki Samejima, Mayumi Kikuta, Keisuke Katura, Daniel Menge, Emily Gichuhi, Cornelius Wainaina, John Kimani, Yoshiaki Inukai, Akira Yamauchi & Daigo Makihara, 2020. *Plant Production Science*, 23(4), pp. 465-476. DOI. 10.1080/1343943X.2020.1777877.

Abstract

Cold tolerance of New Rice for Africa (NERICA) and their parent varieties was evaluated under natural air temperature conditions of Kenyan tropical highlands using the multiple-sown field evaluation method. Rice varieties were cultivated 10 times to expose them to a shift in temperature during 20-day periods before heading (critical period), measuring the average daily mean temperature during the critical period (T_{mean}) for each variety and filled grain ratio, which was used

as an indicator of cold tolerance. T_{mean} of each variety was low in 6 out of 10 experiments. In the remaining four high-temperature experiments, there were no significant varietal differences in filled grain ratio. In the six low-temperature experiments, all varieties experienced 20.1–21.5°C T_{mean} . After comparison under virtually the same cold stress, NERICA 1, 3, 4, 7–10, 12, 17, 18, and WAB 56–104 were judged as cold-tolerant; NERICA 2, 5, 11, 13, and 14, and WAB 56–50 and 181–18 were moderately tolerant, and NERICA 6, 15, and 16 were cold-susceptible varieties. These evaluations generally corresponded with previous experimental results under temperature-controlled environments, showing the practicality of multiple-sown field cold tolerance evaluation in Kenya. It also indicated that NERICA varieties, which recorded different levels of cold tolerance and whose average number of days to heading in all experiments were 66–78, are suitable as a set of standard check varieties in this region to evaluate cold tolerance of rice varieties with this range of days to heading.

Keywords: Cold stress; critical period; daily mean temperature; East African tropical highlands; filled grain ratio

iCB-2020-49

WEG1, which encodes a cell wall hydroxyproline-rich glycoprotein is essential for parental root elongation controlling lateral root formation in rice

Lucob-Agustin, Nonawin, Kawai, T., Takahashi-Nosaka, M., Kano-Nakata, M., Wainaina, C.M., Hasegawa, T., Inari-Ikeda, M., Sato, M., Tsuji, H., Yamauchi, A., Inukai, Y., 2020. *Physiologia Plantarum* 169 (2), pp. 214-227. Doi. 10.1111/ppl.13063.

Abstract

Lateral roots (LRs) determine the overall root system architecture, thus enabling plants to efficiently explore their underground environment for water and nutrients. However, the mechanisms regulating LR development are poorly understood in monocotyledonous plants. We characterized a rice mutant, *wavy root elongation growth 1 (weg1)*, that produced higher number of long and thick LRs (L-type LRs) formed from the curvatures of its wavy parental roots caused by asymmetric cell growth in the elongation zone. Consistent with this phenotype, was the expression of the *WEG1* gene, which encodes a putative member of the hydroxyproline-rich glycoprotein family that regulates cell wall extensibility, in the root elongation zone. The asymmetric elongation growth in roots is well known to be regulated by auxin, but we found that the distribution of auxin at the apical region of the mutant and the wild-type roots was symmetric suggesting that the wavy root phenotype in rice is independent of auxin. However, the accumulation of auxin at the convex side of the curvatures, the site of L-type LR formation, suggested that auxin likely induced the formation of L-type LRs. This was supported by the need of a high amount of exogenous auxin to induce the formation of L-type LRs. These results suggest that the MNU-induced *weg1* mutated gene regulates the auxin-independent parental root elongation that controls the number of likely auxin-induced L-type LRs, thus reflecting its importance in improving rice root architecture.

iCB-2020-50

Metagenomic analysis of plant viruses associated with papaya ringspot disease in *Carica papaya* L. in Kenya.

Mumo, N. N., Mamati, G. E., Ateka, E. M., Rimberia, F. K., Asudi, G. O., Boykin, L. M., Machuka, E.M., Njuguna, JN., Pelle, R., & Stomeo, F., 2020. *Frontiers in Microbiology*, 11, pg.205. <https://doi.org/10.3389/fmicb.2020.00205>.

Abstract

Carica papaya L. is an important fruit crop grown by small- and large-scale farmers in Kenya for local and export markets. However, its production is constrained by papaya ringspot disease (PRSD). The disease is believed to be caused by papaya ringspot virus (PRSV). Previous attempts to detect PRSV in papaya plants showing PRSD symptoms, using enzyme-linked immunosorbent

assay (ELISA) and reverse transcriptase-polymerase chain reaction (RT-PCR) procedures with primers specific to PRSV, have not yielded conclusive results. Therefore, the nature of viruses responsible for PRSD was elucidated in papaya leaves collected from 22 counties through Illumina MiSeq next-generation sequencing (NGS) and validated by RT-PCR and Sanger sequencing. Viruses were detected in 38 out of the 48 leaf samples sequenced. Sequence analysis revealed the presence of four viruses: a Potyvirus named Moroccan watermelon mosaic virus (MWMV) and three viruses belonging to the genus Carlavirus. The Carlaviruses include cowpea mild mottle virus (CpMMV) and two putative Carlaviruses—closely related but distinct from cucumber vein-clearing virus (CuVCV) with amino acid and nucleotide sequence identities of 75.7–78.1 and 63.6–67.6%, respectively, in the coat protein genes. In reference to typical symptoms observed in the infected plants, the two putative Carlaviruses were named papaya mottle-associated virus (PaMV) and papaya mild mottle-associated virus (PaMMV). Surprisingly, and in contrast to previous studies conducted in other parts of world, PRSV was not detected. The majority of the viruses were detected as single viral infections, while a few were found to be infecting alongside another virus (for example, MWMV and PaMV). Furthermore, the NGS and RT-PCR analysis identified MWMV as being strongly associated with ringspot symptoms in infected papaya fruits. This study has provided the first complete genome sequences of these viruses isolated from papaya in Kenya, together with primers for their detection—thus proving to be an important step towards the design of long-term, sustainable disease management strategies.

Keywords: papaya, next-generation sequencing, Carlavirus, Potyvirus, ringspot disease, diagnostic primers

iCB-2020-51

Evaluation of morphological and quality characteristics of introduced grape cultivars produced under greenhouse conditions in Kenya.

Dennis Njoroge Kuria, Aggrey Bernard Nyende and Fredah Karambu Rimberia, 2020. *African Journal of Agricultural Research* 15(2), pp. 269-277.

Abstract

Grape production in Kenya is low and the country imports approximately 4,000 metric tons of wine every year. Three Chinese table grape cultivars (Jingyan, Jingxiangyu and Jingcui) and two Chinese wine grape cultivars (Beihong and Beifeng) as well as three French hybrid wine grape cultivars (Chenin Blanc, Sauvignon Blanc and Cabernet Sauvignon) were evaluated for fruit morphology (berries and bunches) and quality characteristics (Total Soluble Solids, Titratable Acidity, pH and sensory parameters) in 2018/2019 using International Organization for Vine and Wine descriptors and Economic Co-operation and Development procedure for fruit and vegetables respectively. All vines within the row were planted at a spacing of 0.9 and 1.6 m between the rows in a completely randomized design with three vines per replication and four replications for each cultivar. Collected data were subjected to ANOVA. Jingyan and Jingxiangyu had significantly bigger berries and higher bunch weight than all the other cultivars. The TSS of the grapes cultivars ranged from 16.3 to 25.2 °Brix. Beihong and Beifeng had higher TTA levels of 25.7 and 21.2 g/L respectively. Sensory data showed that Jingyan and Jingxiangyu were the most preferred cultivars. All the cultivars had ideal TSS and pH for winemaking and elaboration.

