NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

CONFERENCE PROCEEDINGS

THE FIRST NATIONAL SCIENCE, TECHNOLOGY AND INNOVATION WEEK

THEME: INNOVATION SYSTEMS AND KNOWLEDGE-BASED ECONOMY FOR NATIONAL DEVELOPMENT

Kenyatta International Conference Centre (KICC),

Nairobi, Kenya.

7th - 11th May 2012

Vision:

A National Advisory Institution of Excellence on Matters of Science, Technology and Innovation

Mission:

An advisory institution of excellence on matters of Science, Technology, Innovation and Research

Core Values

- Integrity
- Professionalism
- Accountability
- Teamwork
- Equity

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FOREWORD

The National Science, Technology and Innovation (ST&I) week is established as a major annual event in the Government of Kenya Calendar through the Ministry of Higher Education Science and Technology. It has been set aside to showcase and celebrate the role of ST&I in the socio-economic development of the country. The event brings together, in a collaborative way, various actors in the National Innovation System including the academia, industry and Government to share and engage in ST&I issues through paper presentations in a scientific conference, exhibition of innovations from individual innovators, students from institutions of higher learning and high schools, as well as robot contests by tertiary institutions.

The papers presented, exhibitions and discussions held during the week represent the thinking and experience of Kenyan researchers, students and experts in various fields. Their contributions made the whole week event outstanding and provided valuable input of knowledge. The proceedings consist of two sections. The first part is composed of the full papers presented in the scientific conference on dissemination of research results, whereas the second one is composed of abstracts of innovations exhibited during the week. It is my trust that these proceedings will furnish the scientific world and policymakers in ST&I sector an excellent reference book. I also believe that the proceedings will be an impetus to stimulate further studies and research in various areas with the aim of addressing critical national challenges.

I would like to congratulate all the participants for their valuable contribution to the 1st National ST&I week, without their energy and input, the event would not have been a success. In the spirit of the theme, "Innovation Systems and Knowledge based Economy for National Development", there is a good chance of making a real difference to national development through ST&I, and this is our best chance.

I wish to convey my sincere appreciation to the Ministry of Higher Education, Science and Technology for support. Further I wish to thank all persons who participated in giving key note speeches, paper presentations and display of innovations and products. Finally, I acknowledge the effort of Charity Musembi, Stephen Situma, Josphine Waudo, Salome Guchu and John Ayisi, who compiled this report and Stephen Karimi for editing.

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Contents

INTRODUCTION

Kenya's development blueprint, Vision 2030 is geared towards transforming the country into a newly industrialized, middle income nation with a high quality of life in a safe and secure environment to its citizens. Vision 2030 is hinged on three development pillars namely: economic, social and political. It recognizes Science, Technology and Innovation (ST&I) as a strong base for these pillars.

The Government of Kenya through the Ministry of Higher Education, Science and Technology (MoHEST) has developed the Kenya National Innovation Systems which aims at ensuring that there is harmony in the development and implementation of ST&I policy and programmes. The National Science and Technology week was set aside to showcase and celebrate the role of ST&I in the social-economic development of the country. In addition, it was to encourage the Scientific Community and the public to participate in scientific engagements towards addressing critical national problems.

The theme of the National Science and Technology Week was "Innovation Systems and Knowledge-based Economy for National Development". During the conference, 25 papers were presented by different researchers and all the papers presented were focused on the theme of the conference. Furthermore, there were 42 innovators, 24 National science congress finalists and 56 TIVET fair exhibitors who displayed their innovations and products. The 1st National Science and Technology week was a land mark in Research, Science, Technology and Innovation in Kenya.

1. A COMPARATIVE STUDY OF SMUGEL AND KY JELLY VAGINAL LUBRICATING GELS

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Abstract

Coital lubricants are commonly used to alleviate dryness and discomfort at intercourse. In this study we have assessed the safety of Smugel compared to KY Jelly in the female olive baboons. This study is based on ten healthy, mature, cycling female baboons. At baseline, vaginal pH was determined; blood, vaginal swabs and biopsies were collected from each animal within five weeks for analysis of blood chemistry, vaginal flora and histological changes respectively. Thereafter, the animals were randomly assigned to treatment with either Smugel or KY Jelly twice weekly for five weeks and samples collected during the treatment period for analysis. Baseline vaginal pH was 5.8±0.8. There was no significant difference in the vaginal pH of Smugel treated animals compared to baseline ($p>0.05$). Similarly, analysis of blood chemistry parameters revealed no significant differences. The most frequently isolated microorganisms both at baseline and during treatment included *Corynebacterium glucuronolyticum, C. renale group, Lactococcus raffinolactis, Leuconostoc lactis, Lactobacillus acidophilus, L. fermentum, L. salivarius, Staphylococcus aureus, S. xyloxus, S. hyicus, Aerococus viridians, Escherichia coli and Candida albicans.* No detectable histological changes were observed in the vaginal or cervical sections examined. Smugel, compared to KY Jelly did not induce any adverse events that may facilitate transmission of STI pathogens including HIV.

Keywords: *Papio anubis, women*

Introduction

Insufficient lubrication during intercourse is a common complaint for women at all life stages (Dunn *et al*., 2002). Although often associated with older patients, over 40% of reproductive age women also report intermittent episodes of vaginal dryness and occasional dyspareunia (Oberg *et a*l., 2004). Approximately 60% of post-menopausal women experience atrophic vaginitis, a

common condition related to estrogen deficiency, which results in cellular tissue changes (Goldstein 2010), characterized by dryness, itching, burning, irritation and dyspareunia. The consequences of dyspareunia can be both physical and psychological because of the associated difficulty of maintaining a sexual relationship. The normal aging process of menopause is the most common etiology of estrogen deficiency. However, there are external causes for the interruption of ovarian estrogen production such as radiation, chemotherapy, immunological disorders, surgical removal of ovaries, medications aimed at treating uterine fibroids, cigarette smoking and lactation (Lynch, 2009). Women use a wide range of products, including personal lubricants, applied in a variety of ways inside the vagina to perform intravaginal practices such as cleansing and lubrication for a range of reasons including alleviation of vaginal symptoms and management of their sexual relationships (Gallo *et al*. 2010). These practices could have adverse health consequences which include physical or chemical abrasions that could be exacerbated during sexual intercourse and directly increase HIV risk in the vaginal epithelium or cause mucosal inflammation that may lead to recruitment of HIV target cells. A better understanding of vaginal lubricant use is thus important because of their possible contribution to the acquisition of STIs including HIV. While KY jelly remains the most widely used water based commercial coital lubricant, availability and affordability remain the biggest challenges in many regions of the world, including sub-Saharan Africa. We report on the safety of a new vaginal lubricating gel Smugel, using olive baboon as a model. Smugel is water based vaginal lubricating gel, manufacture by Universal Pharmaceutical Corperation Limited, Kenya, as a result of research carried out at the Institute of Primate Research, a Kenyan biomedical primate centre that is also a WHO designated collaborating centre. In this study, Smugel was compared with the commonly used KY Jelly.

Materials and Methods

Ten healthy sexually mature cycling female olive baboons (*Papio anubis*) used in this study were housed at the Institute of Primate Research, Nairobi, Kenya. All animal procedures and care were conducted in accordance with internationally accepted standard operating procedures. Sample collection was performed following approved Institutional Review Committee (IRC) protocols. Sampling was carried out after animals were sedated by intramuscular injection with a mixture of 10% xylazine (Rompun®) and 10% ketamine (Rotex Medica GMBH Tritau-

Germany) mixed in the ratio of 10cc ketamine to 0.5cc of xylazine. Baseline samples were obtained for vaginal pH, vaginal flora, chemistry profiles vaginal and cervical biopsies. The animals were then randomized into two groups and allocated to treatment with either Smugel or KY-Jelly lubricating gels. (Johnson and Johnson, 51120 Sezanne, France). 15g of the study products packaged in prefilled single use applicators were applied into the vagina of each animal twice weekly for five weeks, and sample collection continued during the entire treatment period. The biopsies were collected again at the end of vaginal gel application. Analysis of vaginal pH and serum chemistries were done using StatView software (version 5.0, SAS Institute Inc, Cary, NC, USA). Differences with p values > 0.05 were considered not significant at 95% confidence interval (CI). Vaginal pH was determined twice weekly by placing pH indictor paper (E. Merck, D-6100 Darmstadt, F. R. Germany) on the vaginal wall; 10 ml of blood was collected from each animal every two weeks, and plasma collected for subsequent analysis of serum chemistries for toxicity. The aliquoted sera were used for analysis of total protein, albumin, urea, creatinine aspartate aminotransferase, alanine aminotranferase, alkaline phosphate and total bilirubin. All the tests were performed using reagents and methods provided by the manufacture in a kit (Max-Planck-ring 21-D 65205 Wiesbaden-Germany) and biochemical analysis was performed using Humalyzer 2000 (Human GmbH, D65205, Wiesbaden, Germany**);** Vaginal swabs were collected weekly for five weeks from all the animals to establish baseline data, and thereafter, from the two treatment groups during the entire period of gel application. Identification was based on culture media (Oxoid), Gram stain, colony morphology, availability of oxygen and biochemical identification using reagents and methods provided in the api® kits (Biomerieux® SA 69280 Marcy l'Etoile, France). Analysis was done using apiwebTM stand alone V 1.2.1 identification software (Biomerieux® SA 69280 Marcy l'Etoile, France) The biopsies were processed and stained using hematoxilin and eosin.

Results

Vaginal pH: Mean vaginal baseline pH was 5.8±0.8. On application of Smugel and KY-Jelly the pH was 5.7±0.7 and 5.8±0.5 respectively.

Vaginal flora: Species of flora isolated throughout the study were 9 Lactobacilli, 2 Corynebacteria,14 Staphylococci and 4 Candida. Other common isolates included *Aerococcus viridians*, *Escherichia coli* and *Aerococcus viridians*.

Table1: *Chemistry profile*

Test Component	Baseline	Smugel	KY Jelly	P value
Total protein	6.6±1.5	6.2±1.2	6.5±0.9	0.86
Albumin	4.8±0.6	4.8±0.8	4.7±0.7	0.96
Urea	49.4±6.9	44.5±6.9	47.6±11	0.6
Total Biliribin	0.26±0.17	0.26±0.13	0.25±0.13	0.99
Creatinine	1.2±0.4	0.9±0.1	0.9±0.2	0.13
Alkaline phosphatase	263.5±114.9	323.6±183.7	268.3±109.2	0.7
Alanine aminotransferase	30.3±10.4	23±10	24.5±10.5	0.4
Aspartate aminotransferase	39.7±12.5	33.8±6.6	33.9±6.5	0.5

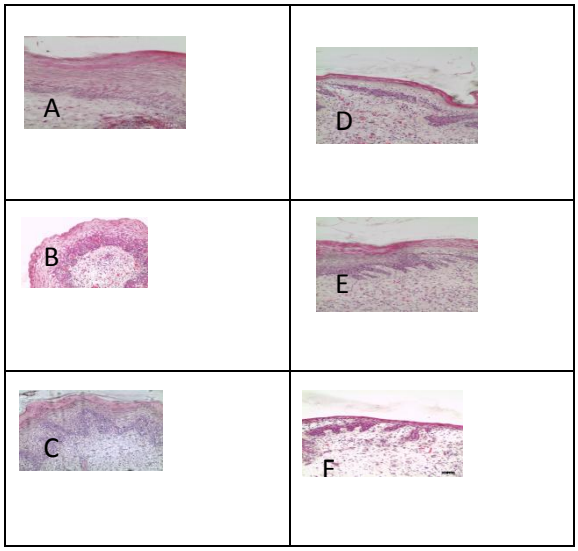

Figure 1*. Photomicrographs, showing histological sections of baboon vagina.A and D are follicular and luteal biopsies respectively at baseline. B, E and C, F are follicular and luteal biospsies after application of Smugel and KY-Jelly respectively. Increased thickness of vaginal mucosa was observed in A, B and C, while in D, E and F there is keratinization of superficial epithelium and a thin wall. No histological changes were observed after application of Smugel lubricating gel. (H&E× 100).*

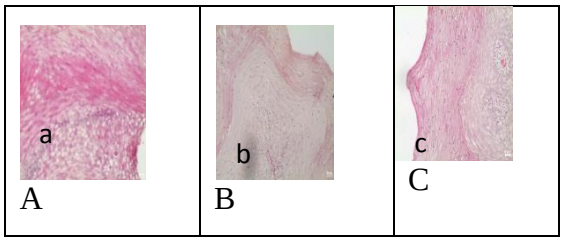

Figure 2. *Photomicrographs, showing sections of baboon cervix, all collected during follicular stage, (a) at baseline, (b) and (c) after Smugell and KY-Jelly application respectively. No cervical histological changes were observed after Smugel application. (H&E × 100).*

Discussions

Non-human primate models have been used in pre-clinical research to test the safety, mechanisms of action and efficacy of new diagnostic or therapeutic approaches before they can be used in humans. In the current study we used the baboon to evaluate the effects of Smugel, a new vaginal lubricant in comparison to KY-Jelly. There were no statistically significant differences in the levels of parameters investigated ($p>0.05$). We have demonstrated that Smugel did not induce any adverse events that may facilitate transmission of STI pathogens including HIV.

Conclusions

Smugel, compared to KY Jelly did not induce any adverse events that may facilitate transmission of STI pathogens including HIV.

Recommendations

Smugel may be made available to the women who need as a vaginal lubricant

Acknowledgments

We acknowledge the Government of Kenya for funding, Universal Pharmaceutical Corperation Limited, Kenya, for product manufacture and Institute of Primate Research for provision of animals.

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2. PHOTO-OXIDATIVE WATER TREATMENT USING TITANIUM DIOXIDE NANOSTRUCTURES

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Abstract

This work describes the use of nanotechnology in water treatment and environmental remediation. We exploit the use of titanium dioxide nanofibers and nanoparticles with high oxidation and reduction potentials in water treatment to eliminate both organic and inorganic water pollutants. The titanium dioxide nanoparticles are adsorbed onto a reactor through

contaminated water flows under sunlight irradiation to initiate photooxidation and reduction. We monitored the rate of photodegradation of the pollutants by UV-visible spectroscopy.

Introduction

Most developing countries lack clean water for use especially in rural areas. Water for domestic use comes from various unprotected sources such as rivers, wells, dams and ponds which is often consumed without any form of treatment. Conventional water treatment utilizes chlorination and iodination which is beyond reach for most consumers or expensive and cannot be recycled. This work describes the use of nanotechnology in water treatment and environmental remediation. We exploit the use of titanium dioxide nanofibers and nanoparticles with high oxidation and reduction potentials in water treatment to eliminate both organic and inorganic water pollutants. The titanium dioxide nanoparticles are adsorbed onto a reactor through contaminated water flows under sunlight irradiation to initiate photooxidation and reduction. We monitored the rate of photodegradation of the pollutants by UV-visible spectroscopy. The main advantages of this technique lies in its ease of use, portability of the reactor and recyclability making it cheap to use in rural areas analogous to solar energy panels.

Materials and Methods

Fabrication of Titanium dioxide Composite fibers

Nanofibers of titanium dioxide were produced through electrospinning. This provides a versatile method of making ultrathin nanofibres from polymer solutions, composites or ceramics. The TiO_2 nanofibres were prepared from titanium isopropoxide–polymethylmethacrylate composite. The electro spinning set-up is shown below.

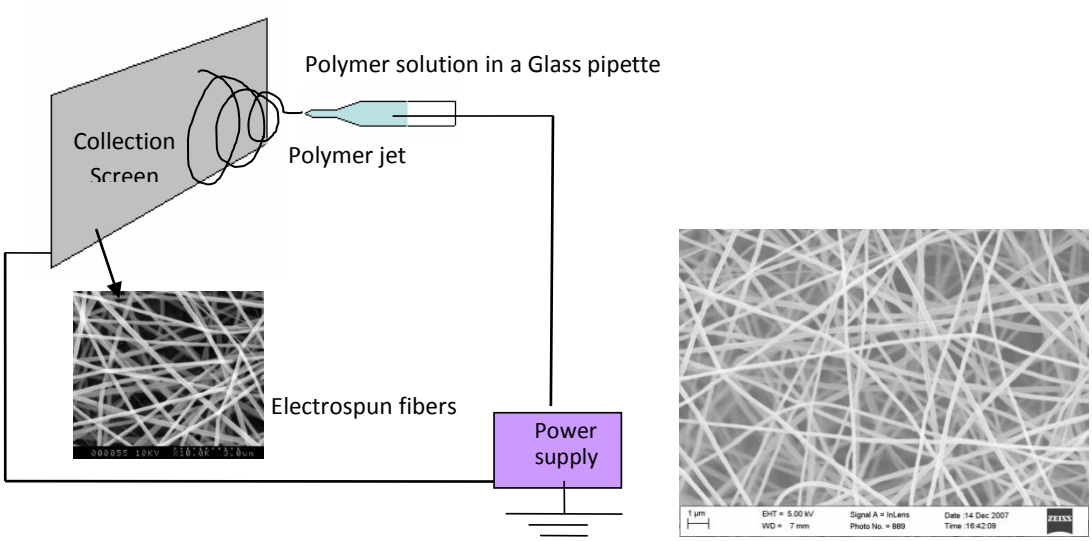

Figure 1(a): *Schematic diagram of electrospinning process set-up, with an electrospun nanofiber mat (inset).* ***b:*** *Scanning Electron Microscopy images of TiO_2 nanofibers 150±50 nm, after calcination.*

Photodegradation of water wastes

The TiO_2-PMMA nanofibers generated are calcined in air at 500 ºC to generate TiO_2. Generated TiO_2 were used in photodegradation of organic wastes in water solution under solar irradiation. UV-visible spectroscopy and high performance liquid chromatography was used to monitor rate of photodegradation and their products respectively.

Results and Discussion

The TiO_2 when dispersed in contaminated water results in the photodegaration of organic dyes present in water as analyzed using UV-visible spectrophotometry, Figure 2. The rate of degradation was found to be very fast from photokinetics of the decay. Similarly, high performance liquid chromatography was used to analyze the by-products of degradation. It was found that large organic macromolecules like methyl orange can be completely be mineralized into carbonates and nitrates as indicated in Figure 3.

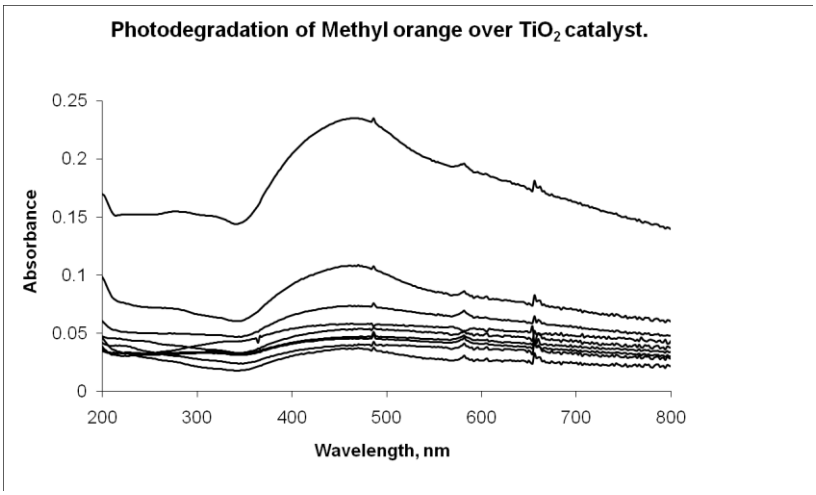

Figure 2*: Uv-visible spectra illustrating the decomposition of organic wastes (Methyl orange)*

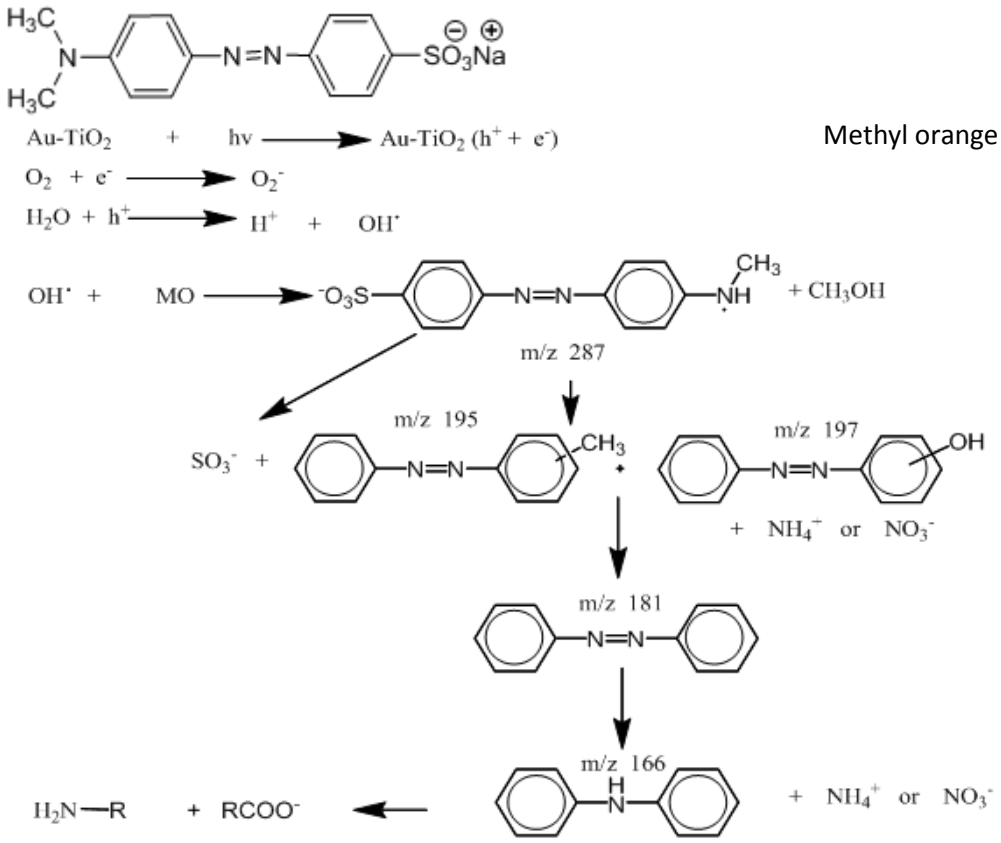

Figure 3: *HPLC photodegradation products of Methyl orange*

Conclusion

Titanium dioxide nanofibers were generated by electrospinning of Titanium isopropoxide/polymenthylmethacrylate composite. These materials were good in

photodegradation of organic contaminants within less a short time without external supply of energy. We are in the process of design large scale systems for environmental remediation.