Keywords: Grapes, cultivar, morphology, quality, greenhouse.

iCB-2020-52

Carbon Sequestration by the Above Ground Biomass Pool in the South West Mau Forest of Kenya, 1985 - 2015

M K. Kigomo, D M. Mburu, J M. Kinyanjui, A D M. Thuo, C N. Mundia, 2020. *Journal of Environment and Earth Science* 10(8), pp. 51-58. Doi: 10.7176/JEES/10-8-05

Abstract

Forests are important for regulation of the global carbon balance. Increase in forest biomass enhances atmospheric carbon sequestration while decrease in forest biomass contributes to carbon dioxide emissions. World over, forest biomass has been declining due to forest loss and degradation. The South West Mau has experienced significant forest loss since 1964. The decline is posited to have significant impacts on carbon sequestration, carbon storage, carbon dioxide emissions and status of atmospheric carbon dioxide. This study assessed interannual trend and variability as well as change point detection in carbon sequestration in South West Mau Forest, Kenya between 1985 and 2015. Above ground biomass carbon sequestration was quantified based on the Carnegie-Ames-Stanford Approach (CASA) and carbon fraction for tropical climate domain. Carbon sequestration dynamics were characterized by increase-decrease cycles of approximately 3 years and low interannual variability (CV= 9.13). It emerged that South West Mau Forest was a net carbon emitter with a carbon sequestration balance of -588.40 Kg/ha between 1985 and 2015.

Keywords: Forest, Carbon sequestration, Carnegie-Ames-Stanford Approach, above ground net primary production

iCB-2020-53

Trend and Variability in Interannual Air Temperature Over South West Mau Forest, 1985 - 2015

M K. Kigomo, D M. Mburu, J M. Kinyanjui, A D M. Thuo, C N. Mundia *Journal of Natural Sciences Research*, 11(16), pp. 29-34. Doi: 10.7176/JNSR/11-16-04

Abstract

Globally high altitude forest regions are considered to be more prone to rapid warming. These regions have also shown great seasonal and inter annual temperatures variability. In Kenya mean annual temperatures increased by 1.0⁰C since 1960. Going by global trends it is plausible to argue that high altitude forest areas in Kenya might have shown great seasonal and inter annual temperatures variability over time. This study assessed interannual trend and variability as well as change point detection in average annual air temperature in South West Mau Forest, Kenya between 1985 and 2015. South West Mau Forest is an indigenous montane ecosystem with a tropical montane climate. Annual average air temperature over the South West Mau forest pointed towards climate warming of 0.01880C per year (Kendall's tau = 0.3677, p value = 0.0033) but with low interannual variability (CV= 0.11%). A shift in the annual average air temperature of 0.3680C at p= 0.0051 was detected between 1985-1998 and 1999- 2015. There was a weak positive anomaly in the annual average air temperature with a slope of 0.0192 and R² = 0.3074. Overall the region experienced climate warming.

iCB-2020-054

Mechanisms of the Regulation and Dysregulation of Glucagon Secretion

Arnold N. Onyango, 2020. *Oxidative Medicine and Cellular Longevity*, Article ID 3089139, <https://doi.org/10.1155/2020/3089139>

Abstract

Glucagon, a hormone secreted by pancreatic alpha cells, contributes to the maintenance of normal blood glucose concentration by inducing hepatic glucose production in response to declining blood glucose. However, glucagon hypersecretion contributes to the pathogenesis of type 2 diabetes. Moreover, diabetes is associated with relative glucagon under-secretion at low blood glucose and over-secretion at normal and high blood glucose. The mechanisms of such alpha cell dysfunctions are not well understood. This article reviews the genesis of alpha cell dysfunctions during the pathogenesis of type 2 diabetes and after the onset of type 1 and type 2 diabetes. It unravels a signaling pathway that contributes to glucose- or hydrogen peroxide-induced glucagon secretion, whose overstimulation contributes to glucagon dysregulation, partly through oxidative stress and reduced ATP synthesis. The signaling pathway involves phosphatidylinositol-3-kinase, protein

kinase B, protein kinase C delta, non-receptor tyrosine kinase Src, and phospholipase C gamma-1. This knowledge will be useful in the design of new antidiabetic agents or regimens.

Key words: Diabetes, Glucagon, Oxidative stress, cAMP signaling

iCB-2020-055

Inter-local climate zone differentiation of land surface temperatures for Management of Urban Heat in Nairobi City, Kenya

Emmanuel Matsaba Ochola, Elham Fakhazadehshirazi, Aggrey Ochieng Adimo, John Bosco Mukundi, John Mwibanda Wesonga, Sahar Sodoudi, 2020. *Urban Climate*, 31, pg. 100540. Doi: 10.1016/j.uclim.2019.100540

Abstract

Rapid Urbanisation often leads to the formation of Urban Heat Island (UHI), which is believed to link to the characteristics of a city. Proper management of UHI, would, therefore, require recognition of the possible range of heat load increase. This paper presents results of inter-local climate zone (LCZ) differentiation of land surface temperature (LST) for the management of urban hotspots in Nairobi city. WUDAPT methodology and LST_Landsat_8_split_window toolbox were used to generate LCZ and LST maps, respectively. Nairobi LCZs had a unique thermal climate that showed statistically significant differences (< 0.05) in mean LSTs among typical LCZs. LST patterns exhibited sensitivity to building densities and heights, land cover types and surface wetness. Dry and Natural zones were more thermally responsive than wet and built-up zones. However, built-up LCZs with heavy industry, compact buildings, lightweight lowrise (slums) and large lowrise buildings were characterised with warmer LSTs while natural LCZs with water bodies, dense trees and sparsely built classes were associated with slightly lower LSTs. The findings further demonstrate and support the use of LCZs for the delimitation and investigation of the influence of complex urban morphology on local climate formation in an equatorial city like Nairobi.

Keywords: Local climate zone, Land surface temperature, Urban heat, Urban morphology, Microclimate

2.3 Abstracts from iCMoB Sub-Taskforce

iCMoB-2019-01

Efficiency of pumpkin (*Cucurbita pepo*), sweet wormwood (*Artemisia annua*) and amaranth (*Amaranthus dubius*) in removing nutrients from a smallscale recirculating aquaponic system.

Gichana, Z., Liti, D., Wakibia, J., Ogello, E., Drexler, S., Meulenbroek, P., Ondiba, R., Zollitsch, W., & Waidbacher, H., 2019. *Aquaculture International*, 27(6), pp. 1767-1786 <https://doi.org/10.1007/s10499-019-00442-x>

Abstract

In aquaponic systems, plants absorb dissolved nutrients from aquaculture wastewater for their growth. The removal of nutrients allows reuse of water and minimises wastewater discharge to the surrounding environment. This study evaluated the relative nutrient removal efficiencies of three plant species and the performance of Nile tilapia (*Oreochromis niloticus*) in a small-scale aquaponic system. Three aquaponic systems were assigned as treatments PU (pumpkin), SW (sweet wormwood) and AM (amaranth). Physical-chemical water quality parameters were measured in the fish tanks as well as hydroponic inlets and outlets. Fish sampling was done every 2 weeks for 60 days. Results showed significantly ($p < 0.05$) lower nutrient concentrations in the hydroponic outlets than the inlets. There was no significant difference in nutrient removal efficiency of the plants ($p > 0.05$) for all the tested nutrients except for phosphorus. Phosphorus removal was substantially high in PU ($75.5 \pm 16.8\%$) than SW ($47.36 \pm 14.5\%$) and AM ($40.72 \pm 13.2\%$). In addition, the SW system had better ($p < 0.05$) relative growth rate (0.06 ± 0.00) than

that of PU (0.05 ± 0.00) and AM (0.05 ± 0.00). Nitrogen and phosphorus content in plant tissues was significantly high ($p < 0.05$) in SW and PU plants respectively. Water quality parameters had a significant influence on the growth of fish ($p < 0.05$). The growth of fish was not different ($p > 0.05$) in the three treatments. The findings indicate that the tested plants can reduce nutrients in aquaculture discharge water.

Keywords: Aquaponic system. Biofilter. Nutrients. Recirculating aquaculture system

iCMoB-2019-02

Effects of aerated and non-aerated biofilters on effluent water treatment from a small-scale recirculating aquaculture system for Nile tilapia (*Oreochromis niloticus* L.)

Gichana, Z, Liti, D., Drexler, S., Zollitsch, W., Meulenbroek, P., Wakibia, J, Ogello, E., Akoll, P., & Waidbacher, H., 2019. *Journal of Land Management, Food and Environment*, 70 (4), pp. 209–219.

Abstract

Most recirculation aquaculture systems (RAS) use aerated biofilters to maintain suitable water quality for fish production. However, application of non-aerated biofilters may provide opportunities to lower aeration costs, water usage and concentration of all nitrogenous wastes in the effluent water. Our study aimed at comparing the biofiltration performance characteristics of two biofilters: a conventional aerated biofilter and a non-aerated biofilter receiving the same effluent water from a small-scale RAS. The two biofilters were evaluated in triplicate and tested concurrently for seven months. Water quality parameters were monitored at the biofilter inlets and outlets and in the fish tanks. At the beginning of the experiment, the concentration of ammonia at the two biofilter outlets were not significantly different. However, the concentrations decreased with time reaching mean values of 1.33 ± 0.02 mg L⁻¹ and 1.23 ± 0.21 mg L⁻¹ N-NH₄ in the aerated and non-aerated biofilters, respectively. Whereas phosphorus and nitrate levels were significantly high in the aerated biofilter. There was no significant difference in the growth of fish between the aerated and non-aerated biofilters. The results suggest that non-aerated biofilters can be as effective as aerated biofilters in maintaining suitable water quality for *O. niloticus* production.

Keywords: Aerated, denitrification, nitrification, non-aerated, removal efficiency

iCMoB-2019-03

Risk factors associated with diarrhea disease among children under-five years of age in Kawangware slum in Nairobi County, Kenya.

Mutama, R., Mokaya, D., & Wakibia, J., 2019. *Food and Public Health*, 9(1), pp. 1-6.

Abstract

The cause of childhood diarrhea multi-factorial. Interaction of socio-demographic, environmental, cultural and behavioral factors influences the occurrence of childhood diarrhea morbidity. Diarrhea disease is among the top ten causes of under-five mortality and morbidity in Kenya. Thus, it is indispensable to find out factors associated with childhood diarrhea at a community level. The main objective of this study is to find out risk factors associated with diarrhea among children under-five years of age in Kawangware slum in Nairobi County. A cross-sectional study was carried out to examine the risk factors for childhood diarrhea among under-five in Kawangware slum in Nairobi County. A total of 198 mothers/caregivers who had lived in Kawangware slum for at least one year and have at least one child above one month but less than under-five and should have lived in the household. Data on diarrhea outcome and its determinants was based on two-week recall and self-reporting of ill health by respondents using systematic sampling technique. The data was analyzed, coded and filtered using SPSS software version 21.0. Diarrhea cases occurring within the 2 weeks preceding the interviews were reported for one in four children's, giving an overall prevalence of 37.3%, a prevalence much higher than the prevalence in Nairobi county of 15.6%. The behavioural factors investigated included hand washing, bottle feeding,

latrine utilization, length of breastfeeding, disposal of infant faeces, method of water storage and breastfeeding. Among these factors, hand washing, bottle feeding, latrine utilization, disposal of infant, faeces and method of water storage were found to be significantly associated with diarrhea among children under-five years of age since their p-values <0.05. The study shows knowledge parity and to some extent traditional and cultural beliefs still plays an immense role towards influencing the behaviour of maternal/caregiver in the event that there is outbreak of childhood diarrhea in the community. There is need to expand the existing child health programmes and put more emphasis on understanding existing traditional and cultural beliefs and set up structures targeting maternal/caregivers on better ways of handling incidence of childhood diarrhea.

Keywords: Childhood diarrhea, Socio-demographic, Under-five, Diarrhea, Cultural beliefs

iCMoB-2019-04

Sustainability of immune response to Hepatitis B Virus vaccination 3 years post vaccination among HIV-1 infected and uninfected adults in Kenya

Kamoni, R., Ngure, K., Ngugi, C., Irungu, E., Mugo, N., & Chohan, B., 2019. *Journal of Medical Science and Clinical Research (JMSCR)*, 7(8), pp. 798-801. Doi: <https://dx.doi.org/10.18535/jmscr/v7i8.1361>

Abstract

Hepatitis B virus (HBV) infection, a leading cause of chronic hepatitis, liver cirrhosis, and hepatocellular carcinoma worldwide is preventable by vaccination. Completion of recommended vaccination over 90% of adults develops protective anti-Hbs antibodies levels. However, there's paucity of data on sustained immune response to HBV vaccine among HIV infected African adults. A retrospective study was conducted and analysed 336 archived serum samples collected 3-years post HBV vaccination from participants enrolled in the Partners PrEP study, for Hepatitis B surface antibody (anti-Hbs) using ELISA. Samples that didn't have protective anti-Hbs titers were further tested for Hepatitis B surface antigen (HBsAg). Univariate logistic regression was used to determine factors associated with non-response. Of the 336 samples tested, 176 (52.4%) were from HIV-1 infected, 40 (22.7%) were male. 160 samples from HIV-1 uninfected, 125 (78.1%) were male. The mean (standard deviation) age of the study population was 34.6 (8.5) years. Of the 62 (18%) who didn't have protective anti-Hbs titers, 50 (81%) were HIV-1 infected. HIV infected were more likely to have less protective anti-Hbs titers ($p < 0.001$) compared to HIV uninfected. Compared to men, women were more likely not to have protective anti-Hbs levels (11.5% vs. 25.1%, $p = 0.002$). Seven (11.3%) of the 62 samples that didn't have protective anti-Hbs titres, also tested positive for HBsAg, all were HIV-1 infected. More than a quarter of HIV infected vaccinated against HBV didn't have protective anti-Hbs titres, some acquired HBV infection. Regular testing for immune response to HBV vaccination among HIV infected should be considered.

Keywords: Hepatitis B Virus, Vaccine, HIV-1 infection, Kenya.

iCMoB-2019-05

Proportion, Aetiology of Urinary Tract Infections and Healthcare Seeking Behaviours among Females of Reproductive Age Attending Out-Patient Clinics in Kinango and Kwale Sub County Hospitals, Kwale County, Kenya

Kajambo Muli Rama, Mohamed Karama, Caroline Wangari Ngugi, Lawrence Ndung'u Muthami, 2019. *IOSR Journal of Pharmacy and Biological Sciences (IOSR-JPBS)* 14(2), pp.56-70. E-ISSN: 2278-3008, p-ISSN: 2319-7676. www.Iosrjournals.Org

Abstract

Urinary tract infection accounts for a major disease burden globally especially in the developing countries. Community-acquired urinary tract infections (UTIs) occur mostly in women and are commonly caused by *Escherichia Coli*. Objective and study design: This was a cross-sectional study carried out in Kwale and Kinango Sub-county hospitals, Kenya. This study aimed to

determine the proportion and etiology of UTI and establish the factors influencing healthcare seeking behaviour of UTI patients among female attending the outpatient department for a period of twelve months (from September 2014 to September 2015). Method: Mid-stream urine samples were collected from seven hundred and sixty-six non-pregnant female participants who consented in our study and fulfilled the study criteria. Physical, chemical, microscopic and culture techniques were performed on urine samples obtained from the seven hundred and sixty-six (766) women. For drug sensitivity, Kirby-Bauer technique was employed where 14 antibiotics were tested against identified uropathogens. Results: Out of the 766 female involved in the study, 220 were diagnosed with UTI where, 152 (69.1%) were young females in the ages between 15 to 29, while those in the age groups 30-39 were 42 (19.1%) the least diagnosed with UTI being females in ages between 40 and 49 who accounted for 11.8% (26 females). Considering marital status of those who were diagnosed with UTI, 141 (64.1%) were married, while those who reported to be single during the period of the study accounted for 30% (66 women) while the third group which were few, were in the group of divorced or widowed who were only 13, representing 5.9%. Out of the 766 subjects who took part in this study, 546 (71.3%) sought healthcare services while 220 (28.7%) did not seek healthcare service even after developing signs of UTI. Among those who hadn't sought healthcare services, 110 (50%) cited the cost of treatment as the barrier for not seeking healthcare, while 106 (48.18%) were ignorant of the disease. Women in the age bracket of 15-29 years old were the most affected. Among the 220 diagnosed with UTI Significant bacteriuria ($>10^5$ colony forming units/ml of urine) was found in 220/766 (28.7%) urine specimens. Of the six bacteria isolated, Escherichia coli was the most predominant at 97 (44.1%), Candida albicans, 29 (13.2%), Pseudomonas aureginosa, 28 (12.7%), Staphylococcus aureus, 26 (12.7%), Coagulase/Catalase negative Staphylococcus saprophyticus, 20 (9.1%) and Proteus mirabilis, 20 (9.1%). This study concludes that, Women aged between 15-29 years old were the most affected with 546 (71.3%) having sought healthcare compared to only 220 (28.7%) who didn't. Escherichia coli were the most predominant urinary tract pathogen isolated (44.1%), with high levels of resistance against most antimicrobial agents to most uropathogens being evident. Low economic status among participants is the major contributing factor that influenced poor healthcare seeking behavior with 28.7% delaying or failing to seek healthcare in the previous episode where 110 (50%) citing the cost of treatment as the major barrier for not seeking healthcare. Making evidence based management of urinary tract infections for both asymptomatic and symptomatic compulsory will be helpful in detecting the etiology of UTI, thus reducing period of infection and cost of treatment. The cost of screening UTI should be revised and scaled down to increase detection of the disease causative agent before prescribing of antibiotics to patients by clinicians.

iCMoB-2019-06

Acute toxicity effect of Artemisia afra plant extracts on the liver, kidney, spleen and in vivo antimalarial assay on Swiss albino mice

Kane NF, Kyama CM, Nganga JK, Hassanali A, Diallo M, Kimani FT., 2019. *Journal of Advanced Bioscience and Bioengineering*, 7(4), pp. 64 – 71.