Acknowledgements

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3. HIGH FREQUENCY REGENERATION OF *MELIA VOLKENSII*, GURKE FROM ZYGOTIC EMBRYOS USING LOW-COST THIDIAZURON: PRELIMINARY FINDINGS

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Abstract

Melia volkensii Gurke is a native multipurpose tree with vast potential for dry land forestry in Kenya. However, availability of planting stock is limited by difficulties in propagation via conventional means. The aim of this study was to develop a protocol for efficient *in vitro* propagation of this species. Rapid and efficient regeneration of *M. volkensii* via somatic embryogenesis was attained from mature zygotic embryos cultured on Gamborg *et al*'s B5

medium supplemented with 0.5 to 4 mg/l Thidiazuron (TDZ). Indirect somatic embryogenesis was observed, with intervening callus. Callus developed multiple somatic embryos (20 to 55 per callus) in 10 to 14 days on hormone-free Murashige and Skoog (MS) or B5 medium. Somatic embryos converted into shoots on hormone-free MS, ½ MS or B5 media. The wide application of TDZ in plant tissue culture is hampered by high costs, with plant culture media suppliers quoting up to Ksh. 219,267 for 0.5g. This study tested the effectiveness, in tissue culture, of a cheaper TDZ from an agrochemical source (Kingtai Chemicals Ltd, China), procured at only Ksh 13,163 for 700g. This TDZ showed a high potency and suitability for use in *M. volkensii* tissue culture.

Keywords*: Regeneration, Melia volkensii, zygotic embryos, unconventional, low-cost TDZ.*

Introduction

Melia volkensii Gurke (Meliaceae) is a drought-tolerant, multipurpose tree indigenous to the arid and semi arid lands (ASALs) of East Africa (Stewart and Blomley, 1994). Its desirable properties include fast growth, mahogany-type timber, termite-resistant wood and suitability for dry land agroforestry (Blomley, 1994). However, wide dissemination of the species is constrained by difficulties in seed extraction, poor germination and high post-germination mortality (Indieka *et al*, 2007). Propagation by stem cuttings is also reported to be difficult (Stewart and Blomley, 1994) thus the need for tissue culture protocols for the species.

There are limited reports on tissue culture of *M. volkensii.* Indieka *et al* (2007) described direct somatic embryogenesis from mature seed cotyledonary explants of *M. volkensii* cultured on MS medium with BAP (0.5- 4.0 mg/l) and 2,4-D (0.2mg/l), with 60% of explants forming somatic embryos (SEs) after 4 weeks in culture. The maximum efficiency attained was 14 SEs per explant. However, zygotic embryos cultured on the same media failed to produce SEs.

The ability of TDZ (Phenyl-1,2,3-thidiazol-5-ylurea) to singly induce shoot organogenesis and somatic embryogenesis in 55 plant families has attracted attention (Guo *et al*, 2011). However, tissue culture has high production costs (Tomar *et al*, 2007), hence the need for identification and testing of new low-cost media components such as PGRs.

This paper reports for the first time a protocol for plantlet regeneration of *M. volkensii* from mature zygotic embryos via indirect somatic embryogenesis using TDZ. Another novelty is the

use of the cheaper agrochemical Kingtai-TDZ (pers. comm.), as a substitute to the more expensive plant cell culture-tested TDZ.

Materials and Methods

Collection and Surface Sterilization of Plant Materials

Mature fruits of *M. volkensii*, collected in November 2011 to January 2012 season from wild trees in Ngongoni, Mwingi West, Kitui County (eastern Kenya) were thrashed to obtain stony endocarps. These were sun-dried for seven days then cracked to extract seeds. Zygotic embryos were detached from the cotyledons and rinsed twice with sterile (autoclaved) water to remove debris. They were then gently shaken for 15 minutes in 10% Jik® commercial bleach (Reckitt Benckiser, 3.85% m/v sodium hypochlorite), with 2 drops of Teepol® detergent added, then rinsed three times with sterile distilled water.

Culture Media, Inoculation and Incubation

Callus induction media was Gamborg *et al* (1968) B5 macro and micro nutrients with Murashige and Skoog (1962) MS organics, 20 g/l sucrose and 12 g/l Oxoid®agar. Kingtai-TDZ (batch no. 20110915-1) was added at concentrations of 0, 0.5, 1, 2 and 4 mg/l. The pH was adjusted to 5.80 ± 0.02 using Exstick® digital pH meter, and 50 ml of media dispensed into 340 ml culture bottles. These were covered with a double layer of Fay® aluminium foil before autoclaving for 20 minutes at 1.06 kg cm^{-2} steam pressure (121^{o} C).

Inoculation was done in a laminar flow cabinet, with five zygotic embryos per bottle and three replicates for each concentration. The experiment was repeated three times. Cultures were incubated in a culture room with max/min temperatures of 29.8 ± 0.8 and 25.5 ± 0.1 ^{o}C (mean ± S.E), fluorescent tube light of approximately 60 µmol photons m^{-2} s^{-1} and 16 hours light: 8 hours dark photoperiod.

After 24 days, callused zygotic embryos were sub cultured to either basal ½ MS + 30g/l sucrose or basal B5 + 20g/l sucrose for induction and growth of somatic embryos. After 14 days, callus pieces with 3 to 5 SEs were sub cultured to fresh medium of same composition for SE conversion into shoots.

Photography and Data Analysis

Emerging SEs were photographed at x 25 with Keyence® (Z35) VHX Digital Scanning Microscope. Plantlets were imaged using a Sony digital camera (Model DSC-S730). Data were analyzed using SPSS version 17.

Results and Discussion

In all the TDZ treatments used and the control, zygotic embryos were visibly swollen after 2 days in culture. Explants started to callus from day 4. Compact, nodular cream callus was obtained. Percentage callus induction was positively skewed and increased with concentration of TDZ (Table 1).

Table 1. *Effect of TDZ on the Induction of embryogenic callus and somatic embryogenesis from mature zygotic embryos of M. volkensii*

TDZ Concentration mg/l	**Total number of explants**	**Mean % callus induction ± S.E, after 24 days**	**% of callus with somatic embryos after 14 days on PGR-free Medium***
0	45	64.43 ± 17.36	0.00
0.5	45	66.67 ± 19.25	25.00
1.0	45	77.80 ± 11.10	83.33
2.0	45	84.43 ± 12.37	50.00
4.0	45	60.00 ± 25.25	50.00

Asterix (*) = combined data for ½ MS and B5, without PGRs

However, TDZ concentration had no significant effect (ANOVA, p = 0.857) on mean percentage callus induction. In 7 to 10 days, the embryos had popped out, with some developing a translucent, friable callus on the surface of the compact cream callus. Within 10 to 15 days, 13 to 40 % of the callus masses on TDZ media turned green on one end and developed multiple green torpedo or cotyledonary stages of somatic embryos (S.Es) within 14 and 24 days (Plate A).

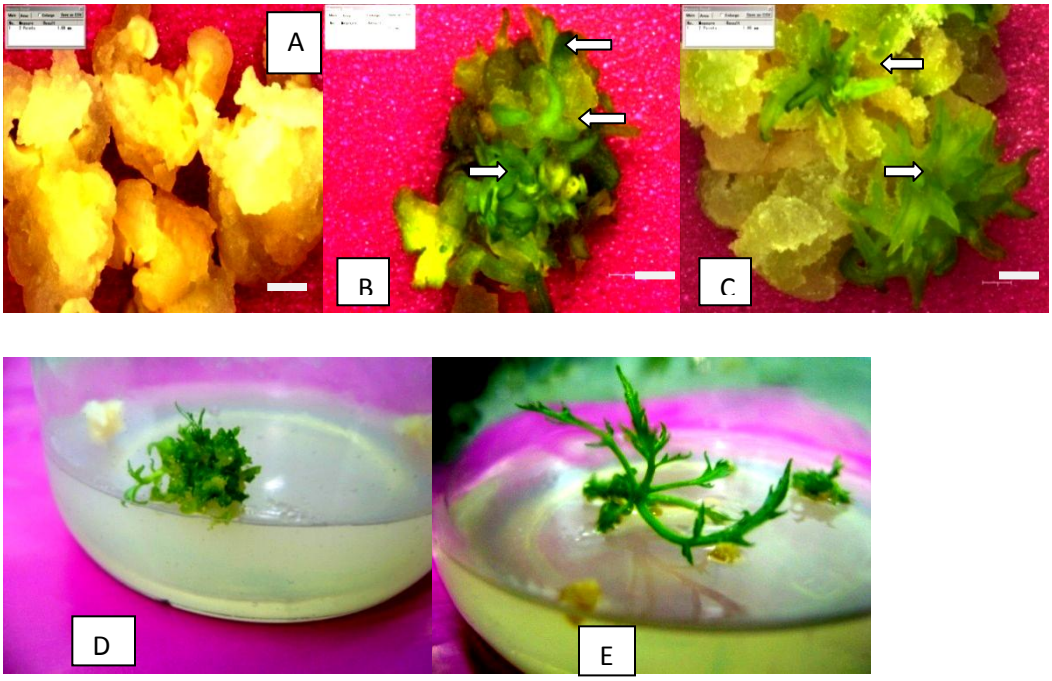
These continued to grow into leafy micro shoots (Plate B) which developed into multiple, well defined shoots (Plate C) when transferred to ½ MS or B5 with no PGRs

Table 2. *Conversion of somatic embryos into shoots*

MEDIA	**Number of callus masses transferred to medium**	**Mean number of shoots per callus after 27days on PGR-free medium ± S.E**
½ MS + 0 PGR	**14**	**25.75 ± 4.71**
B5 + 0 PGR	**14**	**24.25 ± 9.34**

Callus that formed S.Es on TDZ medium showed greening and S.E induction over the entire explant within 1 to 1½ weeks. However, 60% of callus was non- morphogenic on TDZ medium and only developed S.Es when transferred to PGR-free medium. An unexpected outcome was callus formation on control media without PGRs (64.43%), suggesting that endogenous levels of PGRs in approximately 60% of the zygotic embryos may be adequate for callus formation. However, such callus formed in absence of TDZ failed to form SEs (Table 1) suggesting that TDZ is crucial for induction of somatic embryogenesis. The optimal TDZ concentration for somatic embryogenesis was 1 mg/l. (Table 1).

The reported inability of mature zygotic embryos of *M. volkensii* to show somatic embryogenesis (Indieka *et al,* 2007) may be attributed to the use of BAP and 2,4-D) as opposed to the use of TDZ in this study. However, the findings of this study are in conformity to those of Villa *et al* (2003), where efficient regeneration via somatic embryogenesis was attained from immature zygotic embryos of *Melia azedarach* L (Meliaceae) on MS medium supplemented with 0.45 to 13.62 µM TDZ as the only PGR. This suggests the usefulness of TDZ as an alternative to the use of combinations of PGRs in somatic embryogenesis, as reported in many plant species (Guo *et al,* 2011).



***A**-Embryogenic callus formed by mature zygotic embryos after 14 days on B5 medium + 0.5 mg/l TDZ.**B** and **C**- somatic embryos (white arrows) formed in 14 and 20 days respectively after transfer of 24-day old callus to B5 medium + 0 PGR [White bars = 1mm]; cumulative age = 38 and 44 days. **D**- well defined multiple micro shoots formed from somatic embryos in 27 days after transfer of callus to B5 + 0 PGR; cumulative age= 51 days. **E**- Shoot on full MS + 0 PGR medium after 36 days from somatic embryo induction; cumulative age = 74 days.*

Conclusions and Recommendations

Our study offers the possibility of a simple and reproducible protocol for *in vitro* propagation of *M. volkensii* from mature zygotic embryos. The high frequency of indirect somatic embryogenesis attained in this study may have application in clonal production of planting stock, production of synthetic seeds, genetic transformation, and cryopreservation of the species. This study also demonstrates the high potency and usefulness of the low-cost Kingtai-TDZ in plant tissue culture. Further work is in progress to achieve rooting and growth of plantlets to normal plants. We recommend further testing of this TDZ on more plant species and a variety of explants, as one means of cutting costs in plant tissue culture. Plant cell culture tested TDZ (99% purity) from Sigmaaldrich (USA) costs euros 2,025 (Ksh. 219,267) for 0.5g yet 700g of TDZ (97.4%) from Kingtai Chemicals Ltd China, used as a cotton and peanut defoliant costs only USD 160.

Acknowledgements

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4. INCIDENCE OF CASSAVA BROWN STREAK VIRUS AND CASSAVA MOSAIC GEMINIVIRUSES IN LOCAL CASSAVA LANDRACES

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Abstract

Viral diseases, especially cassava mosaic disease (CMD) and cassava brown streak disease (CBSD) cause diseases of major economic significance leading to poor cassava yields.In an attempt to investigate the dual complexity of the two viruses in western Kenya 217 cassava samples were collected from 77 farmers' fields in five districts of western Kenya and subjected to end-point polymerase chain reaction (PCR) and reverse transcriptase polymerase chain reaction (RT- PCR) for detection of CMGs and CBSV respectively. The CMD incidence was confirmed infecting the landraces; Embwanatereka 82%, Serere 86%, Adhiambolera 74%, and Kibandameno 93% while CBSD incidence was present in Serere 65%, Adhiambolera 45%, Kibandameno41% andEmbwanatereka 52%. These results confirm the dual occurrence of CMD and CBSD in western Kenya.

Introduction

Cassava mosaic disease (CMD) is caused by Cassava mosaic geminiviruses (CMGs) (genus *Geminiviridae*; family *Begomovirus)* while *C*assava brown streak disease (CBSD) is caused by cassava brown streak virus (CBSV) (genus *Ipomovirus;* family *Potyviridae*)(MOnger *et al.* 2001). The CMD is widely distributed in the cassava growing region of Western Kenya (Mallowa 2006;Were *et al.* 2004) whereas CBSD is widespread in coastal Kenya (Munga & Thresh 2002). The CMG's and CBSV are transmitted by the whitefly *Bemisia tabaci* (Dubem 1994). Surveys conducted in Kenya (Gibson *et al*. 1996; Mallowa 2006) for CMD and (Mware *et al.* 2009) for CBSD considered the pandemic singly. The co-occurrence of the vector (*Bemisia*

tabaci), Cassava mosaic geminiviruses and CBSV raises the alarming possibility of a 'dual pandemic. However, there is limited information on the dual complexity of the viruses and incidence on the popular cassava landraces in western Kenya. The overall goal of this study was to carry out a baseline study to assess the occurrence of dual pandemic and the incidence of the two diseases on the most popular landraces grown in Western Kenya.

Materials and Methods

Cassava samples and survey area

Symptomatic cassava samples were collected from five districts in Western Kenya (Kakamega, Bungoma, Teso, Siaya and Busia). Sampling was done by stopping at regular predetermined intervals of about 2 - 3km between farmers' fields along major motorable roads traversing each district randomly sampling 3-5 plants in each field. The position of each farm was recorded using geographical positioning system (GPS) equipment. A total of 210 samples were collected and maintained in an insect-proof glasshouse at the Kenya Agricultural Research Institute, Biotechnology Center, Kabete.

Determination of Disease Incidence

The incidence of CBSD and CMD was calculated from the number of plants exhibiting CBSD (foliar) and CMD symptoms as a percentage of the total number of plants assessed in each district.

Nucleic Acid Extraction and PCR Amplification

The total DNA was extracted from approximately 100-150 mg of the leaf samples by an adaptation of Dellaporta (1983) method. Total RNA was extracted from cassava leaves using a CTAB method as described by Lodhi *et al*. (1994). Complementary DNA (cDNA) was generated using SuperScript™ III Reverse Transcriptase 1st-Strand cDNA kit according to manufacturer's instructions. The PCR products were analyzed by electrophoresis in 1% Agarose gel in 1x TBE buffer and visualized by ethidium bromide staining under UV transilluminator. Results of nucleic acid assays were analyzed by SPSS where ANOVA was used to obtain significant

differences and mean incidences separated by least significance difference (LSD) at 5% significance level.

Results

Symptoms of CMD and CBSD

The different cultivars collected in the five districts showed common foliar symptoms in the field. The commonly recorded symptoms on CMD infected cassava were yellow to pale green chlorotic mosaic, leaf curling, distortion on leaves and stunting of severely affected plants, while those of CBSD were yellow vein banding, expressed mainly on the lower, older leaves and chlorosis which occurred along the secondary and tertiary veins, giving a feathery appearance. Generally in the cassava fields observed, CMD symptoms were distinct from CBSV symptoms, as the symptomatic leaves had little or no leaf distortion.

Incidences of CBSD and CMD

Overall CMD incidence was highest in Kibandameno while CBSD was highest in Serere (Table 1). On the severity index Kibandameno and Adhiambolera were severely affected with CMD while Serere and Kibandameno were most affected by CBSD (Table 1).

Table 1: *Percentage incidence of the CMGs (EACMV, ACMV, EACMV-UG) and CBSV viruses on four cassava varieties; Adhiambolera, Embwanatereka, Kibandameno and Serere*

	EACMV	**ACMV**	**EACMV-Ug**	**Overall CMD**	**CBSD**	**CBSD+CMD**	**Mean**
Adhiambolera	17	27	71	74	63	45	50^{b}
Embwanatereka	16	40	70	82	66	52	54^{ab}
Kibandameno	34	37	83	93	60	41	58^{ab}
Serere	22	46	73	86	73	65	61^{a}
Mean	22^{f}	38^{e}	74^{b}	84^{a}	65^{c}	51^{d}	56

SE; variety=2.5; virus=3.0

Detection of CMGS and CBSV

Three CMG species (UgV, ACMV and EACMV) were detected in samples collected from all the districts with primers specific to the virus species. Among the CMGs species, UgV had the highest incidence ranging from 83% in Kibandameno to 70% in Embwanatereka (Table 2).

Table 2: *Incidence of CMD and CBSD in cassava grown by farmers in Kakamega, Bungoma, Siaya, Busia and Teso districts of western Kenya.*

	CMD	**CBSV**	
	mean	**mean**	**No.of**
Variety	**%incidence**	**%incidence**	**plants**
Adhiambolera	82.5	34.9	36
Serere	86.8	51.1	37
Embwanatereka	80.4	45.5	33
Kibandameno	91.4	49.5	30

Average elevation 1259.7 M

The dual incidence of both CMD and CBSV in the cultivars ranged between 65% in Serere to 41% in Kibandameno. Analysis of variance (ANOVA) showed that differences in percentage incidence for the viruses and the cultivars were significantly different ($P \leq 0.05$). There was no significant difference ($P > 0.05$) in the interaction between the cultivars and the viruses.

Discussion

It is clear that CBSD, which was previously endemic in the coastal region of Kenya is spreading widely in the high altitude areas confirming similar reports by Mware *et al.*(2009).The local popular landraces (Adhiambolera, Embwanatereka, Kibandameno and Serere) showed high CMD and CBSD disease incidence with no significant difference in their mean incidences.

The local popular landraces were found to be susceptible to both CMGs and CBSV as was found in Uganda by (Alicai *et al.* 2007). Farmers lack accurate information on the symptoms, cause, spread and management of the cassava viruses. The high incidence of both viruses among the

landraces could be due to the distribution of the common vector and the rate of exchange of planting materials among farmers without due consideration of the disease status of these planting materials. Since cassava is clonally propagated crop, this exchange of planting material across the cassava growing regions of Kenya and neighbouring countries may have contributed significantly to disease accumulation and dissemination of the viruses leading to high disease incidence. The test results confirm the sensitivity of PCR and RT-PCR method in CMD and CBSV detection as it was able to detect the presence of the viruses even in asymptomatic leaves. This is important as accurate diagnosis of cassava viruses is a key factor in screening materials in development of control strategies.

Conclusion

This study reports the presence of dual infection of CMD and CBSD in popular landraces and their foliar effect in cassava in Western Kenya. Western Kenya produces 68% of cassava in Kenya, therefore, the emergence of CBSD with the commonly occurring CMD impacts negatively to cassava production and income in the region. The determination of the virus disease incidences indicate where resistance breeding and other control strategies are urgently needed. In addition to mapping out the areas where deployment of disease free seedlings and development of phytosanitary and regulatory measures to restrict or control further spread are required.

Recommendations

1. Detailed study considering yield effect to ascertain the overall impact of dual infection of both CMD and CBSD.
2. Farmer awareness to improve their skills on disease free selection of planting materials

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5. INDIGENOUS BEEKEEPING FOR SUSTAINABLE BEEKEEPING DEVELOPMENT: A CASE STUDY IN KIBWEZI DISTRICT, KENYA

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Abstract

The study area covered was Kibwezi district of Makueni County, Kenya to assess honeybee production potential and marketing systems with its associated challenges and opportunities. For this study six beekeeping catchment areas were selected and a total of 60 randomly selected beekeeper households were interviewed using a semi-structured questionnaire. Secondary data were collected from the District Livestock Office and past research work. Descriptive statistics were computed using the Statistical Packages for Social Sciences (SPSS) 11.0 for Windows (SPSS 2001). A total of 60 beekeepers were interviewed. The number of colonies in different hives/household were 14.80±8.61 and 3.53±2.49 for traditional and langstroth beehives respectively and also honey production/household/year were 80.55kg and 90.18kg for traditional and langstroth beehives respectively. About 93% of beekeepers sell their honey locally in nearby market centres, while the rest sell their honey to middle men and local brewers. The price of honey in the area varied from Ksh100 – 200/= per kg. Almost all (98%) of the beekeepers reported shortage of water (drought) as a major constraint affecting beekeeping in the area however, measures were in place to overcome the various challenges affecting beekeepers. Almost all beekeeping practices are traditional with minimal attempts at improved beekeeping practices. To sustain the beekeeping activity in the study area, there should be an introduction of affordable and appropriate beekeeping technologies with all accessories, strengthening the appropriate beekeeping management practice and finally mobilizing women, disabled and other non beekeepers in to sub-sector through training.

Keywords: *Honeybee, beekeeper, household, production potential*

Introduction

Beekeeping is an important component of agriculture and rural development program in many countries of the world. The role of beekeeping in providing nutritional, economic and ecological

security to rural communities at the household level and is an additional income generating activity. This, being a non-land-based activity, does not compete with other resource demanding components of farming systems (FAO, 1990). Most parts of Kenya are suitable for beekeeping although the highest beekeeping potential is found in the Arid and Semi Arid areas (ASAL) which are rich in biodiversity in terms of bees and bee plants (Kagio and Mureithi, 1988). Beekeeping is a long-standing practice in the rural communities of Kenya. It is an environmentally friendly and non-farm business activity that has immense contribution to the economies of the society and to a national economy as whole.

Local farmers have acquired knowledge from generations experience and adapted their agricultural systems using limited resources under harsh and insecure conditions. Understanding such knowledge is essential to understand local realities of farmers and can be critical for the success or failure of agricultural development (WinklerPins and Sandor 2003). Most communities in Kenya have exploited the bees (*Apis melliferra*) for their honey since time immemorial. Honey has been used as food, medicine, preservative, brewing, liquid asset, currency for barter trade and gifts and as an important commodity of communities' socio-cultural activities (Muya, 2004; SNV-Kenya, 2004). Bees are also useful in crop-pollination, the more the bee colonies the greater the increase in yields and quality of crop products thus increasing food security. The main honey producing areas in Kenya are found in the Rift Valley Province (Baringo, Laikipia, Kajiado, Keiyo, Samburu, West Pokot, Narok, Koibatek and Transmara Districts) and Eastern Province (Machakos, Makueni, Kitui, Mwingi, Mbeere and Tharaka Nithi Districts) (SNV-Kenya, 2004)

It is estimated that Kenya produces between 15,000 and 25,000 as well as 140 and 5,000 metric tonnes of honey and beeswax, respectively (Mbae, 1999; Muya, 2004; Ministry of Livestock Development, 2009). This is still a relatively low amount considering an estimated potential of 100,000 and 10,000 metric tonnes, honey and beeswax respectively. The current production indicates that the beekeeping industry contributes about 1.89% to the gross domestic product (Muya, 2004). Although the available data shows an increasing trend in the production of honey, bee-wax and beekeeping equipment (Ministry of Livestock Development, 2009), the demand for good quality honey is by far higher than the current production. As a result, honey is imported

from Tanzania, Sudan and Australia among other sources. For example in 2008, Kenya imported about 50 metric tonnes of honey while it exported only about 8 tonnes (MoLD, 2009).