Abstract

Artemisia afra (Jacq. Ex. Wild), or "African Wormwood" belonging to the family of Astereaces and is widely used traditionally for health care in the eastern part of Africa with few research evidence substantiating its safety. The aim of this study was to investigate the safety of the ethanolic, dichloromethane, and hexanolic extracts of Artemisia afra by determining its pharmacotoxicological effects after an acute oral administration in mice and to test also their in vivo antimalarial effects. Oral acute doses of Artemisia afra extracts were given to thirty mice at the doses of 1000, 2000 and 2500 mg/kg of body weight. The mice were then observed for fourteen days, toxicity signs, body weight, organs weight and biochemical parameters were checked. Four days petter's test was run on mice to determine the in vivo antimalarial activity of the plant extracts and the IC₅₀ for each extract was determined. The results show few toxicity signs from the first

two days after oral administration. There were no differences in organs weight and body weight for the experimental mice when compared to the control group. The level of alanine transaminase (ALT) and aspartate transaminase (AST) were found do not be statistically different from the control. The LD50 of the extracts was found to be greater than 2500 mg/kg of body weight. The results also showed a high antimalarial effect of the extracts when tested in vivo using Plasmodium Berghei Anka. In Conclusion Artemisia afra is a strong drug candidate for malaria with no toxic effects in high dosage

iCMoB-2019-07

Improving early diagnosis of cervical cancer lesions using p16ink4a biomarkers on cellblocks from cervical smears.

Martha, W. M., Kyama, M. C., & Kibet, P. S., 2019. *African Journal of Health Sciences*, 32(2), 39-48.

Abstract

Universally, cancer of cervical is the second utmost regular malignant growth in females after cancer of breast. Timely recognition of pre-malignant lesions is an essential segment for the decrease of related morbidity and mortality. Though Pap test has been a helpful screening device, however hampered by high Intra and inter-observer changeability, false negatives at 20– 30% and false positives at 5– 70%. The study determined the role of P16INK4a biomarker in the identification of low grade squamous intra-epithelial abrasions in cell blocks prepared from Pap smears and subsequently compared previous Pap results with colposcopy and cellblock results. This was a laboratory-based, prospective study with a parallel comparative arm at the Kenyatta National Hospital Reproductive health clinic (66). All patients who had abnormal Pap smear reports and referred for colposcopy, and consented for the study were enrolled. A smear was taken just before taking a colposcopy biopsy. The cytobrush was immediately put in Acid alcohol fixative centrifuged and deposits wrapped in a filter paper and processed histologically to form a cellblock. Colposcopy biopsies were then retrieved from the KNH histology lab and both samples subjected to Routine histological stain and eventually with biomarker P16. Total of 85 samples was collected. There was a significant level of agreement between Pap smears and cellblock findings on the routine Histological stain. Of 58 cases analyzed Colposcopy had (39%) 27 negatives and (45%) 31 positives while cellblock had (48%) 33 negative and (36%) 25 positive for pre and malignancy with a confidence interval of 0.016 as the margin of error. Biomarker Colposcopy had (43%) 30 negativity and (41%) 28 positivity while cellblock had negativity of (46%) 32 and positivity of (38 %) 26. The specificity and sensitivity were based on the true values of colposcopy as the golden standard test for cervical cancer. Biomarker cellblock had the “sensitivity and specificity” of 93.3% and 93.8% respectively, while Haematoxyline and eosin-stained cellblock had sensitivity and specificity of 83.8% and 81.8% respectively. Poor inter-rater agreement resulting to mortality and morbidity associated with false positives and false negatives, cellblock prepared from residues of cytobrush stained with haematoxyline and eosin and biomarker is likely to circumvent all the above, together with minimizing loss to follow up as patients only visit health facility once and they acquire all the results without re-sampling hence drastically reducing the cost of colposcopy, which requires highly specialized equipment and experienced personnel who are very few and difficult to find.

iCMoB-2019-08

Determiration of antigen levels: T-plastin, transgelin and CA-125 in baboons with induced endometriosis

Githinji A, Ogilla K, Kyama CM, Gent V, Mwandodo E, Nyachieo A, Chai DC, Waihenya R., 2019. *Journal of Advanced Life Sciences and Technology*, 75, pp. 50-58.

Abstract

Endometriosis is defined as the presence of endometrial-like tissue outside the uterine cavity and is associated with chronic intra-pelvic inflammation. Its symptoms, which are often severe, have a negative impact on a woman's quality of life. They include chronic pelvic pain and infertility. It is estimated that about 10% women in their reproductive ages are affected by the disease globally. Currently, diagnostic methods are laparoscopy with histological confirmation and non-invasive such as ultrasound and the quantification of CA-125 biomarker in serum. CA-125 is known to be elevated in endometriosis, however it does not have sufficient diagnostic power as a single biomarker of endometriosis. Due to this, there is a need to determine other antigens that would act as potential biomarkers for endometriosis. It has been observed that Transgelin and T-Plastin are upregulated in endometriosis lesions and in secretory phase of endometrium respectively. There is insufficient data available showing the concentration of T-plastin in serum or plasma in the development of endometriosis. The main objective of this study was to identify whether T-plastin, Transgelin and CA-125 are potential biomarkers in early diagnosis of endometriosis using animal model for endometriosis. The baboon model represents clinically relevant research models for endometriosis. This study compared the levels of T-plastin, Transgelin and CA-125 in the peripheral blood and peritoneal fluid of baboons before and after induction of endometriosis. In this prospective, case-control study, ten female baboons (*Papio anubis*, 9-15 kg each) of proven fertility that have had at least one menstruation during captivity, were induced by intra-pelvic injection of menstrual endometrium on day 1 or 2 of menstruation followed by staging laparoscopy. Serum and peritoneal fluid samples were collected prior to induction to serve as controls. T-Plastin, Transgelin and CA-125 were measured using commercially available ELISA Kits. Data was analyzed using non-parametric test and level of significance at $p < 0.005$. T-Plastin and Transgelin had insignificant p values in both peripheral blood and peritoneal fluid while CA-125 showed $p = 0.0003$ in peripheral blood and $p = 0.0279$ in peritoneal fluid. Diagnostic performance of individual biomarkers was determined by Receiver Operating Characteristic (ROC) with the Area under the curve (AUC) equal to 0.5 showing T-Plastin and Transgelin in both serum and peritoneal fluid unreliable for use as biomarkers in endometriosis. CA-125 levels in peritoneal fluid had an AUC of 0.7900 indicating it can be used as potential biomarkers for endometriosis.

iCMoB-2019-09

Coagulopathy in treatment of naive HIV negative patients initiating anti TB medications at Thika Level Five Hospital, Kiambu County

Maina M.N., Kyama C.M., Kibet S., 2019. *Journal of Medical Science and Clinical Research*, 7(8), pp. 514-519.

Abstract

Coagulopathy is an abnormal bleeding disorder in which the blood's ability to clot is impaired resulting to prolonged bleeding. Studies have shown a relationship between coagulopathy with many infections such as HIV viral infection after treatment. The study aims to determine the haemostatic changes in TB treatment naive HIV Negative patients initiating Anti TB Medications at Thika Level Five Hospital in Kiambu County of Kenya. Prospective study design was used by carrying out Prothrombin time (PT) and Alternate Partial Thromboplastin Time (aPTT) among TB patients before and after treatment. A total of 197 TB positive patients attending Thika level five hospitals TB clinic were recruited. With acquisition of eight milliliters of blood, samples were analyzed for Prothrombin Time Test and Activated Partial Thromboplastin Time Test prior to initiation of anti TB medication and after initiation of treatment. Results showed Significant differences in prothrombin time in age groups 42-49, 55-65 and above 66 years with p -values of 0.021, 0.000, and 0.000 respectively at 95 % confidence level before and after treatment. Age group above 66 years old showed significantly lower Activated Partial Thromboplastin Time after anti TB administration as compared to when they were naïve ($p = 0.000$). The study concluded that significant hemostatic changes occur after anti TB medication and recommended. Health Care providers should be aware of the haemostatic Changes that occur in TB Patients initiating

treatment and carry out these haemostatic tests and initiate treatment as soon as any problem is identified.

iCMoB-2019-10

Comparison of phytochemical profiles and antimalarial activities of *Artemisia afra* plant collected from five countries in Africa.

Kane, N. F., Kyama, M. C., Nganga, J. K., Hassanali, A., Diallo, M., & Kimani, F. T., 2019. *South African Journal of Botany*, 125, pp. 126-133.

Abstract

Malaria is one of the most dangerous and deadly tropical disease in Africa affecting millions of individuals yearly. It is a major global public health problem, with an alarming spread of parasite resistance to the ACTs drugs. This situation explain the urge to discover new antimalarial compounds. Indigenous species to Africa and traditionally used for years by traditional healers, *Artemisia afra* is a big source for new antimalarial drugs. Aerial parts of *Artemisia afra* plant collected from South Africa, Kenya, Tanzania, Burundi and Senegal were each extracted with solvents of different polarity (hexane, dichloromethane, ethanol, and water), and the different extracts were then screened and compared for their antimalarial activities against two *Plasmodium falciparum* strains W2 (CQ resistant) and D6 (CQ sensitive); and also compared for their total phenols, flavonoids content and antioxidant activities. Phytochemical screening of the extracts revealed the presence of terpenoids, alkaloids, tannins, saponins and cardiac glycosides. Ethanolic extract of *Artemisia afra* collected from Burundi was found to have the highest concentration of phenols (606.9449 mg GAE/g of extract) and flavonoids (242.4745 mg Rutin/g of extract) and also exhibited the highest antioxidant activity ($IC_{50}=3.12 \mu\text{g/mL}$) compare to the others. Total phenols and total flavonoids were found to correlate with the antioxidant activity. *Artemisia afra* collected from Burundi also showed the highest antimalarial activity compare to the other extracts, the hexane extract of *A. afra* from Burundi have the highest ($IC_{50} = 0.71 \mu\text{g/ml}$ for W2 and $IC_{50} = 3.18 \mu\text{g/ml}$ for D6); following by the ethanolic extract ($IC_{50} = 2.66 \mu\text{g/ml}$ for W2 and $7.84 \mu\text{g/ml}$ for D6); then the dichloromethane extract ($IC_{50} = 3.04 \mu\text{g/ml}$ for W2 and $IC_{50}= 7.92 \mu\text{g/ml}$ for D6). Comparison of the five *A. afra* plants collected from South Africa, Kenya, Tanzania, Burundi and Senegal showed that the extracts from Burundi had the highest total content of phenols and flavonoids and also the highest level of antimalarial activity compared to the other plant extracts.

iCMoB-2019-11

A Comparative Study of Haematological Parameters between Sickle Cell Anemia Patients on Hydroxyurea and Hydroxyurea Naïve Patients.

Kanyiri E.W., Kyama C.M., Maturi P., Okinyi F., 2019. *Journal of Medical Science and Clinical Research*, 7 (5), pp. 548-552.

Abstract

Sickle cell anemia is a genetic blood disorder that requires the patients to take a lifelong regimen of hydroxyurea drugs. Kenya, being a third world country, many of these patients are not able to afford to sustain their supply of the drug hence are off it most of the time. The primary aim of this study was to determine whether there were haematological differences between the sickle cell patients taking hydroxyurea and hydroxyurea naïve patients. After obtaining consent and assent, a 2ml blood sample was collected from each study participant. A full blood count was run on the SYSMEX XT – 2000i and data entered into an Excel sheet. The parameters of interest were the hemoglobin, white blood cell count, and platelet count. A questionnaire was used to collect sociodemographic information and clinical history information. Ninety-two sickle cell anemia patients participated in this study. Of these 46 were on hydroxyurea while the other 46 were off hydroxyurea. The mean Hb of those on hydroxyurea and those not on hydroxyurea was 10.4 and 9.0 respectively (P value = 0.01). The mean WBC of those on hydroxyurea and those not on hydroxyurea was 11.0 and 14.7 respectively (P value = 0.005). The mean Plt of those on

hydroxyurea and those not on hydroxyurea was 384 and 485 respectively (P value= 0.01). A clinically significant difference between the Hb, WBC and platelet counts was noted between the 2 groups thus suggesting a positive impact of Hu on the haematological parameters of sickle cell patients. Studies such as this could help policy makers in devising strategies to make hydroxyurea more affordable to the Kenyan sickle cell population.

iCMoB-2019-12

Validation of fine needle aspiration cytology in the evaluation of human epidermal growth factor receptor-2 and hormonal receptor expression patterns in breast cancer

Osale C., Mungania M., Kyama C.M., 2019. *Journal of Medical Science and Clinical Research*, 7(1), pp. 1079-1085.

Abstract

Breast cancer is defined as a group of malignant neoplasms and accounts for up to 22% of all female cancers. It rarely occurs in men. In breast cancer, the level of human epidermal growth factor receptor-2 (HER2) over expression is said to be a prognostic molecular marker that is used for selection of patients for targeted HER2- therapy. Estrogen receptor (ER) and progesterone receptor (PR) are both prognostic and predictive markers for response to hormonal therapy. Fine-needle aspiration (FNA) provides highly cellular sample. Assessment of HER2, ER and PR status in FNA samples is very important clinically. The study was aimed to validate that fine needle aspiration cytology can be used to assess HER2, ER and PR expression patterns in patients with breast cancer. Cell blocks were prepared from FNA material collected from 39 newly diagnosed breast cancer patients and immunocytochemistry (ICC) for HER2 and the hormonal receptors, ER and PR was done. Immunohistochemistry (IHC) for HER2, ER and PR was also done on the corresponding biopsy sections. Both positive and negative quality controls were included in the experiments. The Allred scoring system was used to determine the positivity for PR and ER. The overexpression of HER2 was assessed using a scale of 0-3+ for both proportion and intensity whereby 3+ and above was considered positive. The cell block results were compared with core biopsy results and breast cancer classified into various types as luminal A, luminal B, HER2 over expression and the triple negative. The results were then compared with those of core biopsy immunohistochemistry using ANOVA. Kappa statistics was done to check the level of agreement. Cell block and biopsy results were compared, for ER there was a concordance of 32/35(91.4%) $r=0.842$ Sensitivity of 83.3% and specificity of 85.0%. For PR the concordance was 32/35(91.4%) $r=0.842$ with sensitivity of 84.2% and specificity of 84.2%. For HER2 the concordance was 34/35 (97.1%) $r=0.925$ with a sensitivity of 88.9% and a specificity of 96.3%. There was moderate agreement between the two methods, $k=0.719$, $p<0.001$. The results obtained from FNA cell blocks are reliable when compared with paired paraffin embedded tissue blocks. Therefore, HER2, ER and PR can be adequately assessed using cell blocks prepared from FNA material.

iCMoB-2020-01

Effects of monitoring and evaluation planning on implementation of poverty alleviation mariculture projects in the coast of Kenya. Effects of monitoring and evaluation planning on implementation of poverty alleviation mariculture projects in the coast of Kenya.