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The low production is primarily because of the use of inappropriate beekeeping technologies and inadequate information on flowering plants among other constraints which include environmental degradation through destruction of foraging sources and their natural habitats, insufficient research on: beekeeping technologies, honeybee biology and botany. Inadequate training for extension staff, farmers and equipment manufacturers is also a major weakness. Other constraints include low adoption of improved technologies, relatively high cost of inputs and bee phobia; ineffective control of common pests, unavailability of appropriate bee hives and hive products processing equipment; lack of affordable credit facilities for producers, processors and traders; inadequate coordination at different levels of service providers has limited the industry's expansion. The marketing of honey and bee-wax both locally and internationally is constrained by lack of market research and a weak market information network on apiculture (MoLD, 2009). Thus this research was undertaken with an objective of assessing honeybee production potential and marketing systems with its associated challenges and opportunities.

Methodology

Study Area

The study was carried out in Kibwezi district which is a semi-arid area located approximately 200kms South East of Kenya's capital Nairobi. The district lies between the latitudes 2^{o} 6 S' and

3^0 S' and longitude $37^0$36' E and $38^0$30' E, respectively and has a total area of 3,985.3 km^2 . it is inhabited by Akamba community who are mainly agro-pastoralists. The area is typical semi arid land characterized by low erratic and unreliable rainfall. The average annual rainfall, evaporation and temperatures are 600mm, 200mm and 23^o respectively. Due to its proximate position along the equator, the area experiences a bimodal pattern of rainfall with long rains from March to May and short rains from November to December.

Sampling Techniques, Data Collection and Statistical Analysis

In this study, both secondary and primary sources of data were used. The main sources of secondary data for this study were previous research findings, extension reports, reports of NGOs, and other published and unpublished materials. In addition to thorough review of literature and collection of relevant secondary data, primary information was gathered using different approaches. These include focused group discussions, interview with key informants and households' survey. The survey was undertaken in six cluster areas that best represent the high potential honey production areas in Kibwezi district, these are Kiboko,Kisingo, Nyayo,Machinery, Ivingoni and Nthongoni (Chyulu). The semi-structured questionnaire was administered to the respondents, and information was collected on beekeeper household characteristics, indigenous beekeeping knowledge and practices and honeybee production systems. The collected data were coded and grouped for analysis. Descriptive statistics were computed using the Statistical Packages for Social Sciences (SPSS) 11.0 for Windows (SPSS 2001)

Results and Discussion

General Characteristics

The background information of the respondents was collected to determine the extent of their role and contribution in starting and continuing the enterprise of beekeeping as shown in Table 1.

Table 1. *Summary characteristics of the respondents in the study area*

Parameters	**Variables**	**Frequency**	**Respondents, %**
Age of respondent, (years)	18 – 30	6	10

	31-50	21	35
	>50	33	55
Level of education	Informal	14	23.3
	Primary	26	43.3
	Secondary	15	25.0
	Tertiary	5	8.4
Land holding (ac)	< 5	7	11.7
	6 - 10	22	36.7
	11 - 15	17	28.3
	> 15	14	23.3
Land tenure	Individual	54	90
	Communal	6	10
Experience (years)	< 5	17	28.3
	6 – 10	13	21.7
	11 – 15	5	8.3
	> 15	25	41.7

N= 60

Majority (94%) of beekeepers were more than 31 years old whereby about 57% were above 50 years. This shows beekeeping is the activity mainly undertaken by older people indicating the need of documentation of knowledge gap and beekeeping practices between the young and the old generation. Most of the beekeepers in this study were educated. About 70% of the respondents had attended formal education, very few (7.69%) of beekeepers had got a chance to receive tertiary education, while 23% had attained informal education.

The land holding varied in the study area, some (25%) of the beekeepers had between 6-10 acres few (17.3%) of them owned more than 15 acres. This is probably due to the fact that households with limited parcel of land may invest more on beekeeping activity since the sector is relatively

less land-resource demanding. Majority of the beekeepers (71%) have practiced beekeeping for more than 6years, of whom (40%) have practiced beekeeping for more than 15 years.

Honeybee Production Systems and Beekeeping Trends

Honeybee production systems in the study area were predominantly traditional. The common traditional beekeeping activities practiced in the study area included: log shaping, wrapping hives, smoking hives and putting hives on trees and tree trunks, feeding and watering honeybees, checking ripening of honey and harvesting. Even though there were availability of modern beehives in the area e.g. langstroth, it was not possible for majority to buy because it was considered expensive. Few of them had also received training on beekeeping. The bee colonies possessed by the beekeepers ranged 5 - 30 bee colonies. Some (20%) of the beekeepers possessed more than 20 bee hives. Based on the periodicity of the pollen and nectar flow, two honey harvesting periods were reported in a year. The major honey flow season is April – May, while minor honey flow is from Dec- Jan. All respondents (100%) in the study area did not have any type of modern beekeeping equipments and this was said to be a great impediment during harvesting. Honey is the major hive product but some beekeepers also consider beeswax and bee brood as the minor bee products. The change in the farming systems has become a threat to the beekeeping activities in the study area. Over (90%) of all the beekeepers responded that there had been decline in bee forages overtime and this was attributed to increase in irrigated agriculture coupled with intensive application of insecticides affecting bee population.

Based on the information of the respondent on average the number of colonies in different hives/household were 14.80±8.61 and 3.53±2.49 for traditional and langstroth beehive respectively and also honey yield /production/house hold were 80.55kg and 90.18kg for traditional and langstroth beehive respectively. In this study, accurately determining honey production was found to be a difficult exercise, as most of beekeepers were unable to quantify correctly the quantities harvested in kilogram or any other weighing scale. Nevertheless, based on beekeepers estimate, the number of kilograms taken per hive per harvesting ranged from 5 kg up to 25 kg and 8.25kg up to 30 kg of crude honey for traditional and langstroth beehive respectively (Table 2).

These results are indicators of the existence of room for increasing performances of these beehives through good management practices coupled with favorable beekeeping environment. Therefore, statistically there were highly significant deference ($p<0.05$) between the two types of hives in terms of yield per hive per year.

Table 2: *Least square means and standard error for honey yield obtained from different types of beehives per annum in the study area.*

No.	Type of hive	unit	Minimum	Maximum	Mean
1	Traditional	Kg	5	25	7.20 ± 0.23^{a}
3	Langstroth	Kg	8.25	30	23.37 ± 0.73^{b}

Means in a column having different superscript are statistically different at $P<0.05$

The annual gross income of respondents from the sale of honey in the study area ranged from KES 500 to KES 8,200. As shown in (Table 3), the maximum proportion (50%) of sample respondents earned an annual gross income of between KES 2,501 to 4,500 and about 28.30% of sample households obtained KES 5000 to 2,500. On the other hand, very few respondents (6.70%) obtained annual income of above KES 6,501. Likewise, the mean annul gross income per household during the survey time was about KES 3,540.20, which showed great potential of honey for income generation by farmers. (Table 3).

Table 3: *Distribution of sample farmers by annual total gross income earned from the sale of honey*

Income Category	Kisingo		Kiboko		Nyayo		Machinery		Ivingoni		Nthongoni		Total	
	(n = 10)		(n = 10)		(n = 10)		(n = 10)		(n = 10)		(n = 10)		(n = 60)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
500 - 2500	4	40	3	30	4	40	2	20	2	20	2	20	17	28.30
2501 - 4500	5	50	4	40	5	50	4	40	7	70	5	50	30	50
4501 - 6500	0	-	2	20	-	-	4	40	1	10	2	20	9	15
> 6501	1	10	1	10	1	10	-	-	-	-	1	10	4	6.70
Mean income (KES)														3,850.20

n= Refers number of respondents

Honeybee Flora Resource Base

Vegetation characteristics of the study areas are considered to be an important indicator for potentialities of the area for beekeeping. According to the results of this survey, the honeybee plants of the study area comprise trees, shrubs, herbs and cultivated crops which are a source of nectar and pollen. Some important honeybee plants of the study areas were recorded in vernacular (common) and scientific names with their flowering periods (Table 4).

Table 4: *List of some major honeybeeforages reported by the respondents in the study area*

No	Scientific names	Kamba/common name	Flowering phenology
1	*Acacia drepanolobium*	Kiunga	March
2	*Acacia mellifera*	Muthiia/Honey acacia	March, September
3	*Acacia sengegal*	Gum Arabic tree	March
4	*Acacia seyal*	King'ole/ White thorn acacia	March, September
5	*Acacia tortilis*	Mwaa	March, June, Septembe2
6	*Agave sisalana*	Ikonge/Sisal	April, May
7	*Balanites aegyptiaca*	Mululwe	September, October
8	*Cajanus cajan*	Nzuu/Pigeon peas	June, July
9	*Combretum hexalatum*	mukokola	November
10	*Cynodon dactylon*	Ikoka	April
11	*Dalbergia melanoxylon*	Muvingo/African blackwood	May
12	*Entada africana*	Mwaitha	March
13	*Eragrostis superb*	Mbeetwa/Masai love grass	February, March
14	*Ipomea kituensis*	Kiungu	January, April, June
15	*Mangifera indica*	Muembe/Mango	September
16	*Melia volkensii*	Mukau	June
17	*Newtonia buchananii*	Mukame/ Forest newtonia	May
18	*Zea mays*	Mbemba/ Maize	February, May, December

According to the respondents, April, May, October, November and December are the months of main rainy season hence reported to be periods conducive for pollen and nectar availability. Majority (80%) of the respondents have observed dwindling of vegetation cover and this

condition is posing obstacles to the production potential of honey, this has been attributed to deforestation in the area resulting in destruction of most important plant and forest species which are important bee forage.

Marketing of Hive Products

Majority (97%) of respondents sell their honey while the rest (3%) produce honey only for home consumption. About 40% and 5% of beekeepers sell their honey to middle men and local brewers respectively. The price of honey in the area varied from Ksh 100 – Ksh 200/kg. Almost all farmers have at least a market centre where to sale their honey. The price of honey is subject to fluctuation with highest price in the dry season and lowest during honey harvesting period. In general marketing of honey in the area is promising. Various hive products are used as food, drinks, medicine and for cultural rituals or ceremony. Almost all interviewed beekeepers did not harvest beeswax because of lack of awareness about the product

Beekeeping Constraints in the Study Area

According to the respondents, there are major constraints (Table 5) affecting beekeeping in the study site. This include; shortage of water(drought), shortage of bee forage, prevalence of bee pests and diseases, lack of modern hives, lack of skilled man power, shortage of improved bee equipments, lack of capital and lack of market

Table 5: *Beekeeping constraints (Multiple Responses)*

1	**Constraints**	**Frequency**	**Percentage**
2	Shortage of water(drought)	51	98
3	Shortage of bee forage	48	92.3
4	Prevalence of bee pests and diseases	44	84.6
5	Poisoning by agrochemicals	43	82.7
6	Lack of modern hives	42	80.8
7	Lack of skilled man power	36	69.2
8	Shortage of improved bee equipments	35	67.3

9	Lack of capital	27	51.9
10	Lack of market	16	30.7

The majority of respondents (94.2%) listed shortage of water (drought) as a serious constraint which results in frequent absconding/ migration of bee colonies. This was followed by shortage of bee forage with 92.3%. Diseases and pests were also common problems faced by beekeepers in the study site. Excessive use of pesticides and absence of forage during other months coupled with excessive heat during dry spell worsens the conditions for bee habitation. Slightly over half of the respondents (51.9%) listed lack of capital as another constraint at the time of starting the profession and later on to offset the losses during periods of heavy infestation of pests and diseases or low production.

Marketing of honey and other bee products was felt as another constraint by 30.7% of the respondents. It was felt that due to absence of any organized market or well established cooperatives, the bee keepers have no option than to sell their honey to brokers at very low prices which reduces their profit margin.

Conclusions and Recomendation

Based on the result of this survey people in the most productive age are actively engaged in beekeeping activities with having a moderate experience of beekeeping. For most of the beekeepers, source of bee colony was from swarm caching (87.8%). That shows there was an availability of bee colony in the study area. Based on the results of these survey two types of honeybee production systems were identified, namely: the traditional beekeeping systems and movable frame (Langstroth) beekeeping system. Majority of the beekeepers were engaged in traditional beekeeping practices (91.5%), while 9.5% used movable frame (Langstroth) beehives.

The study area has adequate natural resources and a long tradition and culture of beekeeping. However, mainly because of lack of technological changes, institutional supports and access to market and value chain development. Kibwezi district and the rural beekeepers in particular have not been sufficiently benefiting from the sub sector. Yet, despite all the constraints and challenges currently facing the beekeeping subsector, there are still enormous opportunities and potentials to boost the production and quality of honey production in the area. This was reflected

by the various indigenous knowledge practices, diverse distribution of honeybee floras, and the presence of governmental and non- governmental organizations who are involved in beekeeping activities.

The major constraints to exploit the untapped potential of beekeeping activity in the district are lack of water, lack of beekeeping equipment, agrochemical bee poisoning, shortage of bee forage, incidence of pest and diseases, lack of capital and lack of market. According to the results of this study some of the suggested issues that require attention are;

Improving the management of the traditional hives and introducing improved beehives thus increasing the productiveness of bee colonies. Providing water and introducing bee plants during stress periods. The effect of agrochemicals application on honeybees and means of minimization their effect should be addressed. Farmers' knowledge and skills need to be enhanced through training on apiary management, pre- and post harvest handling of hive products. Honeybee diseases which were elaborated locally by farmers should be confirmed through scientific research.

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6. LAKE VICTORIA MOLLUSC SHELL SPECIES DIVERSITY, ABUNDANCE AND THE POTENTIAL FOR COMMUNITY LIVELIHOOD

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Abstract

Mollusc shells are common and abundant along the L. Victoria shoreline. This could form an important natural bio-resource for the riparian community if adequately utilized**.** An immediate benefit of the constant removal and use would be reduction in breeding sites for disease vectors and enhanced sanitation of the ecosystem. In this project, the researchers documented mollusc shell species diversity, abundance and distribution with an aim of identifying the resilient mollusc shell species for re-working into useful products. At each site a transect perpendicular to

the shore was set, quadrats ($1m^2$) were linearly cast at 5m intervals and collected shells were identified using morphological characteristics. Bivalvia and Gastropoda were ubiquitous taxonomic classes. Higher diversity, species richness and abundance of gastropods than bivalves were recorded from open lakeshore habitats. Decorative multimedia artworkthat combined fine artistic techniques of gluing shell species together, painting and varnishing was used. The hard shells comprising gastropod *Pila ovata* (Olivier), bivalves *Caelatura allaudi* Dautzenberg,*Etheriaelliptica* Lamarckand *Sphaerium* spp. endowed with beautiful shiny lustre were re-worked into ornaments. Training and empowering the riparian communities to re-work shell products and market them would enhance improved livelihood.

Introduction

Lake Victoria is the largest freshwater body in Africa and harbours a number of resources. Over 80% of the L. Victoria riparian communities depend on agriculture and fishing for livelihood. These economic activities are threatened by eutrophication, over-exploitation, introduction of exotic species, aquatic weeds, domestic and industrial wastes, solid wastes, sediments from soil erosion (Kayombo and Jorgensen, 2006).Challenges in the natural environment faced by freshwater molluscs include floods, droughts, siltation, extreme temperature variations and predation among others.With poverty endemic to the area; the riparian communities face various developmental challenges.There is therefore need to identify other bio-resources from L. Victoria that could be exploited for improvement of livelihood. Mollusc shells are among the potential resources along the shores of L. Victoria. Their abundance, distribution and species diversity have not been investigated with reference to potential for value addition and wealth creation. Even though Kohl (2005) pointed out the potential of using freshwater mussels and snails as foodstuffs, trade and manufacture of buttons among some cultures in North America, in East Africa there is insufficient information in this regard. However, the natural habitats accommodating these species continue to experience increasing anthropogenic disturbances (Scheren *et al.*, 2000; Ntiba *et al*, 2001) and may result in seasonal variation in densities (King, 1999; Dillon, 2005) and loss of species that could constitute important source of income. This study was therefore undertaken to determine the diversity, abundance and distribution of mollusc shells in L. Victoria shores that could be exploited through value addition to improve the livelihood of the riparian community.

Materials and Methods

Study area

The study was conducted along the Lake Victoria shoreline in Kenya. The shoreline is convoluted and encloses several bays and inlets. Mollusc shells were sampled at 20 ± 0.5 km intervals along the shoreline. River inlets, sheltered and non-sheltered habitats along the shoreline were also sampled depending on the accessibility. Sampling at each site began with setting of a transect perpendicular to the shoreline and $1m^2$ quadrat linearly cast along transect. Transects were set by holding a 30 m long string with knots at 5 metre intervals. The midpoint of the quadrat marked the first sampling point. Each of the sampling sites was geo-referenced using Garmin® GPS 12XL handset in Universal Transverse Mercator (UTM) mode. This resulted in six sampling points per site with 5 m distances from each other. At every sampling point, one edge of the quadrat was placed touching on the uppermost wave-line. All shells encountered in each transect were collected and kept in labelled polythene bags.

Sample processing

Shell samples were thoroughly washed in water and sun-dried. They were sorted and identified using morphological characteristics with reference to standard taxonomic keys (Brown and Kristensen, 1958; Brown, 1994), grouped according to species for counting and distribution determination.

Value addition

Selected bivalve and gastropod shell species were shaped into pendants, small holes perforated and nylon fishing thread passed through the holes. The shells were then smoothened on the edges using sand paper, file and assembled with different types of beads and seeds to make a variety of ornaments. Multimedia artworkthat combined fine artistic techniques of gluing shell species together, painting and varnishing was employed to generate composite products.

Results

Lake Victoria shoreline has an accumulation of several species of mollusc shells which are not evenly distributed (Table 1). Bivalvia and Gastropoda were ubiquitous taxonomic classes identified (Plate 1). Species diversity and abundance varied among sites. Sites that were open and experienced wave action exhibited higher species richness. Gastropoda comprising of *Bellamya unicolor(*Olivier*)* (74.6%) and *Melanoides tuberculata* (Muller) (15.1%) were the most abundant species. *Pila ovata(*Olivier*)* was the rarest species found in the disturbed and polluted sites. Other gastropod species included *Biomphalaria choanomphala* (Martens*), Bulinus globosus* (Morelet), *Gabbiella humerosa (*Martens*)* and *Lymnaea natalensis* Krauss. The identified bivalves included C*aelatura alluaudi* Dautzenberg, *Mutela bourguignati* (Ancey), *Sphaerium spp.*, *Corbicula africana* (Krauss),*Byasanodonta spp.*, *Mutela rostrata (*Rang), *Etheria elliptica* and C*aelatura allaudi*. The bivalve shells of the species *Caelatura hauttecoeuri* (Bourguignat), *Caelatura alluaudi*, *Mutelarostrata*, *Etheria elliptica*, *Mutela bourguignati*,*Sphaerium* spp. and *Caelatura bakeri* (Adams) as well as gastropod *Pila ovata* and *Bellamya unicolor* elicited variations in morphological features. These were re-worked into a variety of valuable products such as key holders, composite murals, pendants for necklaces, ear rings and hair clips (Plate 2).

Discussion

The present study showed that the freshwater gastropods and bivalves are unevenly distributed at shores of Lake Victoria. Species diversity and abundance varied among sites with *B. unicolor* more frequently encountered in higher densities in both disturbed and undisturbed habitats followed by *M. tuberculata*. Although the shells of two species *B. unicolor and M. tuberculata* are the most common, their utility in ornamental artwork is hindered by their fragile nature. The multimedia artwork used in the present study shaped an array of valuable products surpassing those reported in North America by Kohl (2005) who pointed out the potential of using freshwater mollusc shells for the manufacture of buttons. A lower species richness and distribution of *P. ovata*, in areas with algal blooms demonstrate the impact of pollution on this group. There are proposals that gastropod species are sensitive to various disturbances of freshwater habitats and could thus be used as indicators of the quality of the freshwater ecosystems (Chirombe *et al.*, 1998; Thomas, 1999). Therefore, this study of mollusc shells may

contribute in predicting factors likely to cause changes in species diversity, abundance and distribution status and their associated utility. In view of this, the observed decline in bivalve shells diversity in open, disturbed sites of L. Victoria is further evidence that anthropogenic disturbances and recession of water levels may be causing a decline, which is in line with reports by Kennedy (1997) and Thomas (1998).

Conclusions

The study reveals enormous diversity of mollusc shells along the shoreline of L. Victoria. The hard shells are suitable for ornamentation as part of the value addition enterprise and income generation.

Recommendations

1. The fragile gastropod shells are abundant along the shores of L.Victoria and would be suitable for grinding to determine chemical composition and potential utilization.
2. The multimedia techniques can be imparted to the community to sustain production of beneficial products.
3. Create an inventory of valuable shells and training manuals.

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7. A REVIEW AND ASSESSMENT OF APPLICABILITY OF THE HEAT STRESS INDICES IN KENYAN WEATHER FORECAST

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Abstract

The weather and climate of any given place is an environmental resource since it greatly determines the comfort, health and productivity of humans and other living things. The packaging of weather information especially the forecast into a way that can easily be interpreted and understood by end users is important. Temperature is one of the weather parameters that

have significant impact of human comfort and the wellbeing of other living things. Thermal stress is an important factor in many industrial situations, athletic events and military scenarios. It therefore calls for accurate and timely forecast of the same and dissemination to the public for human safety and comfort. There exist three types of heat strain indices: rational, empirical and direct indices. The study tested the applicability of Discomfort Index (DI) in Kenyan daily weather forecast using both observed and forecast data from Synergie system used by Kenya Meteorological department (KMD). According to almost all literature reviews on thermal indices and their correlates to thermal sensation and comfort, DI is the most practicably used comfort heat stress index globally and this study as well recommends that KMD adopt it in its forecast.
Keywords: *Human Comfort, Discomfort Index and Synergie*

Introduction

Temperature is one of the most important parameters that influence human comfort. Temperature affects the thermal comfort and physiological ability of living things and thus sensitive for human comfort and survival. Human comfort is essential for it determines the output of workers in several industries, sportsmen/women at training and competitions and military officers in their operations among others.

Weather stress index is normally designed to assess the frequency and magnitude of the most uncomfortable weather conditions. Generally, translation of the stress in terms of physiological and psychological strain is complex. There are many indices that have been suggested, categorized into three groups: indices that are based on calculations involving the heat balance equation (rational indices), indices that are based on objective and subjective strain (empirical indices), and measurements of environmental variables (direct indices). Owing to their complexity, the first two groups are not applied in day to day life use. Direct Indices; Discomfort Index (DI) and Wet Bulb Globe Temperature (WBGT) are very easy to use (Yoram E., and Moran S. D., 2006).