Odhiambo, J.O., Wakibia, J., & Sakwa, M.M., 2020. *Marine Policy* 119, pg. 104050. <https://doi.org/10.1016/j.marpol.2020.104050>

Abstract

Mariculture was introduced in Kenya in 1980s to provide economic opportunities to coastal communities and address the widespread poverty and livelihood needs with varying degrees of success and failures. A cross sectional survey was undertaken in Kwale, Mombasa and Kilifi Counties of the coast of Kenya. The study aimed at assessing the effects of monitoring and evaluation planning on implementation of poverty alleviation mariculture projects with focus on examining the effect of timeliness, tracking progress, periodic reporting, mid-term evaluation and

end of project evaluation on implementation of poverty alleviation mariculture projects in the coast of Kenya. The study involved the application of factor analysis, correlation analysis and regression analysis. Factor analysis revealed that outcome effectiveness was the main measure of implementation of poverty alleviation mariculture projects while tracking progress and timeliness were the main measures of monitoring and evaluation planning. A correlation analysis showed a strong positive relationship between outcome effectiveness and tracking progress and timeliness ($r = 0.693$ and $r = 0.723$, $p < 0.001$, respectively). Regression analysis confirmed that timeliness and tracking progress had significant positive relationship with outcome effectiveness ($\beta = 0.538$, $t = 12.058$ and $\beta = 0.491$, $t = 10.993$, $p < 0.0005$, respectively); where, β standardized beta value, p the probability of obtaining results as extreme as the observed results of a statistical hypothesis test, assuming that the null hypothesis is correct. This means there was a significant positive relationship between monitoring and evaluation planning and mariculture project implementation.

iCMoB-2020-02

Bioconjugation of AuNPs with HPV 16/18 E6 Antibody through Physical Adsorption Technique

Lucy Muthoni Mwai, Mutinda C. Kyama, Caroline W. Ngugi, Edwin Walong, 2020. *bioRxiv*.

Abstract

Gold nanoparticle (AuNP) bioconjugates are increasingly being utilized in biomedicine due to their low toxicity on biological tissues and unique electronic and chemical properties. They have been utilized in several biological applications, namely the manufacture of nanomaterials, biosensing, electron microscopy, and drug delivery systems. Mainly, immuno-assays often employ gold nanoparticles (AuNPs) to enhance the detection of a biological component. This paper presents a study on the bioconjugation of AuNPs with Horse Radish Peroxidase conjugated Human Papilloma Virus 16/18 Early 6 antibodies (CIP5) against Early 6 (E6) oncoprotein that is overexpressed in cervical carcinoma progression through physical adsorption. This bioconjugate can be employed in a diagnostic immunoassay for cervical cancer screening. The study also demonstrated that the antibody pI, gold colloidal solution pH, and amount of antibody determine the generation of stable Antibody–AuNPs bioconjugates.

iCMoB-2020-03

Characterization of HIV-1 Integrase Gene and Resistance Associated Mutations Prior to Roll out of Integrase Inhibitors by Kenyan National HIV-Treatment Program in Kenya

Mabeya Sephal^{1*}, Nyamache Anthony², Ngugi Caroline¹, Nyerere Andrew¹, Lihana Raphael³
Ethiopia Journal of Health Science, 30(1) pp. 37-44. Doi: [http:// dx.doi.org/ 10.4314/ejhs.v30i1.6](http://dx.doi.org/10.4314/ejhs.v30i1.6)

Abstract:

Antiretroviral therapy containing an integrase strand transfer inhibitor plus two Nucleoside Reverse Transcriptase inhibitors has now been recommended for treatment of HIV-1-infected patients. This thus determined possible pre-existing integrase resistance-associated mutations in the integrase gene prior to introduction of integrase inhibitors combination therapy in Kenya. Drug experienced HIV patients were enrolled at Kisii Teaching and Referral in Kenya. Blood specimens from (33) patients were collected for direct sequencing of HIV-1 pol integrase genes. Drug resistance mutations were interpreted according to the Stanford algorithm and phylogenetically analysed using insilico tools. From pooled 188 Kenyan HIV integrase sequences that were analysed for drug resistance, no major mutations conferring resistance to integrase inhibitors were detected. However, polymorphic accessory mutations associated with reduced susceptibility of integrase inhibitors were observed in low frequency; M50I (12.2%), T97A (3.7%), S153YG, E92G (1.6%), G140S/A/C (1.1%) and E157Q (0.5%). Phylogenetic analysis (330sequences revealed that HIV-1 subtype A1 accounted for majority of the infections, 26 (78.8%), followed by D, 5 (15.2%) and C, 2(6%). The integrase inhibitors will be effective in Kenya where HIV-1 subtype A1 is still

the most predominant. However, occurring polymorphisms may warrant further investigation among drug experienced individuals on dolutegravir combination or integrase inhibitor treatment

Keywords: integrase, dolutegravir, mutations, resistance

iCMoB-2020-04

Development of HPV 16/18 E6 oncoprotein paper-based nanokit for enhanced detection of HPV 16/18 E6 oncoprotein in cervical cancer screening.

Mwai L.M., Kyama C.M., Ngugi C.W., Walong E., 2020. *Journal of Nanotechnol Nanomaterials*, 1(2) pp. 31-44.

Abstract

Cervical cancer caused mainly by high risk human papillomavirus (HPV) 16 and 18 strains is the second most prevalent cancer among women in Kenya. It is often diagnosed late when treatment is difficult due to very low percentage of women attending screening thus, mortalities remain high. The most available tests in low-and-middle-income countries (LMICs) have relatively low specificity, low sensitivity, require a laboratory setting and huge technical and financial support not readily available. HPV 16/18 E6 oncoprotein has been identified as a potential biomarker in a more specific early diagnosis of cervical cancer. This retrospective cross-sectional study developed a paper-based nanokit with enhanced detection of HPV 16/18 E6 oncoprotein for cervical cancer screening. The HRP labelled antibodies HPV 16 E6/18 E6-HRP (CP15) passively conjugated to citrate stabilized 20 nm gold nanoparticles were evaluated for immune sensing mechanism using a recombinant viral HPV E6 protein. The diagnostic accuracy was evaluated using 50 tissue lysates from formalin fixed paraffin embedded cervical biopsy, including control (n=10), Mild Dysplasia (n=10), Cervical intraepithelial neoplasia 3 (CIN3) (n=10), Cervical intraepithelial neoplasia 4 (CIN4) (n=10) and invasive carcinoma (n=10). The molecular technique used was dot blot molecular assay. A positive result was generated by catalytic oxidation of peroxidase enzyme on 3, 3', 5, 5'-Tetramethylbenzidine (TMB) substrate. The gold nanoparticles were used to enhance the signal produced by peroxidase activity of horseradish peroxidase (HRP) enzyme giving a more sensitive assay as compared to use of non-conjugated antibody. This study provides a significantly high and reliable diagnostic accuracy for precancerous and cancerous lesions with a sensitivity of 90%, a specificity of 90%, a likelihood ratio for positive and negative tests as 9:1 and 1:9 respectively, a Positive Predictive Value of 97.3% and a Negative Predictive Value of 69.2%. The Limit of Detection obtained in the study was 0.0005 pg/ml. This study avails a sensitive, rapid test using paper-based nanotechnology which can be utilised in community-based screening outreaches particularly in low- and middle-income countries.

iCMoB-2020-05

Bioconjugation of AuNPs with HPV 16/18 E6 antibody through physical adsorption technique.

Mwai LM, Kyama C.M., Ngugi C.W., Walong E., 2020. *Journal of Nanotechnol Nanomaterials*. 1(1) pp. 16-22.

Abstract

Gold nanoparticle (AuNP) bioconjugates are increasingly being utilized in biomedicine due to their low toxicity on biological tissues and unique electronic and chemical properties. They have been utilized in several biological applications, namely the manufacture of nanomaterials, biosensing, electron microscopy, and drug delivery systems. Mainly, immuno-assays often employ gold nanoparticles (AuNPs) to enhance the detection of a biological component. This paper presents a study on the bioconjugation of AuNPs with Horse Radish Peroxidase conjugated Human Papilloma Virus 16/18 Early 6 antibodies (CIP5) against Early 6 (E6) oncoprotein that is overexpressed in cervical carcinoma progression through physical adsorption. This bioconjugate can be employed in a diagnostic immunoassay for cervical cancer screening. The study also

demonstrated that the antibody pI, gold colloidal solution pH, and amount of antibody determine the generation of stable Antibody–AuNPs bioconjugates.

2.4 Abstracts from iCCATS Sub-Taskforce

iCCATS-2019-01

The Superiority of the Ensemble Classification Methods: A Comprehensive Review

Silas Nzuva and Lawrence Nderu, 2019. *Journal of Information Engineering and Applications*, 9(5), pp. 43-53. Doi: 10.7176/JIEA

Abstract

The modern technologies, which are characterized by cyber-physical systems and internet of things expose organizations to big data, which in turn can be processed to derive actionable knowledge. Machine learning techniques have vastly been employed in both supervised and unsupervised environments in an effort to develop systems that are capable of making feasible decisions in light of past data. In order to enhance the accuracy of supervised learning algorithms, various classification-based ensemble methods have been developed. Herein, we review the superiority exhibited by ensemble learning algorithms based on the past that has been carried out over the years. Moreover, we proceed to compare and discuss the common classification-based ensemble methods, with an emphasis on the boosting and bagging ensemble-learning models. We conclude by out setting the superiority of the ensemble learning models over individual base learners.

iCCATS-2019-02

An Ensemble Model for Multiclass Classification and Outlier Detection Method in Data Mining

Dalton Ndirangu, Waweru Mwangi, and Lawrence Nderu, 2019. *Journal of Information Engineering and Applications*, 9(2), pp. 22-30. Doi: 10.7176/JIEA

Abstract

Real life world datasets exhibit a multiclass classification structure characterized by imbalance classes. Minority classes are treated as outliers' classes. The study used cross-industry process for data mining methodology. A heterogeneous multiclass ensemble was developed by combining several strategies and ensemble techniques. The datasets used were drawn from UCI machine learning repository. Experiments for validating the model were conducted and represented in form of tables and figures. An ensemble filter selection method was developed and used for preprocessing datasets. Point-outliers were filtered using Inter quartile range filter algorithm. Datasets were resampled using Synthetic minority oversampling technique (SMOTE) algorithm. Multiclass datasets were transformed to binary classes using OnevsOne decomposing technique. An Ensemble model was developed using adaboost and random subspace algorithms utilizing random forest as the base classifier. The classifiers built were combined using voting methodology. The model was validated with classification and outlier metric performance measures such as Recall, Precision, F-measure and AUCROC values. The classifiers were evaluated using 10 fold stratified cross validation. The model showed better performance in terms of outlier detection and classification prediction for multiclass problem. The model outperformed other well-known existing classification and outlier detection algorithms such as Naïve bayes, KNN, Bagging, JRipper, Decision trees, RandomTree and Randomforest. The study findings established ensemble techniques, resampling datasets and decomposing multiclass results in an improved detection of minority outlier (rare) classes.

iCCATS-2019-03

Sensitivity Based Data Anonymization Model with Mixed Generalization

E. Gachanga, M. Kimwele, and L. Nderu, 2019. *International Journal of Advances in Scientific Research and Engineering (ijasre)*, 5(4), pp. 66-72 Doi: 10.31695/IJASRE.2019.33150

Abstract

Published micro-data may contain sensitive information about individuals which should not be revealed. Anonymization approaches have been considered a possible solution to the challenge of preserving privacy while publishing data. Published datasets contain sensitive information. Different sensitive attributes may have different levels of sensitivity. This study presents a model where the anonymization of tuples is based on the level of sensitivity of the sensory attributes. The study groups sensitive attributes into highly sensitive and non-sensitive attributes. Tuples with non-sensitive attributes are anonymized. The study conducts experiment with real-life datasets and uses naïve Bayes, C4.5 and simple logistic classifiers to assess the quality of the anonymized dataset. The results from the experiments show that by using the sensitivity-based approach to anonymization, the quality of anonymized datasets can be preserved.

iCCATS-2019-04

Review of Digital Identity Management System Models

Zabron Githongo Mburu, Lawrence Nderu, Mwalili Tobias, 2019. *International Journal of Technology and Systems*, 4(1), pp. 21-33.

Abstract:

Public and private Institutions are presently facing challenges in the control of users accessing information via online platforms. Institutions presently control classified user identity information via online platforms. Trends indicate there is insignificant control of classified information within organizations, making it one of the serious threats facing governments and organizations. Digital Identity Management Systems (DIMS) are very vital in organization infrastructure for the purpose of authenticating users and supporting unlimited access control of services. The core intention of this paper is to review the existing digital identity management models and analyze the extent of the research work. The paper will review the characteristics of Digital Identity Management Models and evaluate on how trust and privacy issues impact or influence the establishment of an effective digital identity management system. This paper reviews existing digital identity management system models. Regulation of information in cases when the entities requiring access to it are both highly diverse and spread is among the most significant challenges to effective identity management. A variety of normal technical questions also faces the field, for example, the manner in which information in centralized and distributed databases can be controlled. In a bid to ensure that information related to authorization and authentication is up to date and dependable within an organization's systems of information, handling personnel has been a major concern of identity management systems.

iCCATS-2019-05

A K-Means Based Multi-level Text Clustering Algorithm for Retrieval of Research Information

D.N. Waema, P.M. Muriithi & G.O. Okeyo, 2019. *International Journal of Computer Applications Technology and Research*, 8(3) pp. 66-81. <https://doi.org/10.7753/IJCATR0803.1003>

Abstract

Academic researchers in institutions of higher learning and research institutes use research outputs and metadata throughout their research work and to help in identifying research collaborators as well as getting to know existing research. Research outputs range from academic theses, journal and conference articles, books and book chapters, and datasets while research meta-data includes authors, affiliations, research areas, and projects, among others. However, access and retrieval of relevant research outputs and metadata remains a major challenge. As a result there is duplication of research, fewer opportunities for networking, and difficulty in detecting scientific fraud. Efforts need to be made to make academic research outputs and meta-data readily available and easy to retrieve. The main purpose of this work is to develop a tailor-made approach to information retrieval for the retrieval of research information and related meta-data. Therefore, the paper

presents a multi-level text clustering algorithm for retrieval of scholarly research outputs and metadata from a central repository through a web based interface. The algorithm first clusters SQL data records that represents meta-data at the first level, then retrieves and clusters text documents representing research outputs at the second level. The algorithm was tested on retrieving information in the areas of text clustering, cloud computing, banking, HIV/AIDS, food security and cancer. The results show that it enables researchers to retrieve relevant information according to their information needs. To enable further enhancements and improvements, the algorithm will be released to the public domain for use in similar application domains or extension by other researchers.

Keywords: Text Clustering, Multi-level, Research Metadata, Information Retrieval, SQL Data Clustering

iCCATS-2019-06

Estimation of a hybrid Log-Poisson Regression Using a Quadratic Optimization Program for Optimal Loss Reserving in Insurance.

Apollinaire Woundiage, Martine Le Doux Mbele Mbindima, Ronald Waweru Mwangi, 2019. *Advances in Fuzzy Systems*, Article ID. 1393946. <https://doi.org/10.1155/2019/1393946>

Abstract

In this article, we are interested in developing an alternative estimation method of the parameters of the hybrid log-Poisson regression model. In our previous paper, we have proposed a hybrid log-Poisson regression model where we have derived the analytical expression of the fuzzy parameters. We found that the hybrid model provide better results than the classical log-Poisson regression model according to the mean square error prediction and the goodness of fit index. However, nowhere we have taken into account the optimal value of $h(\text{cut})$ which is of greatest importance in fuzzy regressions literature. In this paper, we provide an alternative estimation method of our hybrid model using a quadratic optimization program and the optimized h -value (cut). The expected value of fuzzy number is used as a defuzzification procedure to move from fuzzy values to crisp values. We perform the hybrid model with the alternative estimation we are suggesting on two different numerical data to predict incremental payments in loss reserving. From the mean square error prediction, we prove that the alternative estimation of the new hybrid model with an optimized h -value predicts incremental payments better than the classical log-Poisson regression model as well as the same hybrid model with analytical estimation of parameters. Hence we have optimized the outstanding loss reserves.

iCCATS-2019-07

Application of a Fuzzy Unit Hypercube in Cardiovascular Risk classification.

George Barini, Livingstone Ngoo and Ronald Waweru Mwangi, 2019. *Springer Soft Computing*, 23(23), pp. 12521-12527. Doi: 10.1007/s00500-019-03802-0.

Abstract

Most standard cardiovascular disease (CVD) risk assessment models are based on traditional quantitative approaches. Such models oversimplify complex interactions emanating from the imprecise nature of CVD risk factors. As such, approaches that can handle uncertainty due to imprecision need to be explored. This study proposes a cardiovascular risk classification model based on the geometry of fuzzy sets, which allows for a multidimensional display of qualitative properties associated with risk attributes—that are defined in a fuzzy sense. Within this structure, a risk concept (which defines the degree of risk severity) is simply a continuum of points of the hypercube. Consequently, an individual's risk status would naturally be represented by an ordered fuzzy within the continuum. This representation forms an excellent comparative framework through measures of similarity where an individual's relative position in the continuum can be given as degrees of compatibility with the underlying risk concepts.

iCCATS-2019-08

Optimizing Computer Worm Detection Using Ensembles.