The main objective of this paper is to review Heat Stress Indices (HIS) and give a more practical and effective HIS that can be adopted by KMD to add value to its daily weather forecast to enhance human safety and comfort. The study specifically gives a comprehensive

review of development of human comfort index and a test of the applicability of a number of comfort indices in Kenya.

The temperature forecast issued in Kenya by the KMD only highlights how low or high the temperature will reach without giving scientific interpretation of how the temperature range will affect man and other living things in the areas. KMD uses Synergie; a computer model best fitted decision making tool for National Meteorological Services whatever their size and organization, from national headquarters to regional or specialized forecasting centers. The system combines observations, satellite data, radar images, and model outputs to improve now casting. A number of studies have been done especially in Europe; worst hit by extreme temperature to develop practical models used to predict human comfort based on temperatures. According to (Court, 1981), most discomfort indices evaluate the impact of heat stress on the individual, they usually take temperature, humidity or both into consideration while doing this. In as early as 1905, Haldane developed an index for heat load and claimed that changes in the Wet Bulb Thermometer alone were enough to reflect the heat load. However, with time, environmental indices have been suggested that include wind speed. In 1957, Yaglou and Minard came up with Wet Bulb Globe Temperature (WBGT), which gained popularity owing to its simplicity and convenience of use. It is the most common heat stress index for describing environmental heat stress (Equation 1).

$$WBGT=0.7T_w + 0.2T_g + 0.1T_a \quad (1)$$

where T_g is black globe temperature, which reflects the solar radiation; T_w is wet bulb temperature and T_a dry bulb temperature.

For indoor conditions, WBGT was modified to, $WBGT= 0.7T_w + 0.3T_a$ (2)

According to Froom *et al.*, (1992), WBGT was approved by the ISO (ISO 7243) organization as an international standard in 1982 for heat load assessment, and the index is commonly used as a safety index for workers in various occupations. However, WBGT is limited in evaluating heat stress due to the inconvenience of measuring T_g. Black globe temperature is usually measured by a thermometer surrounded by a 6" blackened sphere.

In 1957, Lind and Hellon proposed the Oxford index (WD); a simple direct index based on T_w and T_a as:

$$WD=0.85T_w+0.15T_a \quad (3)$$

Because of the easiness to apply the WD, other indices based on the same concept were proposed. Thorn (1959) developed an index based only on two parameters (Equation 4);

$$DI = 8.3 + 0.4T_a + 0.4T_w \quad (4)$$

where DI stands for Discomfort Index expressed in Discomfort Units (DU). Sohar *et al.*, (1978), adapted the Dl and changed it to a simple average between T_w and T_a,

$$DI = 0.5T_w + 0.5T_a \quad (5)$$

The following criterion was established Based on a great number of observations on a wide spectrum of population groups and under different climatic conditions, to characterize the environmental heat stress and the correlate thermal sensation:

Table 1: *Classification of Thermal Sensation using Discomfort Index Values*

DI (Discomfort units)	**Thermal Sensation**
Less than 22	No heat stress
22–24	Most people feel a mild sensation of heat
24–28	People feel very hot, and physical work may be performed with some difficulties
Above 28	The heat load is considered severe, and people engaged in physical work are at increased risk for heat illness

(Source: Sohar E., 1979)

Data and Methodology

The climatological data used in this study was obtained from KMD; it consisted of daily dry bulb temperature and wet bulb temperature for the year 2010 from a predetermined stations representing homogeneous zone. The data set for the fifteenth (15^{th}) day of each month was used to represent the month.

The forecasted values of wet and dry bulb temperatures from Synergie for five days, 13 – 17^{th} March 2012 were used to compute DI values that can be derived from the system in the daily weather forecast. The values of DI were computed using the relation: $DI = 0.5T_w + 0.5T_a$.

Results

Discomfort Index Values derived from observed data

The Highlands East and West of Rift Valley and Nairobi counties experience no heat stress throughout the year. However, it is notable that the inhabitants of the North Eastern, Coastal Kenya and North Western counties of Kenya represented Lodwar, Mombasa and Wajir feel very hot especially during March – May season. This implies that physically, they perform with some difficulties reducing their productivity. The Lake Region, represented by Kisumu mainly experience no heat stress and mild heat sensation alternately throughout the year (Table 1).

Table 2: *Discomfort Index Values using observed data*

Year	Station	Month											
		Jan.	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2010	Dagoretti	14.5	18.3	15.2	17.3	15.9	15.3	13.9	13.4	14.8	16.9	16.0	16.0
	Lowdar	21.8	26.9	25.4	27.1	27.3	25.7	23.8	23.8	24.7	25.8	26.1	23.7
	Wajir	23.7	24.5	27.4	25.8	25.4		23.3	23.0	23.5	24.1	24.8	24.4
	Kakamega	14.5	19.7	19.3	19.0	19.3	17.5	18.7	18.2	18.4	20.2	19.8	19.1
	Narok	12.1	16.6	14.6	17.0	15.3	16.7	13.3	13.3	15.0	18.1	17.4	15.2
	Kisumu	18.4	20.7	21.2	20.2	22.9	20.3	20.6	19.2	19.0	22.6	20.6	21.4
	Nyeri	12.3	15.8	15.6	18.2	15.9	14.9	12.9	13.3	13.8	17.0	15.7	13.3
	Mombasa	25.1											

Discomfort Index derived from forecasted values by Synergie

The DI values are slightly higher than those obtained using observed data; the values are however in conformity with DI values for the month of March derived from observed data which are the highest in the year. Discomfort Index values are highest in North Eastern and Western Kenya counties represented by Wajir and Lodwar respectively. The DI values range between 24 – 28, in which people feel very hot, and physical work may be performed with some difficulties. Similarly, Nyeri, representing Highlands East of Rift Valley and Nairobi area has lowest DI values; in the range of 22 to 24 within which most people feel a mild sensation of heat.

Table 3 : *Discomfort Index Values derived from Synergie*

		Time				
	Station	13/03/12	14/03/12	15/03/13	16/03/13	17/03/13
	Dagoretti	24	25	26	25	26
	Lodwar	27	28	26	25	26
	Wajir	27	28	28	28	29
	Kakamega	25	27	27	27	26
	Narok	23	25	25	26	25
	Kisumu	26	26	27	27	27
	Nyeri	22	23	23	23	25
	Mombasa	25	26	27	26	26
	Makindu	25	25	25	26	26

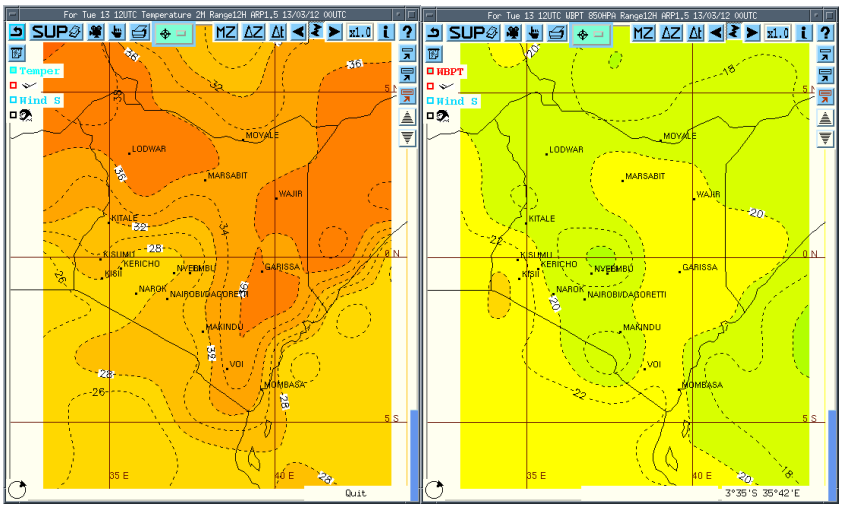

Figure 1 : *Synergie Images showing Dry and Wet Bulb temperatures over Kenya for 13th March 2012, a) – Dry Bulb b) –Wet Bulb Temperature*

Conclusion and Recommendations

Indeed the effect of temperature on living things cannot be underestimated. Packaging of temperature information in a way that can be easily understood and applied by the end users is therefore key to increasing the value of daily weather forecast. Although DI is simple and easy to use, it does not factor some variables, and conditions such as clothing, it was been applicable for almost five decades. The DI is in use in many areas worldwide. The study thus suggests that KMD adopts this index and test its applicability in different climatic zones.

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8. A STUDY OF PLANTS AND PLANT PRODUCTS TRADITIONALLY USED IN LIVESTOCK HEALTH MANAGEMENT IN BUURI DISTRICT, MERU COUNTY- KENYA

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Abstract

To date, nomadic communities in Africa have been the primary focus of ethnoveterinary research. Although mainly arable or mixed arable/pastoral farmers, the Ameru people of central Kenya have a historical and cultural values for livestock throughout their lineages. Their collective and accumulative ethnoveterinary knowledge is likely to be just as rich and worth documenting. The aim of the present study was to document ethnoknowledge of the Ameru people used for managing the health of their livestock. It was envisaged that this would provide a basis for further research on the efficacy of these ethnopractices that could also lead to the discovery of useful ethnopharmaceutical agents. Non-alienating, dialogic, participatory action research (PAR) and participatory rural appraisal (PRA) approaches involving 21 women and men aged between 50 and 79 years old from the Ameru people were used. A total of 48 plant

species distributed in 26 families were documented with the details of the diseases/health conditions they are used for, parts of plants usedand form of application/ preparation method and the target group of animals. Fabaceae had the highest number of species (30.8%) followed by Solanaceae (23%) while Asteraceae and Euphorbiaceae, each accounted for (15.4%) of the total plant species. Most of the families (73%) were represented by a single plant species. Trees constituted the largest category (41.7%) followed by the herbs (31.2%). Shrubs comprised 22.9% of the total documented species while the rest, which included climbers and lianas amounted to 4.2%. The major threats to medicinal ethnobotanicals in the study area included lack of EVM interest among the young people, wanton destruction of forests and destructive harvesting methods. The study confirms that the Ameru people have preserved rich ethnoveterinary knowledge and practices. It provides some groundwork for elucidating the efficacy of some of these ethnopractices in managing livestock health as further research may lead to the discovery of useful ethnopharmaceutical agents to be used in livestock industry.

Introduction

The use of medicinal plants in the management of animal health is an old practice that dates back to the time of the animal domestication (Mathappanet al., 2010). Ethnoveterinary medicine (EVM) encompasses all approaches, methods, skills, techniques, knowledge and practices of animal healthcare of a given community. This form of indigenous knowledge (IK) has existed in various forms and levels among the Ameru people and has been handed down orally and through apprenticeship from one generation to the next. This important ethnoknowledge of the Ameru is however, faced with a lot of challenges, which are significantly resulting into its erosion such as the expanded range of arable farming activities, which are currently dominating land use and threatening the survival of grasslands, woodlands, bushes and forests, the source of ethnopharmacologically active agents upon which ethnoknowledge is based (Biosafety News, 2002). Other factors contributing to the erosion of ethnoknowledge of the Ameru include: (1) untimely deaths of persons with ethnoknowledge without its documentation, (2) extinction of specific plant and animal species and ritual practices, (3) encroachment of development and modernization on cultural and traditional life, (4) adoption of lifestyles and education systems that do not embrace ethnoknowledge, (5) shifting bias in religious beliefs, (6) perception of certain socio-cultural practices as unhygienic and satanic, and (7) cost- and health-related risks

involved in certain socio-cultural ethnopractices. The result of this is that either little or no information is being passed on to the next generation.

This study was therefore undertaken to survey, generate and document a database of plants and plant products traditionally used in the management of livestock health amongst the Ameru people. This resource may provide useful information for further scientific research, which may clarify the relative efficacies of different products and ethnopractices in the management of livestock health (Alghali, 1992). In so doing, value added knowledge can be provided back to the community in the form of useful innovative products and services, and help ethnopractitioners gain incremental confidence in their own ethnoknowledge. This may help establish active links with the modern science network for sustainable use and management of local environment and its resources for improved animal productivity and livelihood.

Materials and Methods

As praxis research, it required dialogic and action participatory approaches, which are non-alienating and multi-strategic in nature. This was due to the fact that there was a considerable intra-and inter-cultural variability, rather than cultural homogeneity in resource population of the Ameru people and the highly individualized nature of Ethnoveterinary medicine (EVM) knowledge (not everyone has the knowledge). The methods for data collection included: - (a), Rapid Rural Appraisal (RRA), (b) local administrative village meetings-RRA, (c), community/village elders-Participatory Rural Appraisal (PRA), (d), group and individual interviews-PRA, (e), focus group discussions-PRA, (f), Individual healers, herbalists and spiritualists, and (g), secondary literature review. Approaches from (a) to (g) comprised a set of triangulation approach needed in EVM research for non-experimental validation process of the local communities' ethnoknowledge (Lans, 2001). After the survey and collection of plant specimens from the field under the guidance of key informants, the plant specimens were taken in the university herbarium for taxonomic studies, scientific identity and naming and literature review of each plant species.

Results and Discussion

Informants and their perception of ethnoveterinary knowledge, services and practices

Through the help of local chiefs (from the office of the President, Republic of Kenya), village elders and church leaders, a systematic selection of 21 key informants spread out in the district was made using a combination of snowball and purposive sampling methods. The selection process was based on the knowledge base, experience and current ethnopractices in ethnoveterinary medicine of the target individual. The key informants comprised mainly practicing ethnoveterinarians. The study revealed that majority of the key informants were males aged between 50-69 years old with informal education (Table 1). The EVM knowledge was noted to be secretly transmitted through and maintained within family lineages and its services mostly offered freely by a good number of ethnopractitioners who are gradually regaining confidence in their EVM knowledge, services and practices.

Table 1: *A description of the profiles of informants and their perception of EVM knowledge, services and practices (n = 21)*

S/n	Description of the categories of key informants	No. of respondents	Percentage (%) response
1.	**Gender**		
a	Male	18	86
b	Female	3	14
2.	**Age (yrs)**		
a	50 - 59	6	29
b	60 - 69	12	57
c	70 - 79	3	14
3.	**Education status**		
a	Formal education	5	24
b	Informal education	16	76
4.	**Acquisition of EVM knowledge and experience**		
a	From parents /grandparents/ extended and non-extended family members	15	71
b	From an experienced senior ethnopractitioner not related	6	29
c	From own experience-dreams/visions	-	-
d	Ceremonies/meetings	-	-
5.	**Provision of EVM services**		
a	Not charging (free)	9	43

b	Always charging	5	24
c	Charging under certain circumstances only	7	33
6.	**Exchange of EVM knowledge amongst professionally experienced colleagues**		
a	Yes	4	19
b	No	17	81
7.	**State of EVM knowledge/ services/ practices**		
a	Falling in disfavor	5	23.8
b	Gaining ground	10	47.6
c	Status quo	6	28.6

Key: EVM – Ethnoveterinary medicine

Enumeration of documented plants from the survey

The survey study recorded a total of 48 medicinal plant species distributed in 26 families used in livestock health management by ethnoveterinarians in Buuri district (Table 2). The documentation of 48 plant species distributed in 26 families included the details of the diseases/health conditions they are used for, parts of plants usedand form of application/ preparation method and the target group of animals.Of the 26 families, Fabaceae had the highest number of species (30.8%), followed by Solanaceae (23%) while Asteraceae and Euphorbiaceae, each accounted for 15.4% of the total plant species. Most of the families (73%) were represented by a single plant species. Family Use Value (FUV) is an important Relative Cultural Importance (RCI) index, which was applied to calculate a value of biological plant taxon. This index together with other important ethnobotanical indices can provide data that can be used in hypothesis-testing, validation and comparative analysis of ethnoproducts (Hoffman and Gallaher, 2007). The study found out that of the recorded 48 plant species, some such as *Warburgia ugandensis*, *Tagetes minuta* and *Azadirachta indica* were already well established and confirmed medicinal plants that had been studied extensively for their use in ethnoveterinary medicine (Wanzala *et al*.,2012).

Table 2: *Analysis of documented plant species by family use values (n=26)*

S/n	Family	No. of Species	% of all species	Respondents' Use citations	% Use citations	Family use value
1	Aloaceae	1	2.1	12	2.07	0.571
2	Apocynaceae	2	4.2	29	4.99	0.690
3	Asteraceae	4	8.3	67	11.53	0.798
4	Bignoniaceae	1	2.1	12	2.07	0.571
5	Boraginaceae	2	4.2	29	4.99	0.690
6	Burseraceae	1	2.1	9	1.55	0.429
7	Canellaceae	1	2.1	19	3.27	0.905
8	Cannabaceae	1	2.1	5	0.86	0.238
9	Cucurbitaceae	1	2.1	9	1.55	0.429
10	Ebenaceae	1	2.1	8	1.38	0.381
11	Euphorbiaceae	4	8.3	68	11.70	0.810
12	Fabaceae	8	16.7	112	19.28	0.667
13	Lamiaceae	3	6.3	37	6.37	0.587
14	Liliaceae	1	2.1	9	1.55	0.429
15	Meliaceae	1	2.1	17	2.93	0.810
16	Menispermaceae	1	2.1	8	1.38	0.381
17	Moraceae	1	2.1	11	1.89	0.524
18	Oleaceae	1	2.1	10	1.72	0.476
19	Poaceae	1	2.1	9	1.55	0.429
20	Polygonaceae	1	2.1	11	1.89	0.524
21	Rosaceae	1	2.1	6	1.03	0.286
22	Rubiaceae	1	2.1	7	1.20	0.333
23	Salicaceae	1	2.1	6	1.03	0.286
24	Sapindaceae	1	2.1	10	1.72	0.476
25	Solanaceae	6	12.5	54	9.29	0.429
26	Verbenaceae	1	2.1	7	1.20	0.333

Based on FUV values presented in Table 2, Canellaceae family, which has a single plant species was found to be the most useful family utilized in ethnoveterinary medicine in the area followed by Euphorbiaceae and Meliaceae, which are represented by four and one plant species, respectively.

Traditional understanding of livestock diseases amongst the Ameru people

A total of 24 livestock diseases and ill-health conditions were reported. All respondents had at least one local name for the reported and described diseases/ill-health condition. The respondents were also able to describe various signs and symptoms associated with the reported disease/ill-health conditions. Among the diseases/ill-health conditions reported to have a high prevalence in the study area are: - anaplasmosis, East Coast fever, pneumonia and helminthiasis.

Table 3: *Common livestock diseases and ill-health conditions evaluated in Buuri district, Meru County, Kenya*

S/n	Common name of animal disease/condition/aetiologic agent	Local name of animal disease/condition	Type(s) of animal group(s) affected
1	Anaplasmosis	Ntigana	Ruminants
2	Theileriosis (ECF)	Itaa/Ngarangari	Ruminants
3	Typanosomiasis	Mutombo	Cattle
4	Retained placenta	Kuremera thigiri	Ruminants
5	Mastitis	Kuimba riere	Mammals
6	Ticks (aetiologic agent)	Igumba	All species
7	Diarrhea/Dysentery	Kuarwa	All species
8	Helminthiasis	Njoka	All species
9	Conjuctivitis	Meetho	Cattle
10	Pneumonia	Mpio	Cattle, Goats and Sheep
11	Dystochia	Kuremera njau	Cattle
12	Foot and Mouth disease	Ikunguri	Ruminants and Pigs
13	Bloat	Kuuna	Ruminants
14	Mites, lice and fleas	Nthuuga	Poultry
15	Lumpy skin	Ngoci	Cattle
16	Loss of feather	Guta mbui	Poultry
17	Foot rot	Maronda maguru	Ruminants
18	Poor milk letdown	Kuitha iria	Cattle
19	Miscarriage	Guta Njau	Cattle
20	Newcastle disease	Kuthinka	Poultry
21	Sores and Wounds	Ironda	All species
22	Infertility	Kuthata	Cattle, Goats and Sheep
23	Cough	Gukora	All species
24	Lung diseases	Mauri	Cattle, Goats and Sheep

Conclusions and Recommendations

The survey study revealed a wealth of preserved ethnoknowledge on plants, plant products, and ethnopractices associated with the traditional management of livestock health by the Ameru people. Evidence from respondents' information revealed that some of the plants used were brought from their original area/location to Buuri district by immigrants. Some plants and livestock health ethnopractices had very few ethnoknowledge references in the literature; perhaps, they were truly indigenous to the Ameru people or perhaps relevant references could not be accessed. Nevertheless, some of the local claims of the plants and plant products have been supported by scientific studies reported in literature. Further elucidation of the science underlying the efficacy of these plants, plant products, and health ethnopractices may lead to the discovery of useful pharmaceutical agents and tactics that may be integrated in livestock health management programmes for the wellbeing of livestock industry in Africa. This may also foster wider acceptance of these ethnoremedies by different stakeholders and help restore recognition accorded to ethnopractices held in the past. Ethnoveterinary medicine is the type of medicine of choice for many small-scale livestock farmers in the area. Ethnoveterinary medicine in the area is practised mainly by men and there is need therefore to encourage women to participate. There is little sharing of information, knowledge, skills, techniques and experiences amongst the ethnopractitioners. Continuity and sustainability of EVM knowledge, services and practices are amongst the major challenges facing ethnopractitioners.

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9. ADAPTABILITY OF PGMS AND TGMS RICE LINES FOR HYBRID RICE SEED PRODUCTION IN KENYA

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Abstract

Low rice yield per hectare in Kenya has been associated with to food shortage. The yields can be increased by use of hybrid rice seed technology. Photosensitive genic male sterile lines (PGMS) and thermosenstive genic sterile (TGMS) lines have been evaluated at KARI- Mwea for their suitability in hybrid rice production. The objective was to increase the day-light length to 14hours and to raise temperature to above 36°C and 20˚C day and night respectively so as to induce complete sterility in PGMS and TGMS respectively. Two PGMS (V1PGMS, V3PGMS) and one TGMS (V2TGMS) rice lines were obtained from International Rice Research Institute (IRRI) and sown in greenhouse at Kenya Agricultural Research Institute (KARI), Mwea-Kimbibi station. At premordial stage PGMS and TGMS were treated with long day-light length and high temperature growth conditions. All the PGMS and TGMS grown under long day length and High temperature growth conditions recorded over 98% spikelet sterility indicating that they are usable as male parents in the production of hybrid seeds without risk of contamination by self bred seeds.

Keywords: *Thermo-sensitive genic male sterility, Photo-sensitive geneic male sterility, Long day, High temperature.*

Introduction

Rice (*Oryza sativa* L.) is the third most important crop in Kenya as source of calories. On average Kenya produces about 50,000tones yet annual consumption is about 300,000tones of rice (Kenya, Ministry of Agriculture, 2008). As evidenced by frequent famine relief food, Kenya experiences acute food shortage challenges and people die of hunger or are under fed. Despite this yield in rice per hectare has remained very low compared to other countries like China. To increase rice yields above the plateau set by the green revolution many countries like China have adopted the technology of "**super hybrid rice** (Xie and Hardy, 2009). *Heterosis* has been reported to increase rice yield by between 20 to 30 % above the current yields of the dwarf lines (Xie and Hardy, 2009). To produce hybrid seeds, two inbred genetically fixed varieties are needed. Plants from such seeds are special in that they express hybrid vigor (Xie and Hardy, 2009). Over the years manual removal of anthers has been practiced to emasculate male gametes of the parent receiving pollen to avoid inbred seeds. This made production of hybrid rice seeds in large scale difficult, but with the discovery of cytoplasmic male sterility (cms) it was possible (Virmani et al., 1981). However, use of cms proved to be expensive, since it uses three lines (sterile line, maintainer and restorer), compared to Photoperiod sensitive genic male sterile (PGMS) that uses two-lines (Mao, 1990). In long day-light (above 14 hours) and high temperature (above 33°C and 26°C day and night respectively) the PGMS is completely sterile and it is used as female parent in hybrid rice production (Ku *et al.,* 2001). In short day-light length (10hours) and low temperatures (between 22°C night and 26°C day) growth conditions it reverts to fertility, thus it maintains itself (Lopez and Virmani, 2000). Thermosensitive genetic male sterility (TGMS) which is sterile in high temperature growth conditions and fertile in low temperature growth conditions provides a possibility of hybrid rice seed production in the tropics (Reddy *et al.,* 2000). In this research adaptability of PGMS and TGMS lines have been tested under green house conditions with excellent performance.