Nelson Ochieng, Waweru Mwangi, Ismail Ateya, 2019. *Security and Communication Networks*. Article ID: 4656480. <https://doi.org/10.1155/2019/4656480>

Abstract

The scope of this research is computer worm detection. Computer worm has been defined as a process that can cause a possibly evolved copy of it to execute on a remote computer. It does not require human intervention to propagate neither does it attach itself to an existing computer file. It spreads very rapidly. Modern computer worm authors obfuscate the code to make it difficult to detect the computer worm. This research proposes to use machine learning methodology for the detection of computer worms. More specifically, ensembles are used. The research deviates from existing detection approaches by using dark space network traffic attributed to an actual worm attack to train and validate the machine learning algorithms. It is also obtained that the various ensembles perform comparatively well. Each of them is therefore a candidate for the final model. The algorithms also perform just as well as similar studies reported in the literature.

iCCATS-2019-09

Certificateless Pairing-Free Authentication Scheme for Wireless Body Area Network in Healthcare Management System

Philemon Kasyoka, Michael Kimwele, Shem Mbandu, 2019. *Journal of Medical Engineering & Technology*, 44(1), pp. 12-19. ISSN: 03091902

Abstract

With the current advancement in technology, the use of Wireless Body Area Networks (WBANs) has become popular in the healthcare management. They provide a mechanism to collect and transmit physiological data to healthcare providers in remote locations. With the need to secure healthcare data becoming a global concern, mechanisms must be put in place to ensure secure communication of physiological data collected in WBANs. This paper, presents a new authentication scheme for WBANs based on Elliptic Curve Cryptography. Sensor nodes used in WBANs are resource constraint and for that reason, the proposed scheme is both certificateless and pairingfree. We compared the efficiency of our proposed authentication scheme with other related schemes and found that our scheme had considerable efficiency in terms of communication cost and running time.

Keywords: Authentication, digital signature, remote healthcare, wireless body area networks

iCCATS-2019-10

Feature Based Data Anonymization for High Dimensional Data

Esther Gachanga, Michael Kimwele, Lawrence Nderu, 2019. *Journal of Information Engineering and Applications*, 9(2), pp. 274-279. Doi:10.7176/JIEA/9-2-03

Abstract

Information surges and advances in machine learning tools have enable the collection and storage of large amounts of data. These data are highly dimensional. Individuals are deeply concerned about the consequences of sharing and publishing these data as it may contain their personal information and may compromise their privacy. Anonymization techniques have been used widely to protect sensitive information in published datasets. However, the anonymization of high dimensional data while balancing between privacy and utility is a challenge. In this paper we use feature selection with information gain and ranking to demonstrate that the challenge of high dimensionality in data can be addressed by anonymizing attributes with more irrelevant features. We conduct experiments with real life datasets and build classifiers with the anonymized datasets. Our results show that by combining feature selection with slicing and reducing the

amount of data distortion for features with high relevance in a dataset, the utility of anonymized dataset can be enhanced.

Keywords: High Dimension, Privacy, Anonymization, Feature Selection, Classifier, Utility

iCCATS-2019-11

Target Sentiment Analysis Model with Naïve Bayes and Support Vector Machine for Product Review Classification

Rhoda Viviane A. Ogutu, Richard Rimiru, Calvins Otieno, 2019. *International Journal of Computer Science and Information Security (IJCSIS)*, 17(7), pp. 1-17.

Abstract

Sentiment analysis has demonstrated that the automation and computational recognition of sentiments is possible and evolving with time, due to factors such as; emergence of new technological trends and the continued dynamic state of the human language as a form of communication. Sentiment analysis is therefore an Information extraction task that aims at obtaining private sentiments that can either be classified as positive or negative, toward a specific object or subject. However, social media platforms are marred with informal texts that make extraction and parsing of relevant information a problem for most systems and models. This can pose as a challenge to business enterprises, individuals or organizations seeking to make specific strategic decisions based on the available data. To overcome such inefficiencies, this research first proposes implementation of two classifier models on the basis of feature selection and extraction; and performance evaluation on sentiment classification of product reviews. The research will explore the use of a detailed pre-processing technique with the implementation of Naïve Bayes and SVM classifiers. The effect in terms of performance measure of such computational models, evaluation of how the models can be implemented within Social Listening application fields and Machine Learning approaches to Sentiment analysis; has formed grounds for this research. This paper is however intended to further evaluate the performance of Naïve Bayes and Support Vector Machine (SVM) classifiers with an intension of integrating the two classifiers, and creating an ensemble model.

iCCATS-2020-01

Adaptive boosting in ensembles for outlier detection: Base learner selection and fusion via local domain competence

Joash Bii. Richard Rimiru. Waweru Mwangi, 2020. *Journal of Electronics and Telecommunications Research Institute (ETRI) Wiley*, 0(0), pp. 1-13. Doi: 10.4218/etrij.2019-0205

Abstract

Unusual data patterns or outliers can be generated because of human errors, incorrect measurements, or malicious activities. Detecting outliers is a difficult task that requires complex ensembles. An ideal outlier detection ensemble should consider the strengths of individual base detectors while carefully combining their outputs to create a strong overall ensemble and achieve unbiased accuracy with minimal variance. Selecting and combining the outputs of dissimilar base learners is a challenging task. This paper proposes a model that utilizes heterogeneous base learners. It adaptively boosts the outcomes of preceding learners in the first phase by assigning weights and identifying high-performing learners based on their local domains, and then carefully fuses their outcomes in the second phase to improve overall accuracy. Experimental results from 10 benchmark datasets are used to train and test the proposed model. To investigate its accuracy in terms of separating outliers from inliers, the proposed model is tested and evaluated using accuracy metrics. The analyzed data are presented as crosstabs and percentages, followed by a descriptive method for synthesis and interpretation.

iCCATS-2020-02

Towards an Efficient Certificateless Access Control Scheme for Wireless Body Area Networks

Philemon Kasyoka, Michael Kimwele, Shem Mbandu Angolo, 2020. *Wireless Personal Communications*, <https://doi.org/10.1007/s11277-020-07621-7> ISSN 0929-6212

Abstract

Wireless body area networks have become popular due to recent technological developments in sensor technology. A sensor can be used to collect data from different environments of interest, process and communicate the data to other nodes in a network. By its very nature, a sensor node is limited in resource usage. Due to these limitations, numerous security challenges have emerged in their applications, hence the need for more efficient and secure cryptosystems. In this paper, we give an efficient certificateless pairing-free signcryption scheme then design a secure access control scheme that can satisfy both the properties of ciphertext authentication and public verifiability using the signcryption scheme. A formal security proof of our scheme in random oracle model is provided. In addition, we compare the efficiency of our access control scheme with other existing schemes that are based on signcryption scheme. The analysis reveals that our scheme achieves better trade-off for computational and communication cost.

Keywords: Access control, Certificateless scheme, Signcryption, Wireless body area network

iCCATS-2020-03

Multi-User Broadcast Authentication Scheme for Wireless Sensor Network Based on Elliptic Curve Cryptography

Philemon Kasyoka, Michael Kimwele, Shem Mbandu Angolo, 2020. *Engineering Reports published by John Wiley & Sons, Ltd.* Pp. 1-14. Doi:10.1002/eng2.12176

Abstract

Wireless sensor networks (WSNs) have found use in many areas ranging from military to healthcare among other areas of interest. Multiuser broadcast authentication is an important security feature in WSNs that can enable users to securely broadcast their data in a WSN. By its very nature, a WSN is resource constrained in nature making security implementation on such a network a major challenge of concern. In this paper, we present an efficient pairing-free broadcast authentication (BA) scheme with message recovery based on a lightweight digital signature protocol for use on WSNs. Our proposed BA scheme is able to accelerate message authentication broadcasted over a WSN while providing user anonymity. Comparing our proposed BA scheme with previous existing and related BA schemes, we have demonstrated that a reduction in computation, communication, and energy cost is possible making our scheme efficient for use on WSNs.

Keywords: broadcast authentication, elliptic curve cryptography, identity-based signature scheme, wireless sensor networks