Materials and Methods

Plant materials

The PGMS and TGMS varieties were imported from International Rice Research Institute –IRRI (Philippines). Importation of the plant materials was done under the supervision of Kenya Plant

Health Inspectorate Service (KEPHIS) for Phytosantry testing. Among them V1PGMS and V3PGMS were PGMS and V2TGMS was a TGMS. Materials were sown and tested at KARI Mwea Scheme which is located in Kirinyaga district in Central province of Kenya on Latitude -0.7°S, and Longitude 37.37E.

Methods

Long day and high temperature treatment effects on PGMS and TGMS rice

Seeds were pre-germinated first before sowing. All the three varieties (V1PGMS, V2TGMS and V3PGMS) were sown in two concrete troughs in green house. Trough one was divided into three blocks. Lines V1PGMS, V2TGMS and V3PGMS were sown in block1,2&3 of trough one in this order. Each block had ten rows each with 6 plants at spacing of 15 x15 cm. Trough two was divided into three rows along the trough. Rows1, 2 and 3 were sown with varieties V1PGMS, V2TGMS and V3PGMS in this order. Each row had ten plants at a wider spacing of 30cm between rows and 30cm between plants. All the plants in troughs one and two were allowed to grow in greenhouse conditions until primordial stage. At this stage three plants of each variety were carefully uprooted and transplanted outside the greenhouse in a bucket where they were allowed to grow until maturity for evaluation under normal day-light length (NDL) and normal temperature (NT). The remaining plants of each variety in trough two were allowed to grow in greenhouse conditions until maturity, a treatment referred to as NDL and high temperature (HT). Plants in trough one were given long day-light length (LDL) treatment by illuminating the plants with solar light when coved with a black cloth (to trap and concentrate the light around the plants) from 6.30pm to 9.00pm so as to experience 14hours of day-light period. This is what was referred to as long day length (LDL) treatment and higher temperature (HT). LDL treatment was done till flowering when it was withdrawn.

Assessment of plant fertility

Spikelet in all three varieties were sampled and fixed in 70% ethanol for analysis of pollen fertility. Anthers were extracted from the glumes using forceps and placed on a microscope glass slide with a drop of 1% potassium iodide (I/KI) solution after which they were macerated using the forceps to release the pollen cells. Anther-husks were removed from the glass slide leaving the microspores only a cover slip was placed on a glass slide and observed under x10 objective

of light Microscope. Spikelet fertility was scored by counting yellow staining abortive pollen against the blue black staining fertile ones. Also at post ripening stage three tillers with full grown panicles were picked from each hill in each row for seed set evaluation. Fertility was calculated as a percentage of total number of grains to total number of glumes per each panicle x 100. Evaluation of gross panicle was done by picking whole panicle from plants under LDL+HT and NDL and NT growth conditions and directly scanned using Cannon scanner (CanoScan Lind100- Japan). Photographs were processed using Photo element version 2.

Results

Fertility assessment

Among the plant grown under LDL +HT growth conditions 100% of pollen grains from lines V1 PGMS and V3 PGMS stained yellow with 1% K/I and seed set was 0% (Table 1), while line V2 TGMS recorded 99% yellow pollen when stained with 1% K/I and 3 % seed set under the same conditions. The staining pattern of pollen from V1PGMS and V3PGMS grown under HT+NDL conditions had no observable difference from those under LDL +HT. However V2TGMS grown under HT and NDL recorded 100% while those from LDL+HT recorded 99% yellow-staining pollen with 1% K/I. Seed set rate of V2PGMS grown under LDL+HT and HT+NDL was 3% and 2% respectively (Table 1).

Table 1: *Effects of LDL and HT treatments on Pollen fertility and seed set rate. In LDL plants were exposed to 14hours lighting and elevated greenhouse temperature, while in NDL and HT they were grown under NDL and HT in the green house. Plants under NDL+ and NT were grown in wire mesh shed outside the greenhouse. Fertile pollen stained blue-black while sterile or abortive pollen stained yellow with 1% potassium iodide.*

Rice line	**Treatment**	**Average Pollen Sterility**		
		Fertile pollen %	Abortive pollen%	**Average Seed set per panicle %**
V1PGMS	LDL + HT	0	100	0
V2TGMS	LDL + HT	1	99	3
V3PGMS	LDL + HT	0	100	0
V1PGMS	HT +NDL	0	100	0
V2TGMS	HT +NDL	0	100	2
V3 PGMS	HT +NDL	0	100	0
V1PGMS	NT +NDL	64	36	45
V2TGMS	NT+NDL	60	40	30

V3PGMS	NT+NDL	55	45	26

Panicles of rice lines V1PGMS, V2TGMS and V3PGMS grown under LDL and HT did not have observable seeds in them (Fig.1). This was same as panicles sampled from the three lines grown under NDL and HT growth conditions. Under NDL and NT growth conditions all the three lines (V1 PGMS, V2 TGMS, V3PGMS) were fertile with conspicuous seeds in the spikelets (Fig. 2).

Figure 1: *Spikelet fertility of PGMS under LDLT+HT and HT+NDL. Fig. a,b and c shows rice lines V1PGMS, V2TGMS and V3PGMS in LDL and HT and under NDL growth conditions in this order.*

Figure 2*: Spikelet fertility of PGMS under NDL and NT growth conditions. Fig. a, b and c shows rice lines V1PGMS, V2TGMS and V3PGMS all under NDL and NT growth conditions.*

Discussion

Rice lines V1PGMS and V3PGMS when grown under LDL+HT conditions and when grown under NDL and HT all recorded seed set rate of 0%. Thus, there is no observable difference between the two growth conditions (treatments). Although V2TGMS under LDL+HT and those under NDL and HT gave seed set of 2% and 3 % respectively, the difference was insignificant. Besides, both treatments (LDL+HT and NDL+HT), for variety V2TGMS had over 97% spikelet sterility. Pollen staining can be used to correctly predict spikelet sterility since for V1PGMS and V3PGMS staining using 1% K/I indicated 100% sterility same as observed seed set rate. Assessment of V2TGMS assessment of seed set also indicated 97% spikelet sterility while prediction by staining with 1% K/I indicated 99% sterility. PGMS requires long day to be completely sterile (Xue et al., 1999). In this research results indicate that V1PGMS, V2TGMS and V3PGMS grown under LDL and HT growth conditions was nearly the same as those from NDL and HT growth conditions.Therefore, under NDL and HT growth conditions high temperature seems to compensate long day length effects for PGMS to realize 100% sterility.

Conclusion

The three rice lines are adaptable enough for use in hybrid rice seed production technology without contamination with self bred seeds.

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10. CAN ORGANIC MATERIALS SUBSTITUTE FOR LIME TO AMELIORATE PHOSPHORUS-DEFICIENT ACID SOILS?

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Abstract

The effect of two organic materials (OMs); farmyard manure (FYM) and *Tithonia diversifolia* green manure (tithonia), and lime, each when applied alone or in combination with triple superphosphate (TSP), on soil acidity, P availability and maize dry matter yield (dm) was tested. Lime and FYM significantly increased the soil pH but tithonia and TSP did not. Lime was the most effective in reducing the exchangeable Al followed by tithonia and FYM. TSP when applied alone gave the highest amount of plant available P but this did not translate to high dm likely due to Al toxicity. A reduction in exchangeable Al by OMs or lime led to higher dm. OMs can therefore play the dual role of providing nutrients and mitigating the deleterious effects of soil acidity and are therefore likely to be more cost effective than lime.

Introdution

Phosphorus deficiencies and Al phytotoxicities limit crop production in many acid soils. Soil acidity can be ameliorated with application of lime while inorganic fertilizers are used to mitigate P deficiencies. However, increasing costs of lime and fertilizers have renewed interest in the use of locally available organic nutrient inputs to replace them in Kenya. Tithonia, in particular, has attracted great research attention due to its ability to effect dramatic increases in maize yields when compared to inorganic P fertilizers and other traditional OMs such as FYM (Jama *et al.,* 2000; Opala *et al.,* 2010). The reasons tithonia's effectiveness remains a subject of

intense debate with a many workers attributing it to its ability to increase P availability in P-fixing soils (Mziguheba *et al.*, 2007). Knowledge gaps controversy however still exist. The objective of this study was, therefore, to contribute to the understanding of the effects of OMs such as tithonia on soil chemical properties related to fertility and subsequent maize growth.

Materials and Methods

Top soil was collected from Bukura farm, air-dried and applied to each pot at a rate 4 kg in a greenhouse. Tithonia had 3.0% N, 0.3% P and 3.8% K, and pH 6.5 and the FYM had 1.8% N, 0.4% P and 1.2% K and pH 7.7. A completely randomised design with three replications was used. The treatments are shown Table 1. Lime was applied to the appropriate pots and incubated for 30 days at field capacity. The other treatments were applied on the planting day after which 2 maize seeds were planted per pot in April 2009. Regular watering was done and the plants harvested at 6 weeks after planting. The dry matter yield (dm) and the N and P content of the treatments were determined. At harvest time, soils were sampled from each pot and analyzed for pH, exchangeable acidity and Al, and Olsen P using standard procedures (Okalebo *et al.* 2002).

Results

The application of lime or FYM significantly increased soil pH compared to the control, but tithonia alone, TSP alone or citric acid combined with TSP did not (Table 1). Addition of tithonia, FYM or lime reduced both the exchangeable acidity and exchangeable Al but the magnitude of the reduction varied with each of these materials (Table 1). The effect was extremely marked with the lime treatments where the exchangeable Al was reduced by 100%. Tithonia was more effective in reducing exchangeable Al, but not exchangeable acidity, compared to FYM. Addition of both organic and inorganic inputs generally increased the soil Olsen P (Table 1). The magnitude of the increase depended on input source and rate of P application. Among the treatments where P was applied at the same rate of 60 kg ha^{-1}, TSP alone gave the highest Olsen P value while Tithonia combined with TSP gave the least. Amongst the OMs, FYM was more effective in increasing the Olsen P than tithonia.

All the treatments with P inputs significantly increased the dm with lime, tithonia FYM applied with TSP having similar yields (Figure1).At the same P rate of 60 kg P ha^{-1}, lime, tithonia or FYM when combined with TSP gave dm yields that were not significantly different from each other but they significantly out-yielded TSP when applied alone. There were no significant

treatment effects on the P and N contents in the maize biomass (Table 1) and, therefore, the P and N uptake trends closely followed those of dm accumulation (data not shown). `Lime when applied without P did not significantly increase the dm above the control. FYM and tithonia applied alone at P rate of 20 kg P ha^{-1} gave dm and nutrient uptakes that were not significantly different from that of TSP applied alone at 60 kg P ha^{-1}.

Table 1: *Effect of treatments on selected soil properties and P and N concentration in maize in the green house pot experiment*

Treatment	pH	Exch‡ acidity	Exch‡ Al	Olsen P (mg kg^{-1})	% P In plant	% N in plant
1. Control (no P input)	4.67	0.60	0.41	6.1	0.08	1.34
2. Lime (no P input)	5.49	0.28	0.00	7.8	0.09	1.12
3.Tithonia (20 kg P ha^{-1})	4.58	0.49	0.31	10.5	0.11	1.43
4. FYM (20 kg P ha^{-1})	5.17	0.48	0.35	10.2	0.11	1.33
TSP(60 kg P ha^{-1})	4.57	0.60	0.40	23.5	0.10	1.30
5. Tithonia (20 kg P ha^{-1}) + TSP (40 kg P ha^{-1})	4.93	0.48	0.18	16.5	0.12	1.36
6. FYM (20 kg P ha^{-1} + TSP (40 kg P ha^{-1})	5.27	0.45	0.26	18.9	0.10	1.43
7. Citric acid + TSP (60 kg P ha^{-1})	4.60	0.56	0.38	19.9	0.10	1.41
8. Lime + TSP (60 kg P ha^{-1})	5.61	0.34	0.00	21.2	0.11	1.29
SED	0.1	0.07	0.07	1.5	NS	NS
CV%	2.5	18.4	32	12	13	6.6

FYM= Farmyard manure; TSP= triple superphosphate; ‡ exchangeable; NS = not significant SED = standard error of difference between means.

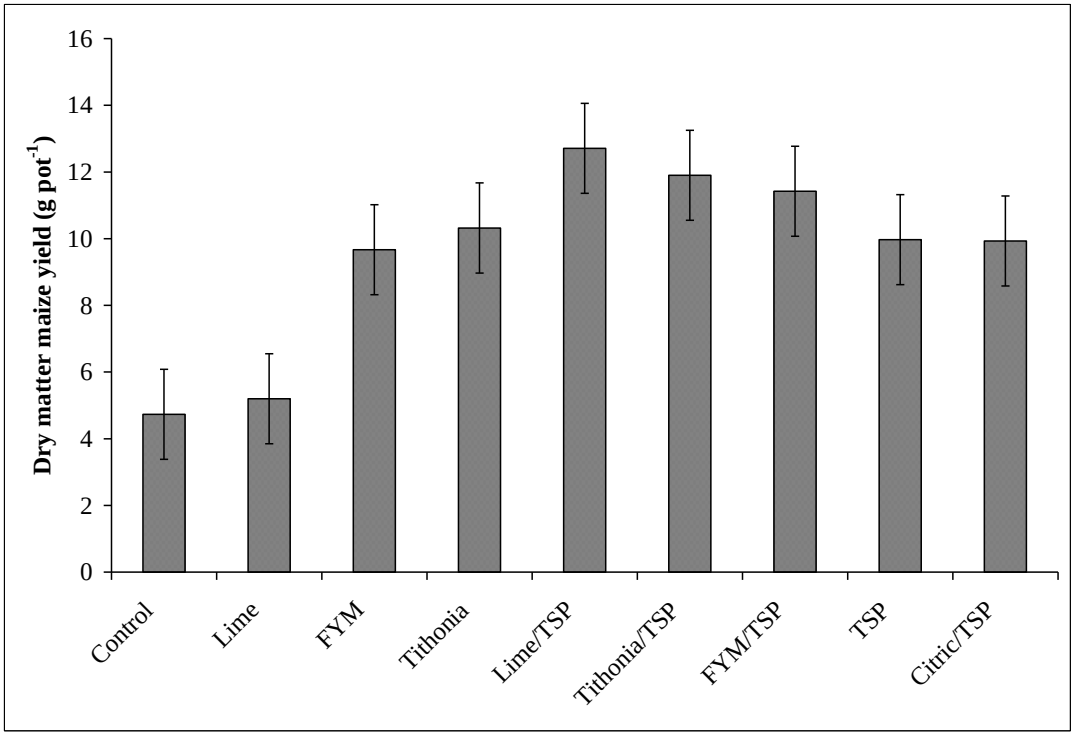

Figure 1*: Dry matter yields of maize as influenced by organic and inorganic inputs*

There were few significant correlations between the measured soil properties and the P uptake by maize when all the treatments were included in the correlation analysis (data not shown). Excluding the treatments with no P inputs, i.e. the control and Lime alone treatments, from the analysis greatly improved the correlation between the pH, exchangeable acidity and Al with P uptake, but that of Olsen P with P uptake declined (Table 2). In general, the P uptake increased with declining exchangeable Al as indicated by a high negative correlation (r = -0.96) between exchangeable Al and P uptake.

Table 2: *Coefficients of determination (r^2) and regression equations relating dry matter yield of maize in the pot experiment to measures of selected soil properties.*

Variable	**(r^2)**	**Regression equation**
pH (only treatments with P inputs)	0.52	P uptake = 3.11 x pH + 3.7
Olsen P (treatments with P inputs only)	0.02	P uptake = 0.05 x Olsen P + 10.8
Exch. acidity (treatments with P inputs only)	0.69	P uptake = -14.23 x exch. acidity + 119
Exch. Al (treatments with P inputs only)	0.92	P uptake = -11.95 x exch. Al + 14.89

Discussion

The increase in pH due to lime was expected and is well documented. The increase in soil pH due to application of FYM can partly be attributed to the high pH of the FYM (7.7). Other mechanisms have been described be Tang *et al..*, 2007. The failure of tithonia to significantly increase the soil pH likely due to the low rate 5 t ha^{-1} applied. The reduction in exchangeable acidity and Al can partially be attributed to increase in soil pH by FYM or lime which precipitates exchangeable and soluble Al as insoluble Al hydroxides. Other mechanisms that involve complex formation with low molecular weight organic acids produced during the decomposition of the OMs and adsorption of Al onto the decomposing organic residues may also account for reduction in Al by OMs especially tithonia which did not increase the pH.

FYM was more effective in increasing the Olsen P than tithonia likely because it had decomposed and therefore had some of its P in the inorganic form at the time of application unlike tithonia green manure. At the same P rate of 60 kg P ha^{-1}, lime, tithonia or FYM when combined with TSP gave dm that were not significantly different from each other but they significantly out-yielded TSP (applied alone), with higher Olsen P values in the soil. This implies that some other factor was likely to be more important in governing the nutrient uptake in this soil than availability of P. This is confirmed by the correlation analysis which showed that in general, the P uptake increased with declining exchangeable Al as indicated by a high negative correlation ($r = -0.96$) between exchangeable Al and P uptake when only treatments with P inputs were included in the regression analysis suggesting that Al toxicity may have contributed to the lower nutrient uptakes in treatments without lime or OMs. The Al saturation (22%) of this soil was above the critical value of 20% for maize (Farina and Chanon 1991). The application of lime and OMs reduced the exchangeable Al levels in the soils and thus gave higher nutrient uptakes than TSP (applied alone), which was unable to reduce exchangeable Al.

Conclusions

Application of FYM or lime increased the soil pH but tithonia did not. The effectiveness in reducing exchangeable Al followed the order lime > tithonia > FYM. TSP alone failed to increase the pH or reduce Al. Although TSP when applied alone gave the highest amounts of available P, it did not give the dm possibly because Al toxicity was preventing proper utilization of P by the maize plants. A reduction in exchangeable Al by application of OMs or lime led to increased nutrient uptakes. It is concluded that OMs can play the dual role of providing nutrients

and mitigating the deleterious effects of soil acidity and in this respect are therefore likely to be more cost effective than lime, which controls mainly only the soil acidity.

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11. CONTRACTLIE ACTION OF *ADENIA GLOBOSA* ENGL ON MAMMALIAN SMOOTH MUSCLE

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Abstract

The aqueous extract of ***Adenia globisa*** Engl (Passifloraceae) was tested for activity on ***invitro*** preparations of the guinea pig ileum, the guinea pig trachea and the rat uterus. A significant and

dose-dependent contraction was recorded in all the tissue preparations. The effect of some well established smooth muscle stimulants were also determined for comparison, as was some well known antagonists. These results are discussed in relation to the traditional uses of this plant.

Introduction

Adenia globosa Engl. (Passifloracea) is found in many parts of Kenya, Tanzania and Somalia (1, 2). It is a shrub or climber with stems emerging from above-ground tuber of up to 2.5M wide. Many of the ***Adenia*** species are extremely toxic and have been used for homicidal or suicidal purposes or for poisoning wild animals. Nevertheless, several of the species are used in traditional herbal medicine in Eastern and Southern Africa (3-5). In Kenya, it is claimed that a freshly prepared juice of the tuber of ***Adenia globosa*** Engl. is given to cows and goats that have difficulty in giving birth to hasten the process. In the present study we report on and discuss the results on the contractile action of the water extract of the tuber of ***Adenia globosa*** on ***in vitro*** preparations of the guinea pig ileum, the guinea pig trachea and the rat uterus.

Materials and Methods

The plant material was collected from Emali in Machakos district of Kenya and the identity of the plant was established by the East African Herbarium, Nairobi. The succulent tuber was cut into small pieces, dried in the sun and stored in a cool dry place. It was then ground into a powder and extracted with warm water at 80^0 C for 15 min with stirring. The mixture was vacuum-filtered ***in vacuo*** at 40^0 C. to give a brownish and a hygroscopic residue which was stored under refrigeration till use in the experiments.

The Guinea Pig Ileum

A small piece of the guinea pig ileum was set up in an organ bath containing Tyrode solution aerated with a mixture of 95% O_2 and 5% CO_2 and maintained at 37^0 C. The contractions of the tissue were recorded by an oscillograph with a 50g transducer.

The Guinea Pig Trachea

An intact trachea was set up in an organ bath of a capacity of 20 ml containing an aerated (95% O_2& 5% CO_2) Tyrode solution and maintained at 37^0 C. The response of the tissue was recorded by a change in the level of Tyrode solution in a fine bore tube attached to the trachea (6).

The Rat Uterus

Uteri from young virgin rats were used (200-400g). The uterus was first sensitized by giving the animal a sub-cutaneous injection of oestradiol (0.1 mg/kg) 24-48 hr before sacrifice. A small piece of the uterus was set up in an organ bath containing De Jalon solution maintained at 32^0 C and aerated with a mixture of 95% O_2 and 5% CO_2. The contractions of the uterus were recorded using an oscillograph with a 50g transducer.

Drug Addition

After the tissue had stabilized, a small volume (maximum 1.0ml) of distilled water containing an accurately known concentration of the drug preparation was introduced into the organ bath and the response of the tissue recorded. When an adequate response had been obtained, the organ bath was rinsed thrice and refilled with the solution. The tissue was allowed a 3 min rest before the next addition of the drug; but when antagonists were used, the tissue was allowed to rest for 60 min. To determine the effect of two the drugs, the first drug was allowed a contact time of 1 min before addition of the second drug.

Results

The crude drug preparation caused a significant and dose-dependent contraction of all the tissues tested. In each case, the contractile response at each dose of the drug is expressed as a percentage of the maximum response for each tissue while the concentration of the drug is expressed as mg/ml of the solution in the organ bath of a capacity of 20 ml. Each result is a mean of 3-4 animals.

The Guinea Pig Ileum

The contraction of the guinea pig ileum was dependent on the extract concentration**.** Similar results were obtained for acetylcholine, histamine and prostaglandin F2α which were done under the same experimental conditions for comparison. These drugs are well known to cause

contraction of smooth muscles.The contractile action by the extract was potentiated by small doses of prostaglandin F2α; but not by acetylcholine and 5-hydroxytryptamine. Secondly, the action was antagonized by atropine and mepyramine in a dose dependent manner. It was interesting to observe that the extract and nicotine combination produced antagonistic effect.

The Guinea Pig Tracheae

Similarly, the extract caused a dose-dependent constriction of the guinea pig trachea**.** The constriction of the guinea pig trachea by various doses of the extract was measured at 1 min intervals for 6 min. The constriction of the trachea was dependent on both the dose of the drug and contact time. A similar result was obtained for different doses of histamine. Histamine, a well established bronchoconstrictor was tested for comparison. Increasing concentrations of histamine measured at 5 min contact time gave rise to tachyphylaxis. This phenomenon was not observed with extract concentrations under similar conditions.

The Rat Uterus

The extract preparation caused a dose dependent contraction of the rat uterus.

Discussion

The results obtained in this study clearly demonstrate that the crude extract of ***Adenia Globosa*** has a contractile effect on the smooth muscle of guinea pig ileum, trachea and the rat uterus. The results showing antagonism by atropine and mepyramine suggest an involvement of cholinergic and histaminergic system in the mechanism of action of the plant extract. However the crude drug preparation failed to display tachyphylaxis on the guinea pig trachea and lacked additive effect with acetylcholine on the guinea pig ileum suggesting a difference in pharmacodynamic profile. It was also notable that the contractile action was antagonistic with that of nicotine. Moreover, the contractile action of the extract was potentiated by small doses of prostaglandin F2α. Taking all these results together, it is evident that further work is required to elucidate the mechanisms involved.

We have reported elsewhere that the contractile action of crude extract of this plant preparation on the rat uterus was potentiated by small doses of oxytocin, ergometrine and prostaglandin F2α;

and that the action was not antagonized by atropine (7). It is therefore interesting that atropine, as mentioned above, antagonized the action of the extract on the guinea pig ileum suggesting that it may be acting via different mechanisms in the two tissues. It can be postulated that the contractile action on the rat uterus observed in the present study is probably responsible for speeding up birth process in domestic animals as mentioned in the introduction. The traditional use of this plant is therefore scientifically justifiable.

Conclusions and Recommendations

In conclusion, the results obtained from this preliminary study clearly show that ***Adenia globosa*** Engl. appears to contain principle(s) causing a contraction of the smooth muscles of the ileum, the uterus and the trachea. The identity of the active compound(s) and their mechanism of action, to our knowledge remain to be elucidated. Further work is therefore required to isolate and identify the active ingredients to elucidate their mechanisms of action and to investigate their potential for pharmacological or clinical application, if any.

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12. DETECTION OF BEGOMOVIRUSES INFECTING SWEET POTATO IN KENYA BY POLYMERASE CHAIN REACTION

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Abstract

Begomoviruses infection of sweet potato (*Ipomoea* spp.) acquired from Kenya chief sweet potato growing regions is common. Graft inoculation of the indicator host, *Ipomoea setosa*, is the accepted detection method for these viruses, but the assay is laborious and requires up to 5 weeks. When infected, sweet potato is subjected to tissue culture methodologies such as meristem tip culture to eliminate these viruses but the eradication rate is low. In this study, a polymerase chain reaction detection assay was optimized for the detection of Begomoviruses in a variety of samples collected in different regions. A cetyltrimethylammoniumbromide method was evaluated to extract nucleic acids suitable for amplification. Nucleic acid extracts of the expected sizes were amplified from infected plants using degenerate primer SPG-1 and SPG-2 and specific primers Specific primers were SPB1&2, PW 285-1 and PW 285-2. However, the best result was obtained with degenerate primers SPG1/SPG2, which detected 70% in western and Coastal region. Polymerase chain reaction was shown to be a reliable method for virus detection.

Keywords: *Begomoviruses, DNA extraction, Ipomoea, degenerate primer, polymerase chain reaction.*

Introduction

Sweet potato, *Ipomoea batatas* (Convolvulaceae) is an important global food crop (Woolfe, 1992). Based on analysis of morphological characters of sweet potato and the wild Ipomoea species, the centre of origin of *I. batatas* was thought to be somewhere between the Yucatan Peninsula of Mexico and the mouth of the Orinoco River in Venezuela (Austinet al.,1987). It is among the most important food crops in the world and is ranked seventh based on total production and the fifth most important crop in developing countries. Sweet potato is a valuable source of vitamins and other micronutrients, especially its storage roots, which contain carotenoids the precursor for vitamin A. It is often crucial during famine due to its rapid production of storage roots following the onset of rains and this makes it a good food security crop in marginalized areas.

The crop does well in less fertile land and demands few inputs, making it affordable for resource-poor farmers. Sweetpotato is an extremely important food crop for subsistence farmers in the relatively humid areas of sub-saharan Africa, from the coastal west to the central and southern areas of the continent (Anonymous, 2007). The crop has been an important staple food for consumption and income generation for smallholder farmers in Kenya (Horton, 1988, Carey, 1996). Despite its high potential for food security, production of sweet potato is constrained by pests and diseases (Carey et al., 1997; Karyeija et al.1998; Gibson and Aritua, 2002; Aritua et al.,2007). Weevils are ranked second in infestation and causing yield reduction (Geddes, 1990). Currently, several sweetpotato viruses have been identified and confirmed to be widely distributed in East Africa.

In surveys carried out in Kenya four groups of sweetpotato viruses have been detected in Kenya (Ateka et al., 2004). These comprise of the potyvirus, Sweet potato feathery mottle virus (SPFMV), the crinivirus Sweet potato chlorotic stunt virus (SPCSV), the ipomovirus Sweet potato mild mottle virus (SPMMV) and the Carlavirus Sweet potato chlorotic fleck virus (SPCFV) (Aritua et al., 2003). Begomoviruses have become one of the most important group of plant viruses in tropical and subtropical regions, that lead to devastating yield losses of many crops, including bean, cassava, cotton, cucurbits, and tomato (Otim-Nape et al., 2000). Sweet potato leaf curl virus (SPLCV) is a begomovirus which has been reported infecting sweetpotato in different parts of the world. It is transmitted by B-biotype of the whitefly *Bemisia tabaci*

(Gennadius) and other members of the Bemisia complex species (Oliveiraet al., 2001). However, the potential importance of sweet potato begomoviruses has been overlooked. Developing a control program for SPLCV is made difficult by the fact that symptoms are rarely expressed in infected plants, and when they do, the symptoms are transient (Valverde et al., 2007). In other places viral genotypes that do develop characteristic upward curling symptoms generally do this only during warm periods of the year and may require the presence of other viruses for it to show (Clark et al., 2002). This type of virus (Sweet potato leaf curl virus) was first reported in Taiwan and Japan (Chung et al. 1985; Osaki and Inouye, 1991).

In Kenya, the virus has been confirmed and reported in western region (Miano et al., 2006). The distribution of SPLCV in Kenya is still limited, thus limiting development of a suitable crop protection programme. To overcome disease diagnosis limitations associated with observing of symptoms, the use of polymerase chain reaction (PCR) adopted from other parts of the world and optimized for use in Kenya. Here we report on the optimization of PCR technique for use in screening sweet potato for the presence of begomoviruses infecting sweetpotatoin Kenya.

Materials and Methods

Sweetpotato materials used were a collection of sweetpotato initially collected from different parts of the country in previous studies.Kenya agricultural Research Institute (KARI) Biotechnology Centre for establishment in an insect proof screen house. The plants were first inspected for any expression of symptoms and then used for DNA extractions.

DNA Extraction.

Leaves were collected from the plants in the screen house by cutting a small portion in a polythene bag. DNA was extracted using cetyltrimethylammoniumbromide (CTAB) extraction buffer (3% CTAB, 1% polyvinylpyrrolidone, 100 mM Tris-HCl, pH 8.0, 1.4 M NaCl, 0.5M EDTA, and 0.17% 2-mecaptoethanol). Leaves of about 30mg were homogenized in a mortal and pester; homogenate was incubated in water bath at 65°C for 10 min with gentle shaking. Equal volume of chloroform: isoamyl alcohol (24:1) was added then inverted twice to mix.

The mixture was centrifuged at 12,000rpm for 10 min and the supernatant (500 µl) was transferred into a 1.5-ml micro centrifuge tube containing 700 µl of chilled isopropanol and

inverted once. The mixture was incubated on ice for 10 min and centrifuged at 12,000 rpmfor 15 min.The pellet was washed with 70% ethanol and centrifuged at 12,000rpmfor 5 min. Pellet was air dried and dissolved in 50 µl free molecular grade water(Fisher scientific, PA,USA).

Primers in PCR Sweet Potato Leaf Curl Virus Detection

Specific and degenerate primers were used to detect SPLCV; Specific primers were PW 285-1/ PW 285-2 were used to amplify a fragment of the conserved sequences within ORF AC1 (Lotrakul et al 1998).While the SPB- 1/SPB2 was used to amplify the coat protein gene {AV1} Gutierrez, (2008). Degenerate primers SPG1/SPG2 were used to amplify regions of the open reading frame (ORF) AC2 and ORF AC1, Li et al (2004).The amplifications were performed on a Gene Amp PCR system 9700(APPLIED BIOSYSTEM) in 25-µl reaction mixtures containing 2 µl of the DNA extract, 0.5 µl of each primer (10 µM), 0.5 µl of 10 mM dNTP mix, 1.6 µl of *Taq* DNA polymerase (BIOLABS USA), 2.5 µl reaction buffer, 2.5 µl of 25 mM MgCl2, 0.2 µl, and 16.34 µl of molecular water.PCR conditions used were as follows: (94°C for 1min, 94°C for 1min, 55°C for 1 min,72°C 3 min),45 cycles and 72°C for 10 min. PCR products were assessed by electrophoresis in 1% agarose gels in TBE (Tris, boric acid, EDTA) buffer (0.9M Tris, 20 mM EDTA, 0.9M boric acid, and pH 8.0), stained with ethidium bromide, and viewed under ultraviolet light.

Results

The samples collected were showing various symptoms includes-, mosaic, curly leaf, yellowing, vein clearing, stunting, upward cupping, reduced leaf size, and chlorotic leaf after greenhouse establishment. A total of 25 samples were used in optimization after which 495 of samples under sturdy were subjected to PCR detection using Specific and degenerate primers were used to detect SPLCV, Specific primers were SPB1&2, PW 285-1 and PW 285-2 degenerate primer SPG-1 and SPG-2 respectively.In western region 37 samples were positive with degenerate primer SPG-1 and SPG-2, 34 samples were positive with SPB1 and SPB2 and 60 samples were positive with PW 285-1 and PW 285-2. Central region there was no sample that was positive with degenerate primer, 8 samples were positive with SPB1&2 and 2 samples were positive with PW2851&2. Coastal region had the highest respond where 110 samples were positive with SPG-1 and SPG-2 and 32 samples positive with SPB1&2 and 21 samples were positive with

PW2851&2. To increase the sensitivity and detection range, degenerate primers SPG1/SPG2 and Specific primers SPB1&2, PW 285-1{forward} and PW 285-2 {reverse} were compared in PCR assays and found to be highly sensitive, for instance in central region degenerate primer did not respond to any infection but after subjecting to specific primers SPB1&2 turned out to be highly sensitive followed by PW2851and 2.Three PCR assays were carried out on a DNA extracted from a plantlet infected with SPLCV.

Polymerase chain reaction results

Agarose gel electrophoresis results

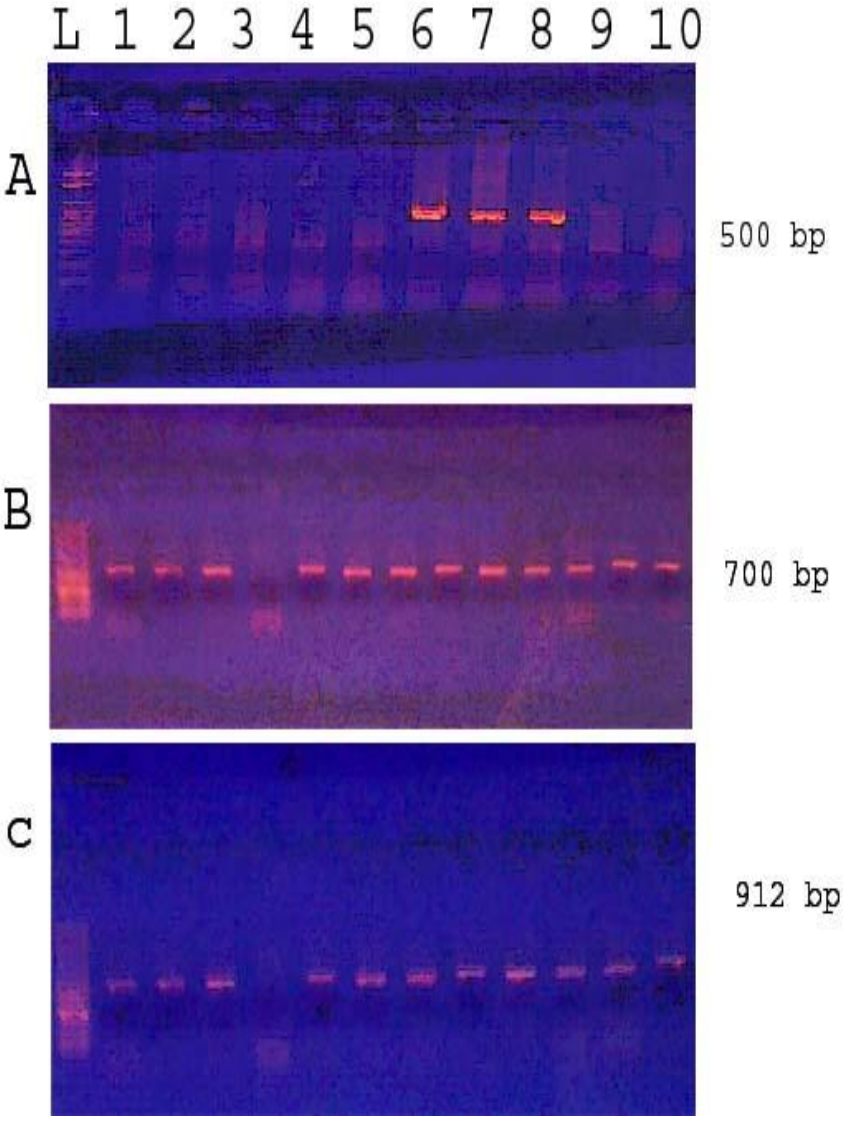

Figure: 2:*Polymerase chain reaction (PCR) products from coast,western and central region amplified from dilutions of the DNA extracted from.Sweet potato infected with SPLCV Lane 1, 1-kb DNA ladder; lane 8 positive control lane 3 negative control, with a concentration of 50ng/ µl). Primers were* ***A,****PW285-1/PW285-2,****B,****SPB1&2, and* ***C,****SPG1/SPG2.****A,****500-bp,* ***B,****700-bp, and* ***C,****912bp.*

Discussion and conclusion

Due to its nutritional qualities, sweet potato (*Ipomoea batatas* (L.) Lam) is considered as a crop with great potential to alleviate food security concerns in Kenya. Yields of sweet potato cultivars have appeared to gradually decline over the years. Several factors such as viral infection are involved in yield reductions. However Sweet potato begomoviruses could be a problem for quarantine and seed foundation programs in Kenya because infected plants are symptomless. Therefore, sensitive methods for their detection and identification are very important. Methods available to detect SPLCV include graft inoculations to indicator hosts (*I. setosa, I. nil, I. aquatica*), and molecular hybridization (Valverde et al., 2008). Serological detection of SPLCV from crude sap extracts, which can be agreat use for diagnosticians in developing countries, is not currently available due to the lack of an antiserum specific for SPLCV. Attempts to purify the virus for antiserum production have not been successful. PCR using both degenerate and virus-specific primers also has been used for virus detection and identification in indicator plants (Lotrakul *et al.,* 1998).

Despite the use of the above techniques for virus detection in infected plants, they have not been used in Kenya for serious detection of begomoviruses since reported by (Miano et al., 2006). In this study, we report the successful application of PCR to detect the presence of SPLCV in greenhouse samples collected in sweet potato growing regions in Kenya. Primers amplified PCR products of different base pairs infecting sweet potato, regardless of geographic Origin of the plant material. Variation at the primer regions among these isolates was low despite the central region where no samples was detected by degenerate primer but responded to specific primers according to table 1.SPG1/SPG2 were more sensitive than the other primer pairs tested in the PCR assays degenerate primers have been used extensively in identification and detection of geminiviruses (Rojaset *et al.,* 1993). Degenerate primers SPG1/SPG2 anneal to regions of ORFs

AC2 and AC1 which are highly conserved in geminiviruses infecting sweet potato and other begomoviruses. They amplified PCR products not only from Begomoviruses infecting sweet potato, but also from other Begomoviruses as per our results. According to our findings the degenerate primer amplified other products despite the SPLCV; this is seen in Coastal region where 110 begomoviruses were detected. The high sensitivity and broad detection range of these primers make them the best choice for general use in PCR-based detection. To specify the presence of Begomoviruse of interest, the tested samples in procedure was repeated with specific primers SPB1&2, PW 285-1{forward} and PW 285-2 {reverse} gave an average of 3.2 detection. The specific primers annealed the nucleotide sequences in coat protein gene AV1and ORFs AC2. The high occurrence of Begomovirus in Kenya could be related to the practice of farmers using vines from their existing gardens as planting materials, and without sanitary control as a result facilitating spread of the disease. The developed detection methods will be used to determine the distribution of SPLCV in the different sweetpotato growing regions of Kenya.

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13. IMPACT OF COMPACT FLUORESCENT LIGHTING BULBS ON POWER QUALITY

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Abstract

This paper presents a study carried on effects of Compact Fluorescent Lighting (CFL) bulbs on the power quality supplied by the power utility. In recently time, the power utilities are retrofitting the incandescent bulbs with CFL bulbs with aim of reducing the peak demand of National grid. The CFL bulbs is known to consume less power (80% less) viz- á- viz the counterpart bulbs. This has contributed to enhancement of security of energy supply by reducing the power outages, thermal emission reduction (green power) and decrease of technical losses in the power system network. However, it has been established that CFL bulbs have both positive and negative effects on the power quality. Thus the study was carried to establish these effects on power quality. From the study, it has been established that use of CFL bulbs is advantageous in that they contribute to energy saving and improve the voltage profile of the power system for having a low leading power factor. It is worth noting that CFL bulbs have disadvantage of introducing harmonic current distortions on the power system. The study also established that, current waveform is improved significantly by having a resistive load/s in CFL bulbs circuit.
Keywords: *CFL bulbs, Incandescent bulbs, power factor and harmonic current distortions*

Introduction

Due to increase of power demand and increase of cost of power generation, most of power utilities are advocating use of Compact Fluorescence Light (CFL) bulbs as one of the method of managing the available power to enhance security of energy supplies. The bulbs are able to consume less power by up-to 80% of the lighting energy and can last 10 times than the ordinary bulbs (incandescent bulbs). In recent time, the power quality has attracted a lot of attention due to extensive emphasis by power utility to improve on the power system efficiency and end users awareness of power quality issues. This has occurred mainly due to the deregulation of the power distribution and sensitivity of the modern equipment. In addition, there are usually massive losses both to power utility and end users due to poor power quality supplies which fall below the set standards. Power quality primarily constitutes of voltage dip/ swell, power system interruptions (power outage), harmonic distortions, voltage flickers and frequency deviations. Research which was conducted by Georgia Power Company (2001) on both power utility and power customers, revealed that power outage caused myriad complains from the customers seconded by harmonic distortions which was raised by both parties. The purpose of this paper is to determine the effects of the phasing out of incandescent lamps and retrofitting with more

energy efficient CFL bulbs on power quality. The CFL bulbs are technologically developed from conventional fluorescent lamps. They differ mainly from size and they can directly fit into normal light socket holders. The study focuses on the harmonic distortions and reactive power generated by the CFL bulbs and the effects they have on the power system. The CFL bulbs are inherently associated with low leading power factor (0.5 -0.65) and high harmonic distortions as compared with incandescence bulbs as they withdraw current in non- sinusoidal waveform.

Methodology

The study was carried out using 10 numbers CFL bulbs sampled from the market of each 8 Watt. A working reference equipment (MT310) of accuracy class 0.05 was used to record the instantaneous active power, reactive power, total power, power factor and harmonic distortions values. Incandescent bulbs, 10 numbers of rating 40 Watt were used for the study. The bulbs were connected in parallel on wooden board and supplied with 240 V. The recorded data were as depicted in the figures below;

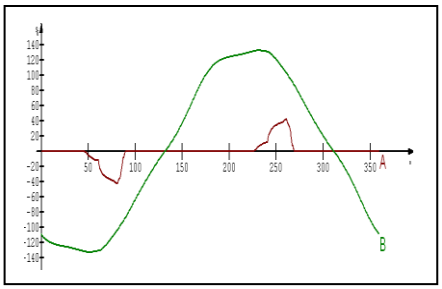

Fig.1. CFL bulb Current and voltage waveforms

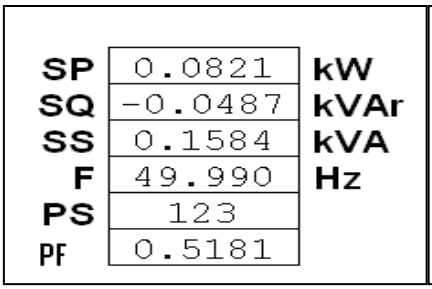

Fig.2. CFL PF and reactive power

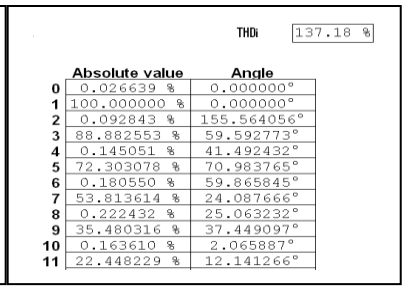

Fig. 3. CFL Harmonic order levels

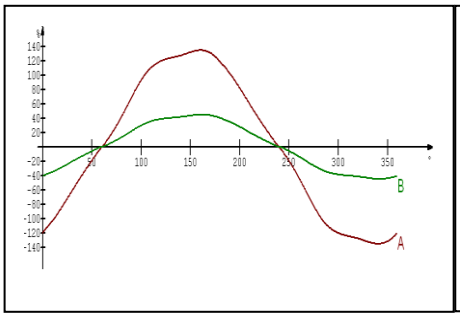

Fig. 4. Incandescent bulbs current and voltage waveforms

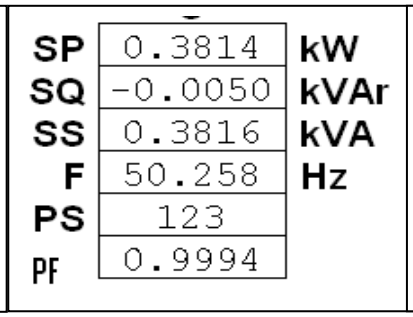

Fig. 5. Incandescent bulbs PF and reactive power

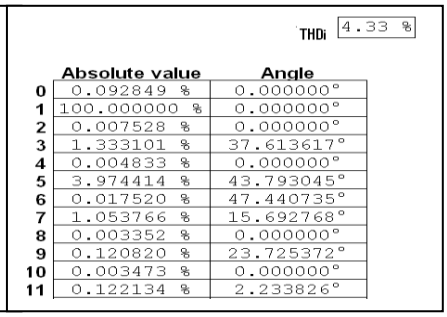

Fig. 6. Incandescent Harmonic order levels

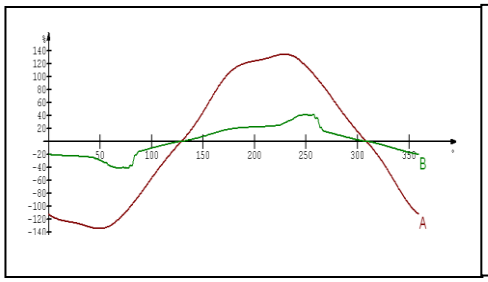

Fig. 7. Combined bulbs current and voltage waveforms

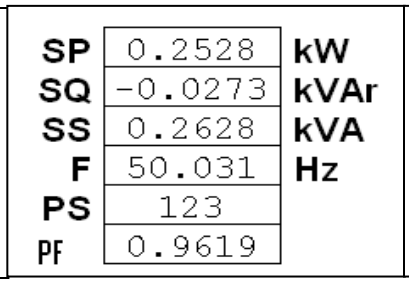

Fig. 8. Combined bulbs PF and reactive power

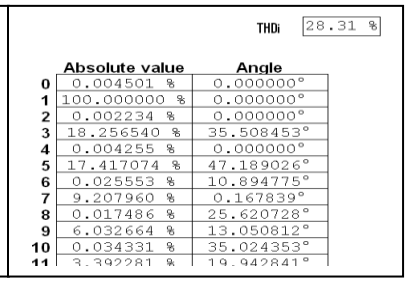

Fig. 9. Combined Harmonic order levels

Combined: Combination of 5nos. CFL bulbs and 5nos. incandescence bulbs

Data analysis

From the data collected, it is observed that CFL bulbs generate high reactive power hence low leading power factor. Due to non-sinusoidal current waveform, CFL bulbs generate substantial odd harmonic current distortions and consequently high current Total Harmonic Distortion (THDi) which is given by $\frac{\sqrt{\sum_{h=2}^{h} I_h^2}}{I_1}$x100% (*where I_1 is fundamental current amplitude).*

Apparently, due to their low power rating, the current Total Demand Distortion (TDDi) which is given by $\frac{\sqrt{\sum_{h=2}^{h} I_h^2}}{I_r}$x100% (*where I_r is the rated current*) is relatively low hence does not cause severe effects on the power system. Worth to note is that, combination of CFL and incandescent bulbs improve considerably the power quality (increases PF and reduces the harmonic distortions) as shown in figures 7,8 and 9.

The results obtained from the 10nos. CFL bulbs used for the study, the following can be deduced;

Individual bulb leadings PF contribution = **0.51** (*from figure 4*)

Individual bulb reactive power contribution = $\frac{48.7}{10}$ = **4.87** VAr (*from figure 5*)

Individual bulb total harmonic current distortion contribution = $\frac{137.5}{10}$ =**13.75%** (*from figure 6*)

Conclusions

The followings are the summary of the study carried out;

ii) The CFL bulbs are more efficient vis – á – vis incandescent bulbs on lighting power (uses less power and give more light)

iii) The total current drawn by the CFL, almost 50% are reactive and harmonic currents.

iv) The generated reactive power by CFL bulbs can be used by inductive loads such as fan, fridge, and air conditioners hence improving the resultant system power factor and voltage profile

v) Presence of resistive loads is found to improve the quality of the power supplying the CFL bulbs

Recommendations

i) The utility can be recommended to ensure that the CFL bulbs imported meet specific threshold of power factor and total harmonic current distortions (THDi)

ii) Pure CFL bulbs in any installation should be discouraged. It can be recommended to have other resistive loads to improve the power supplied at point of common coupling.

Acknowledgment

I do wish to thanks the NCST for providing research money to carry out the study. I also pass my regards to my supervisors Prof. Nderu and Dr. Ngoo for their contributions toward the success of this study. Finally my Creator for giving me good healthy and sober mind.

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14. EFFICACY OF THE *Anopheles gambiae* PREDATOR THE DRAGONFLY NYMPHS IN THE MANAGEMENT OF MALARIA.

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Abstract

Dragonfly nymphs are efficient predators of *Anopheles gambiae* larvae. Results indicated that they predated on a mean of 9.3 larvae out of ten. In laboratory bioasssays. The dragonfly nymphs are thus potential in reducing mosquito populations in the western Kenya highlands.

Key words. *Dragonfly nymphs, Anopheles gambiae,*

Introduction

Controlling vectors at source in aquatic stages can significantly reduce malaria (Shallan *et al*. 2009). In aquatic ecosystems mosquito larvae coexist with a number of arthropods such as

dragonfly nymphs, backswimmers, water beetles, water scorpions, damselfly nymphs, and water striders (Blaustein *et al* . 2007). These arthropods are predators of mosquito larvae and therefore should not be affected by the larvicides in their natural habitats. Previous research studies have shown that diving beetles are predators of mosquito larvae hence can be used to reduce mosquito populations (Lundkvist *et al* . 2003). In their study Quiroz- Martinez in 2007 observed that many aquatic insects feed on mosquito larvae, these insects include dragonflies, backswimmers, damselflies, and water beetles. In a pilot study conducted at Iguhu in Kakamega district, Munga confirmed that backswimmers are predators of *Anopheles gambiae* larvae (Munga *et al.* 2006). From these reports it is evident that aquatic arthropods are important components in aquatic ecosystems and thus need to be protected from any adverse effects of broad spectrum larvicides aimed at controlling mosquito larvae. Field surveys done by (Ndenga *et l*. 2006) documented that dragonfly nymphs were found in large proportions in the western Kenya highlands.

Materials and Methods

Predation experiment

Collection of dragonfly nymphs was conducted at Mahanga in Vihiga district which has been used for extensive ecological studies in western Kenya. The study area has been previously described by (Ndenga *et al*. 2011) as flat bottomed, with many natural swamps characterized by valleys, flowing streams and surrounding hills.

The dragonfly nymphs were collected from mosquito breeding habitats. Twenty ice cream containers one litre capacity were filled with filtered tap water. One dragonfly nymphs was placed in each container using a sieve. Ten *Anopheles gambiae* third instar larvaewere introduced in each container using a pipette. Turfs of nut grass were introduced in each container to provide ideal aquatic habitats for dragonfly nymphs. The container was covered with anet to prevent the dragonfly nymphs from crawling away. The number of *Anopheles gambiae* larvae eaten by the dragonfly nymph was counted after every 24 hours. Fresh batches of larvae were added each day for five day.

Results

Predation efficiency of the dragonfly nymphs on An. gambiae larvae

Predation assessment of dragonfly nymphs on *An. gambiae* third instar larvae confirmed that a mean of 9.3of *An. gambiae* were eaten by the dragonfly nymphs. In each experiment 200 *Anopheles gambiae* larvae were used and 93.3%, 95% and 95% of larvae were eaten after 24 hours respectively.

Table 1. *Percentage and mean number of An. gambiae predated upon by dragonfly nymphs*

Experiment	24 HRS	48 HRS	72 HRS	Total larvae eaten	Larvae dead	Total larvae per tray
DAY 1	181(93.3%)	9 (4.6%)	4 (2.1%)	194	6	200
DAY 2	189 (95%)	8 (4.0%)	2 (1.0%)	199	1	200
DAY 3	190 (95%)	10 (5.0%)	0 (0%)	0	0	200

Average larvae eaten per day =9.3

In day one of the experiment, after 24hrs exposure of the *An. gambiae* larvae to the predator, only 93.3% were predated upon. After 48hrs the remaining 4.6% were predated upon and after 72hrs 2.1% were predated upon. Out of the 200 larvae that were exposed only 194 were predated upon but six larvae died.

In day two of the experiment, after 24hrs exposure of the *An. gambiae* larvae to the predator, only 95% were predated upon. After 48hrs the remaining 4% were predated upon and after 72hrs 1% was predated upon. Out of the 200 larvae that were exposed only 199 were predated upon but one larvae died.

In day three of the experiment, after 24hrs exposure of the *An. gambiae* larvae to the predator, only 95% were predated upon. After 48hrs the remaining 5 % were predated upon and after 72hrs all the larvae were predated upon. Out of the 200 larvae that were exposed all the 200 were predated upon.

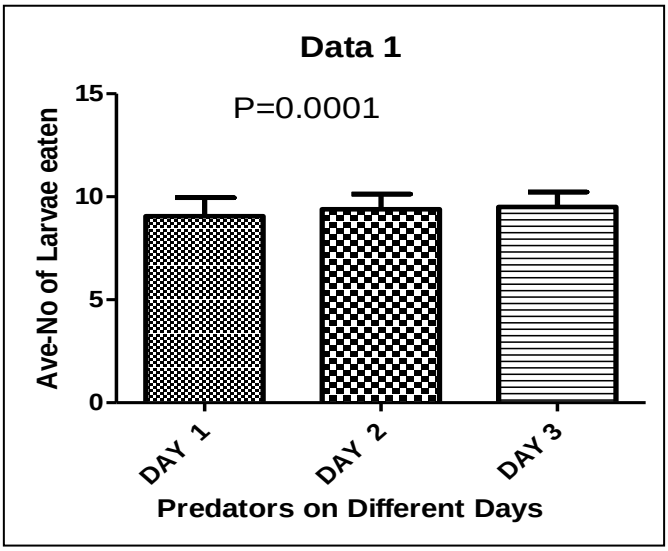

Figure.1: *Mean number of An. gambiae predated upon*

The figure represented above shows mean number of *Anopheles gambiae* larvae predated upon in each day of exposure to the dragonfly nymph. Ten larvae were put in each tray containing one dragonfly nymphs and a mean of 9.3 larvae was predated on.

Discussion

The predation experiment demonstrated that dragonfly nymphs are efficient predators of *An. gambiae* larvae. The purpose of this study was to determine the predation efficiency of dragonfly on mosquito larvae. In the western Kenya highlands valley bottoms there are plenty of adult dragonflies flying in the valleys. This is an indicator that they have abundant food source. During field collections, it was found that the densities of dragonfly nymphs were higher as compared to other predators like backswimmers and aquatic beetles. Dragonfly nymphs are found in swamps characterized with grasses such as nut grass, papyrus, with slow moving to still water. They co-exist with other arthropods predators like tadpoles.

Among the various natural ecological forces controlling vector populations size, predation on immature *An. gambiae* appears to be a major factor controlling population size. Predation on An. gambiae contributes considerably (between 13.4 and 84.5 % to overall larval mortality (between 92.6 and 97.1 %) (Ohba *et al*, 2010). In search for alternatives in the fight against mosquitoes, biological control could provide ecologically acceptable reductions if suitable biocontrol agents become available (Quiroz-Martinez et *al*, 2007).

Odonates are generalists and voracious predators that detect their prey by means of compound eyes and mechanoreceptors and suddenly capture them with the labium or palps. Mechanical stimuli have a predominant role in predation (Rebora *et al*., 2004).

Conclusion

Malaria is a serious problem in the western Kenya highlands. Many control interventions have been done but with less success. The use of natural enemies to predate on mosquito larvae is a step in the right direction. The use of the dragonfly nymphs to control rapid proliferation of malaria vectors will go along to help fight malaria in the endemic area of western Kenya.

Acknowledgement

Iwould like to appreciate my supervisors Prof. Elizabeth kokwaro of Kenyatta University, andDr. Bryson Ndenga of KEMRI Kisian for their support during the research process. Many thanks also go to Mr. Mulaya, Mr. Aswani and Joan shiroko for their assistance in this study.

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15. EMBRYOGENIC CALLUS INDUCTION AND PLANT REGENERATION FROM IMMATURE EMBRYOS OF TROPICAL MAIZE GENOTYPES

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Abstract

Genotype independent embryogenic calli were induced from immature zygotic embryos of maize (*Zea mays* L.) inbred lines CML 216, CML 144, A 04, E 04 and TL 21 12 days after pollination on MS medium supplemented with 1 to 5 mg/1 of the growth regulator dicamba. The optimal concentration of dicamba for induction of embryogenic callus in all the genotypes was 3 mg/l. The frequency of embryogenic callus induction ranged from 34–79%, with CML 216 having the highest frequency at this optimal concentration of dicamba. Somatic embryos obtained germinated plantlets produced normal R_1 progeny. This regeneration method is expected to facilitate the development of a more efficient *Agrobacterium* mediated transformation system for the genotypes reported in this study.

Introduction

Plant regeneration from tropical maize tissue has mainly been overwhelmingly obtained from immature zygotic embryos (Anami et al., 2010, Leta et al., 2012). This is because immature zygotic embryo-derived callus is more embryogenic and efficient for plant regeneration than calli from other explant tissues (Ombori et al., 2008). Callus induction and plant regeneration in tropical maize genotypes is done on media supplemented with 2,4-D where the response has always been genotype dependent. Genotype independent embryogenic callus induction and plant regeneration in five well adapted maize genotypes using dicamba is reported in this publication.

Materials and Methods

Plant Material

Five well adapted tropical inbred lines, CML 216, CML 144, E 04, A 04 and TL 21 were used in the study. Inbred lines CML 216 and CML 144 seeds were obtained from CIMMYT (Kenya) while locally adapted inbred lines A 04, TL 21 and E 04 were supplied by Dr. G. A. Ombakho of Kenya Agricultural Research Institute (KARI) (Nairobi, Kenya). The tropical genotypes were grown under field conditions at Kenyatta University (Nairobi, Kenya). Plants were self-pollinated and whole ears were collected 12 days following pollination as described previously (Anami *et al*., 2010). Harvested cobs were aseptically prepared for tissue culture as prescribed by Anami *et al.* (2010).

Callus Induction

Callus induction media (CIM) consisted Murashige and Skoog (MS) basal salts and vitamins (1962) supplemented either with 1, 2, 3, 4 or 5 mg/l dicamba, 0.7 g/l *L*-proline, 30 g/l sucrose, l and 0.85 mg/l $AgNO_3$ andpH adjusted to 5.8 prior to autoclaving at 121^{o}C (108kPa) for 20 minutes. Three replications per treatment was used and arranged in a completely randomized block design. Explants were incubated in the dark at 28^{o}C and after 2 weeks, the number of immature embryos forming embryogenic and non embryogenic callus were visually quantified and recorded. Embryogenic calli were transferred to callus maturation medium (CMM) then regeneration medium (Anami et al., 2010).

Regeneration

Individual clones of calli were transferred to hormone free shoot induction medium (Anami et al. 2010) and cultivated at 28^{0}C with 16-h light/8-h dark cycle. The number of shoots formed was recorded after 1 week. Plantlets were gradually acclimatized and hardened then transferred into 20 litre pots containing soil for development to maturity according to Anami et al. (2010) procedure.

Results

Embryogenic callus induction from immature zygotic embryos was observed in all the five genotypes 5 to 7 days after culture initiation. The scutellum tissue increased in size, and in some

cases within 2 weeks, the coleoptile emerged from the embryo axis side. The embryo axis side also became swollen and developed into an irregular callus mass (Anami et al., 2010).

In all the genotypes, the formation of embryogenic callus increased with increase in dicamba concentration up to 3 mg/l level (Table 1) with the highest percent formation of 74% recorded among inbred line CML 216 tissues. The average embryogenic calli formation was generally highest compared to non-embryogenic calli formation in all the genotypes except for inbred line TL 21. For instance, in genotype TL 21, the number of immature zygotic embryos forming embryogenic callus was also high at 3 mg/l (34%) but this was far lower than the overall non-embryogenic calli formation at all dicamba concentrations (Table 1).

Table 1: *Percentage callus induction in tropical maize genotypes on MS medium supplemented with dicamba. E. Embryogenic calli, N.E. Non embryogenic calli.*

Callus induction in tropical maize genotypes										
	% callus induction ± SE									
	MS + Dicamba (mg/l)									
Genotypes	1		2		3		4		5	
	E	N.E	E	N.E	E	N.E	E	N.E	E	N.E
CML144	45.94±0.49	45.94±1.49	60.97±1.49	36.58±1.49	73.17±0.99	26.82±1.49	54.76±1.49	45.23±0.49	48.71±0.49	51.28±0.99
A04	63.63±2.4	33.33±0.49	67.56±1.49	35.13±0.49	74.28±0.0	28.57±1.99	57.14±0.99	28.57±0.99	52.5±0.49	30±1.99
CML216	67.21±0.33	27.86±0.33	73.77±0.0	21.31±0.33	79.36±0.33	15.87±0.33	65.57±0.66	26.22±0.33	58.33±0.88	33.33±0.33
E04	52.5±0.49	25±0.0	53.65±0.0	21.95±0.49	65.85±0.49	14.63±0.99	53.48±0.49	18.60±0.0	42.22±0.49	24.44±0.49
TL21	22.5±0.49	57.5±0.49	32.55±0.0	44.18±0.49	34.88±0.49	39.53±0.49	23.25±0.0	48.83±0.49	20.45±0.49	50±0.0

Interestingly, in these genotypes, the number of immature zygotic embryos forming non-embryogenic callus decreased with increase in dicamba concentrations up to the 3 mg/l mark after which the number of immature embryos forming non-embryogenic callus increased with increase in concentrations of dicamba. This pattern was not unique to inbred line TL 21 however, only that non-embryogenic calli formation was significantly lower in the rest of the lines compared to embryogenic calli formation (Table 1).

Regeneration

Regeneration started with the appearance of green dots on mature somatic embryos within 4-5 days of incubation under light. Green shoots were formed within 1 week later. Mature somatic embryos produced shoots that coiled at first but eventually emerged into normal shoots. More plants per calli were produced from tissues generated at 3 mg/l dicamba except for inbred line E 04 (Table 2).

Table 2: *Regeneration of tropical maize genotypes from callus supplemented with Dicamba The table shows the number of shoots per calli.*

Shoot induction on calli					
No. of shoots/calli					
Precultivation	Dicamba (mg/l)				
	1	2	3	4	5
Genotypes					
CML144	2'/6	4/7	5/6	2'/6	3'/6
A04	2'/6	3´/6	3´/6	2/5	2/5
CML216	2'/6	5/6	5/6	3'/6	3'/6
E04	2'/6	3´/8	1´/8	1´/8	1´/7
TL21	7'/18	8'/17	6'/10	5'/10	6'/12

Discussion

We report genotype independent optimal somatic embryogenesis on MS medium containing dicamba. In all the genotypes studied, dicamba effectively induced embryogenic calli formation from immature zygotic embryos. The optimal concentration for embryogenic callus induction was 3 mg/l in all the genotypes. Additionally, 3 mg/l dicamba was the concentration at which the number of immature embryos from all the genotypes formed the least non-embryogenic callus. This indicates a new phenomenon in tropical maize tissue culture where embryogenic callus induction and non embryogenic callus inhibition/induction seems to be genotype independent. Suggestively, the effectors and signaling pathways are distinct for the two processes (Gleason et al., 2011).

Tropical maize genotypes therefore vary greatly in embryogenic capacity reflecting differences in their ability to activate key elements/pathways of embryogenesis. Our data shows that at 3 mg/l of dicamba, these key elements of the embryogenesis pathway are uniformly activated in all the genotypes, but these elements and pathways might have an inhibitory effect on non-embryogenesis. Differential transcription is highly suspect.

Conclusions and Recommendations

To our knowledge, this is the first report of genotype independent tissue culture response of immature zygotic embryos in tropical maize genotype. The data presented here is expected to

facilitate the development of a more efficient agrobacterium mediated transformation system for the maize genotype reported in this study.

Acknowledgement

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16. EVALUATION OF AIR AND BLOOD LEAD LEVELS ACROSS THE SELECTED INDUSTRIES IN KENYA: A CASE OF OCCUPATIONAL EXPOSURE

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Abstract

The concentration of airborne and blood lead (Pb) was assessed across the industries in Kenya. Across these plants, a full-shift personal breathing zone air samples that were collected in several production sections showed a highest mean value ± standard deviation (SD) of 183 ± 53.6 µg/m^3 battery recycling. This was followed by battery manufacturing (133 ± 39.6 µg/m^3), steel and scrap welding (126 ± 39.9 µg/m^3), paint (76.3 ± 33.2 µg/m^3), leather and tannery (27.3 ± 12.1 µg/m^3) and the least was from pharmaceutical (5.3 ± 3.6 µg/m^3) plant. All these mean values of airborne Pb exceeded 50 µg/m^3 set by U.S. Occupational Safety and Health (OSHA) permissive Exposure Limit (PEL) 8-hour Time Weighted Average (TWA) except for those of leather and tannery and pharmaceutical plants. Production workers in battery recycling had the highest average blood lead (BPb) level ± SD of 501 ± 96 µg/L), which was followed by those of lead acid battery manufacturing plant (470 ± 76 µg/dL, steel and scrap welding industry (409 ± 86 µg/L), paint industry (361 ± 86 µg/L), leather and tannery (234 ± 75 µg/L) and from a pharmaceutical industry (129 ± 58 µg/L). All the measured BPb levels exceeded 300 µg/L, which is the maximum BPb level recommended by the American Conference Governmental for Industrial Hygienists. Observations made in these facilities revealed numerous sources of Pb exposure due to inadequacies in engineering controls, work practices, respirator use and personal hygiene.In this context, the current study was undertaken to assess airborne Pb and BPb levels among workers across the industries in Kenya. The results obtained from this study will therefore establish the baseline levels of Pb exposure in the targeted workplaces.

Introduction

Occupational lead Pb exposure causes a variety of serious adverse health effects (Were *et al.* 2012). High airborne Pb exposures have been reported in Pb acid battery recycling, manufacturing facilities and steel and scrap welding plants (Gottefeld *et al.* 2011). Kenya, like other developing countries, is transitioning to an industrial economy with minimal attention to controlling occupational health hazards (Odhiambo, 2003). In addition, this country has limited resources for performing Pb analyses in air and biological media (Were *et al.* 2008). The incidence of Pb poisoning is likely to increase among workers in Pb establishments during the phase of rapid industrialization as anticipated in Kenya (Were *et al.*, 2012). It should also be emphasized here that Kenya does not have national workplace standards for permissible airborne Pb exposure and BPb levels (Were *et al.*2012).

Materials and Methods

The research design was a cross-sectional study that involved field surveys and laboratory analysis. The field survey was based on a purposive sampling strategy which was designed to voluntary recruit male subjects who were working in industries in Athi-River or Industrial Area, Nairobi. The survey involved collection and analysing of blood and air from the workers to determine levels Pb due to occupational exposures using standard procedures (Were *et al.* 2012). Ethical issues about this study were sought from relevant authorities.

Results

The results for Pb in air and blood, shown in Figure I and II, respectively. In each production areas of the industry, the table lists the arithmetic mean of the measured values. The lead acid battery recycling facility had the highest level of 183 ± 53.6 $\mu g/m^3$, which was followed by battery manufacturing (133 ± 39.6 $\mu g/m^3$), steel and scrap welding (126 ± 39.9 $\mu g/m^3$), paint (76.3 ± 33.2 $\mu g/m^3$), leather and tannery (27.3 ± 12.1 $\mu g/m^3$) and the least was from pharmaceutical (5.5 ± 3.6 $\mu g/m^3$) plant. All these mean airborne Pb concentrations exceed the 50 $\mu g/m^3$ 8-hour TWA PEL (OSHA, 1978), shown by a blue horizontal line in Figure 3.1.

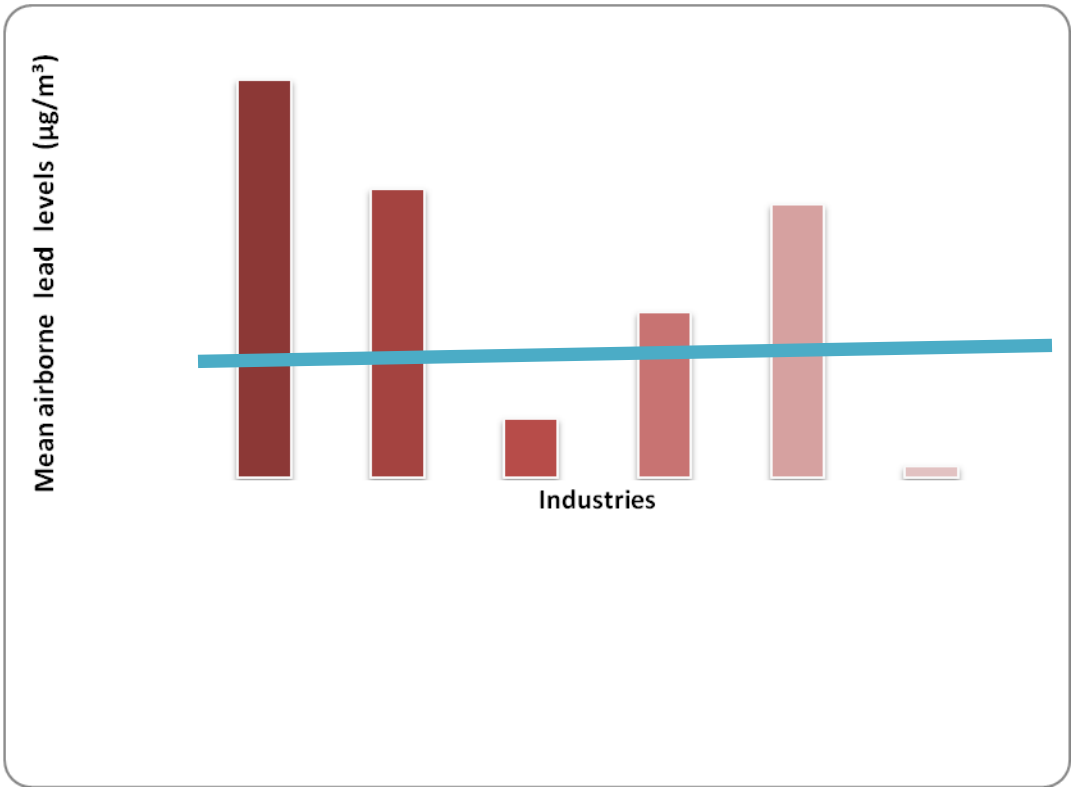

Figure 3.1: *Airborne lead levels across the industries*

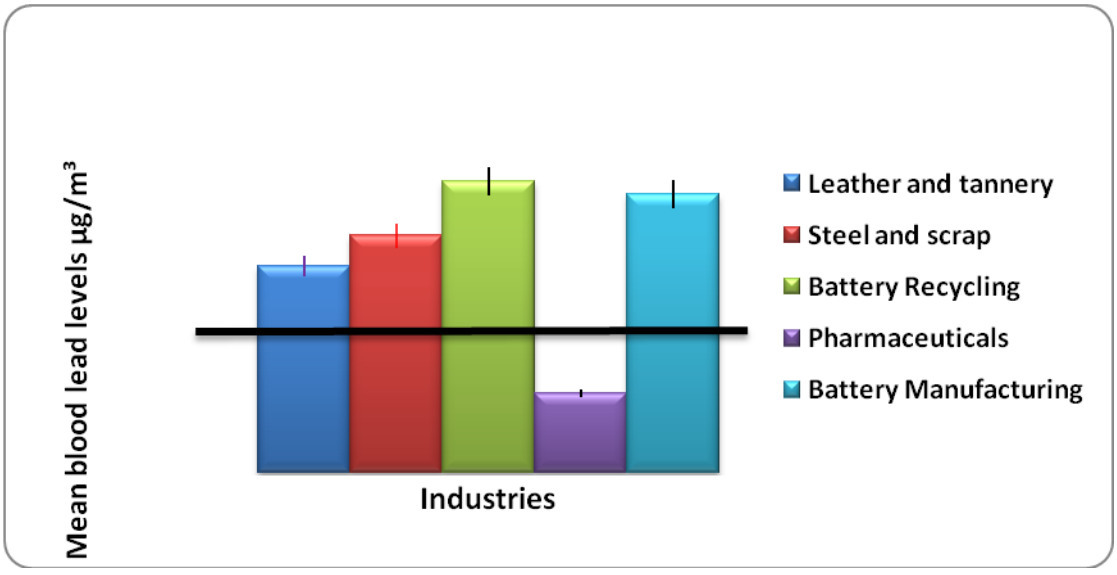

Figure 3.2: *Blood lead levels across the industries*

From results of Figure 3.2, there were variations in the mean BPb level between the workers in the different production areas. The highest BPb level ± SD of 501 ± 96 µg/L) was from battery recycling, which was followed by those of battery manufacturing (470 ± 76 µg/dL, steel and

scrap welding (409 ± 86 µg/L), paint (361 ± 86 µg/L), leather and tannery (234 ± 75 µg/L) and from a pharmaceutical plant (129 ± 58 µg/L). All the mean BPb values exceed the recommended maximum 300 µg/L level set forth in the American Conference of Governmental Industrial Hygienists (ACGIH) Biological Exposure Indices as shown by a black horizontal line.

Discussion

Previous studies have documented high levels of Pb exposure among workers in battery recycling and manufacturing facilities in developing countries (Were *et al.*2012). This study showed that not only did the mean airborne Pb levels exceed the OSHA PEL in all monitored areas except those of pharmaceutical plant, but that the BPb level of every sampled worker exceeded 300 µg/L. Blood lead levels more than 30 µg/L are associated with adverse health effect. Kosnett et al. (2006) recommend the medical removal of Pb-exposed workers if a single BPb concentration exceeds 300 µg/L until the levels fall below this criterion value.

All production workers in both lead acid battery recycling and manufacturing plants had the filtering-facepiece respirators. It therefore expected that when respirators are utilized appropriately they should be able reduce the average inhaled Pb concentrations. From these results it is obvious that inhalation exposure was substantial for production workers in both plants. A walk-through survey in these plants revealed that there was no respiratory protection training programs for the workers and as a result there was inadequacy in respirator use. In general, the visual observations made in the these plants showed that that the engineering controls, work practices and personal hygiene measures, along with respiratory protection use, were inadequate to minimize Pb exposures.

Recommedations and Conclusions

This study provides a baseline of the Pb exposure levels in a battery recycling and a battery manufacturing plant in Kenya. We believe that the Pb exposures measured in this study are representative of the Pb exposures in similar and related establishments in Kenya. The results of this study were shared with the relevant authorities, to serve as a basis for developing policies on Pb exposures of affected workers. Specific recommendations were made to address Pb exposures through proper engineering controls, good work practices, respiratory protection and

personal hygiene. It is expected that on complete implementation of the recommendations, a follow-up study will be conducted to assess the Pb levels in these facilities.

Acknowledgements

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17. LOCALIZED EDUCATIONAL CURRICULUM AND KNOWLEDGE BASED ECONOMY FOR NATIONAL DEVELOPMENT IN KENYA

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Abstract

Innovation systems and knowledge-based economy for national development is achievable with a suitable curriculum. Curriculum is a powerful tool that affects both the learning process and the product. Each curriculum should satisfy the society because it is society that consumes the curriculum. The current Kenyan curriculum has served its mandate and therefore a review of education in Kenya in relation to its relevance and responsiveness to Vision 2030 is required in order to achieve national development.

The paper outlines trends in the current curriculum under the 8-4-4- system of education. It also makes a comparison between Kenya's curricula with selected countries with good practices in curriculum issues. These countries include Finland, Mongolia, Indonesia and Japan. Finally, recommendations to align the curriculum to address the requirements of the constitution and Vision 2030 are made. The paper points out that reform in curriculum are required to include provisions for a localized curriculum to address decentralization. Data for this paper was collected from public records, the media as well as education through experience in the field. The paper was hinged on the problem-solving method (P-S) model of innovation by Ronald Havelock of 1969.

Introduction

A curriculum is a powerful tool that affects the learning process. It should meet the demand of both the leaner and the society and also foster national development. Each curriculum should be valuable, responding continually to knowledge, skills and attitudes whose nature is dynamic. Oluoch (2002:7) defines curriculum as all that is planned to enable the student acquire and develop desired knowledge, skills and attitudes. By localized curriculum therefore, it means that

the curriculum be planned in such a way as to integrate aspects of knowledge from the local community. Part of the knowledge to be learnt should be fetched from the immediate environment. It should not involve imitating models that are not flexible to the economic changes affecting the country. Rather, the curriculum should be designed in a way that innovative thinking is developed at every level. Localization of the curriculum will prevent an overproduction of scholars steeped in books but deeply unproductive. There are varied talents and abilities in each of the 47 counties in Kenya that need to be taken into consideration when developing a curriculum that is geared towards creating a robust economy and achieve national development.

A curriculum being a plan for providing sets of learning opportunities should be hence, designed in such a way so as to enable the learner attain educational objectives. The planning process should consider the following:

- Content
- Course of study
- Educational experiences
- Subjects to be studied
- Subject matter
- Educational activities
- Policies governing education

Materials and Methods

Research data was collected from public records such as the syllabus, the KIE document and the Finnish National Board on Education (2020) document. We also used the print media.

The P-S Model

Havelock made an exhaustive study of how innovation, whether in education, or science, or agriculture, or industry, came about…The problem solving model is built round the user of innovations. It assumes the user has a definite need and that innovation satisfies that need Bishop

(1985).This model has been adopted because the need for innovation is Kenya centred rather than a manipulation from outside. According to the P-S, a need is identified. This need is translated into a problem which is then diagnosed.

This diagnosis leads to a search for solutions. The innovation which seems to provide the best solutions is then tested for its effectiveness. This is shown diagrammatically below;

Need

↓

Diagnosis

↓

Search for solutions

↓

Select the best alternative

↓

Implement the innovation

Critical Analysis of the Kenyan Curriculum

During the colonial administration education prepared one for work. Vocational form of education was used to prepare an individual hurriedly for particular skills without making considerations to the cultures of the individual learners. The colonial education prepared learners for low paying jobs. The effect of this was to create thirst for academic pursuits so as to access well paying white collar jobs. Thus, education leading to prestigious employment attracted students and was preferred by parents for their children more than education for skill training leading to low status employment Tum (1996:94). This has been the trend since Kenya attained its independence. Kenyan parents and curriculum developers as well as policy formulators collectively seem to have ignored a very crucial aspect that would have come from having a localized curriculum.

Currently, the curriculum of education in Kenya is highly centralized with the government instructing commissions as well as K.I.E to formulate the curriculum for National Education. The syllabus is prepared to cater for all schools irrespective of location, conditions under which the curriculum is implemented and specific needs of the learners.

Achieving innovation through education is a requirement in Kenya at the moment. For example, Learners need to learn modern skills of Agriculture to be able to practice better land utilization. This is because Kenya is an agricultural based economy and advancement in agriculture will contribute immensely to National Development through job creation and increased market demand for Kenyan goods. It is particularly ironical that there are Universities in Kenya that do not offer Agricultural based courses yet agriculture is the backbone of our economy. For instance, an originally Agriculture based University such as Egerton has diversified into many non-Agriculture courses thus diluting its original mandate. Masinde Muliro University on the other hand, is located in Kenya's sugar-belt region and started a course in sugar technology. Unfortunately, less than 30 students apply to take the Sugar Technology in any one given academic year yet MMUST has almost 10,000 students in any academic year. How can National development be achieved if graduates have no skills in what they should be best at? What Kenya has been doing with the 8-4-4 system of education is equipping the individual merely with skills for the immediate needs of the society, (Tum, 1996:97).We are talking about moving towards decentralization yet we are not walking the talk by decentralizing the curriculum. The school in Kenya is exclusively busy preparing learners for jobs in Nairobi and not in the counties.

Current Trends in the Kenyan Curriculum of Education

The modified 8-4-4 System of education has achieved its objectives because it solved most of the challenges that were facing Kenya at that time. The Kamunge Report and the Koech commission made significant changes within the 8-4-4 system which included narrowing the gap that existed between primary education and secondary education as well as relating the secondary cycle and university/tertiary cycle. The Koech Report specifically came up with a totally integrated quality education and training (TIQET) and made the system more integrative, inclusive, and accommodative as well as focused on quality. Amid the changes made to education, the national aims of education were not phased out. The proposals being made in this paper do not include phasing out the National aims/objectives of education. Indeed, the National goals/objectives of education bind Kenyans although, are divergences stemming from each culture. Thus, these divergences should not be ignored when drawing a Kenyan curriculum. Besides, there are many changes taking place within and outside education that need to be considered when designing the

new changes in the curriculum. The changes include trends in society such as economic development, political changes, cultural movements as well as ideological changes. Community assumptions and expectations are also important for the products of a curriculum to fit and comply in a society. Knowledge is changing with the emergence of new ideas hence; the curriculum should change to comply with current trends. It should also be noted that Kenya is moving towards a multi-cultural country. This requires that the curriculum empowers cultures in order to achieve multiculturalism. A localized curriculum is likely to provide room for developing multiculturalism as well as develop innovative minds that will enable our country develop. Localization of the curriculum will help us reclaim knowledge that will in turn address the challenges of uncertainty and provide answers for development.

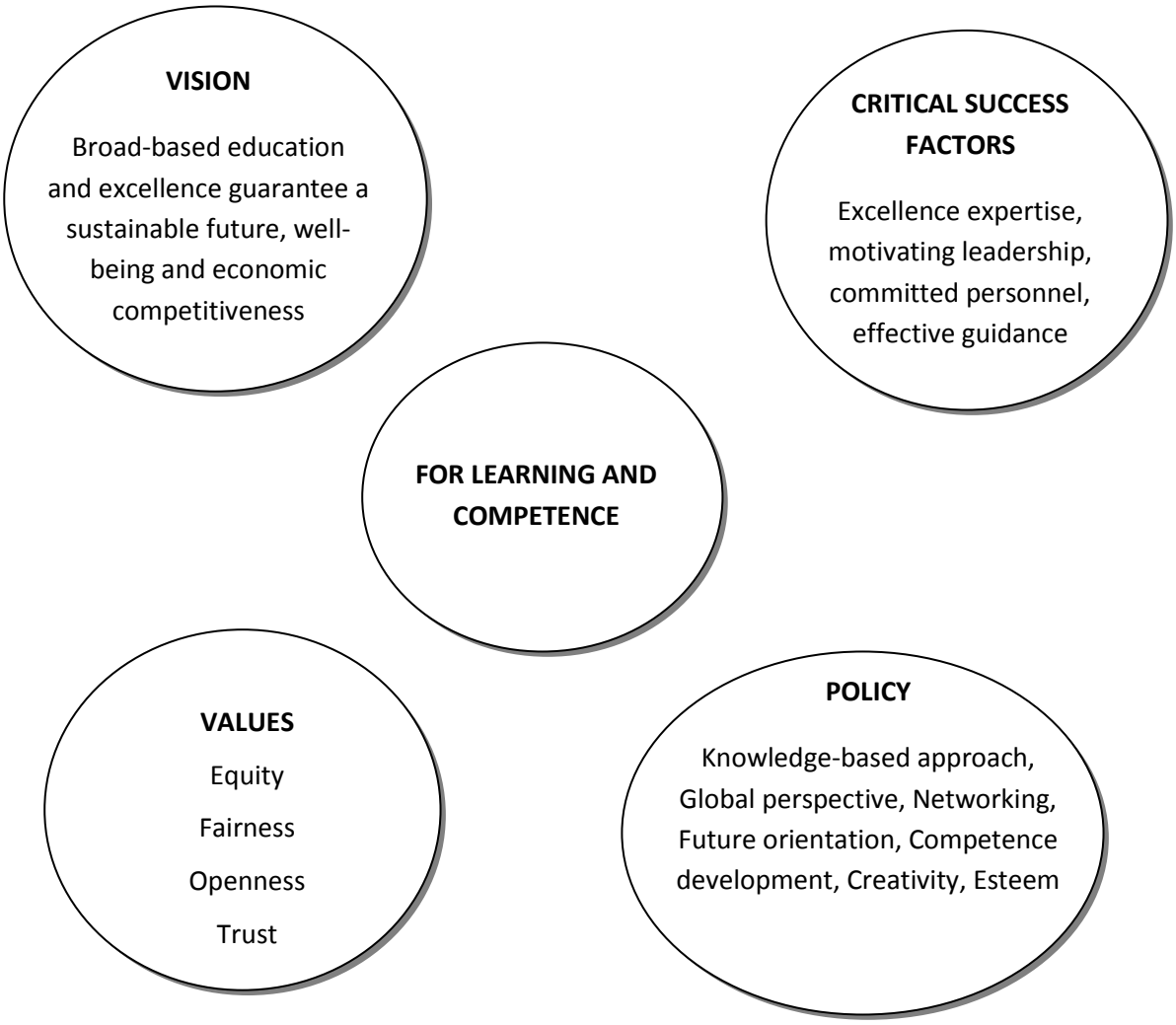
A localized curriculum on the other hand will make the curriculum content to be relevant to learners. Relevance of curriculum is a basis for quality in education. The promotion of localized curricula will reinforce such relevance in all contexts with regards to decentralization of education, governance and management. A localized curriculum will make learning flexible, meaningful as well as support policy formulation and standard setting for reform. A localized curriculum will involve the use of locally available and accessible resources. For MMUST for example, the resources would involve the sugar factories such as Mumias,Nzoia,West Kenya Butali all located near the university. It also involves making the local culture an integral part of the curriculum. Integration of culture in the curriculum has been achieved in Finland, U.S.A and other developed countries of the first world.

Comparison of Kenya's Curriculum with Selected countries of the World: Finland, Philippines, Japan, Mongolia and Indonesia

Kenya's curriculum is state controlled and is highly centralized. The Kenya Institute of Education KIE is held with the responsibility of designing the curriculum preparing the curriculum as well as recommending instructional materials for use in schools.

Through an exchange programme between Hermelina city -Finland and Municipal Council of Nakuru-Kenya, it has been established that in Finland, education matters are handled by the Finnish National Board of Education (FNBE). At the moment the FNBE has a strategy for

learning and competence for 2020 with objectives for education and training for 2020. The FNBE objectives can be summarized diagrammatically.



Source: FNBE (2012)

Other countries that have benefited from innovation include, Japan whose schools make their own educational plans in line with standards while taking into account the actual circumstances of each school and community. China has two ministries handling education; The Ministry of Education and the Local Education Authority.

Indonesia and Mongolia changed their primary curriculum reform to include the local curriculum subjects (LCS) as an independent subject that takes more than 20% of the curriculum. This curriculum has dealt with an overcrowded curriculum, through integration, reduction of

instructional time and decentralization of content. The learning and teaching content is classified into two categories. The state prescribed content is compulsory and takes up to 50% of the total content. The school based content takes two parts namely: prescribed and altering content 20% while school chosen content takes 25%.The school chosen content takes into consideration the ever changing interests ,demands and needs of learners ,the actual conditions of the community and school itself as well as the development level and characteristics of the students.

Conclusion

This paper proposes localization of the curriculum in Kenya to address issues of decentralization, innovation and development. A flexible curriculum is required to cater for all learners in the 47 counties. Localization of the curriculum will make education fit and relevant with regard to content, adaptable to changing socio-economic needs of the country and requisite quality to match global competitiveness and, achieve national development (Daily Nation, March 26: 32)

Recommendations

This paper proposes a break with the past by making the objectives of the curriculum aim at creating jobs through innovations. According to Brown (1990:56) the most effective curriculum is that set by the market by the consumers of the education service. Kenya should consider diversifying the curriculum by localizing some aspects of the national curriculum. Diversified schooling will be more closely attached to the manpower requirements for industrialization and growth… diversified curricular will promote a clear understanding of the modernizing world of work and this will facilitate the development of enhanced values and aspirations with the requirements of the labour market (Sifuna and Otiende, 1992:252).

It is also proposed that rather than duplicating and reduplicating courses, each university should design and develop courses offered to cater for diversity. Besides, internship should be emphasized to provide university graduates with practical skills through practicum.

With a decentralized government, the curriculum should be decentralized through localization of the curriculum at every level of education in Kenya.

Funds should be provided for research to be carried out by educational planners on management and implementation and this should include a localized curriculum.

In-servicing of teachers (INSETS) should be done regularly to make them aware of changes taking place in society. There is no education system that will be better than its teachers. Thus teachers have a role to play in innovation especially with regard to localization (Beecher and Maclure 1978:150)

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18. MECHANICAL AND ELECTRONIC PROPERTIES OF CUBIC BN AND BC_2N

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Abstract

The ternary compound BC_2N has been thought to have some fascinating properties attractive to technological applications such as extreme hardness and high melting point, that are just lower that diamond's, the hardness and melting point of BC_2N is expected to be higher than that of c-BN. in this study, mechanical and electronic properties of c-BN and BC_2N were studied using the methods of Density Functional Theory, while Quantum Monte Carlo methods were also used to study the mechanical properties of c-BN. Using the Quantum Monte Carlo approach c-BN was found to have a lattice parameter of about 3.59 Å, and a bulk modulus of about 408 GPa, compared to published values of 3.61 Å for the lattice parameter and 409 GPa [1] for the bulk modulus respectively. From density functional theory the values of the lattice parameter were calculated as 3.58 Å (LDA) and 3.65 Å (GGA), and the bulk modulus 398 GPa (LDA) and 405 GPa (GGA). The bond length for c-BN was found to be 1.55 Å between the B and the N atoms, while in BC_2N the bond Lengths were found to be C-C (1.547 Å), B-C (1.566 Å), B-N (1.57 Å) and C-N (1.539 Å). The bonds lengths in BC_2N involving carbon and another atom were found to be shorter than those involving Boron and Nitrogen. BC_2N was found to have hardness that is relatively high, with the bulk modulus being 401 GPa. c-BN was found to be an indirect band gap material, with a band gap of about 4.4 eV, while BC_2N was found to be a direct band gap material, with a band gap of about 2.5 eV. Additionally this study showed that BC_2N is a suitable candidate for superhard material applications.

Introduction

The search for superhard materials has recently led to the identification of a prospective novel material, BC_2N. It's probable that the properties of the compound such as hardness will be found to lie between those of diamond and c-BN. c-BN has been studied before both theoretically and experimentally [3, 4, 5, 6, 7, 8, 9, 10, 11], since it was first synthesized [12] in the mid-20th century. The structure and properties of BC_2N on the other hand has not been extensively studied, though BC_2N has been synthesized experimentally [13], [14], [15]. This ternary structure has attracted special attention because of the expected high hardness and potential for application on mechanical tools. Hubble et al [16] experimentally identified a new super hard phase, but noted the need for a new comprehensive theoretical approach to distinguishing diamond from the new B-C-N phase using Raman spectroscopy. Fan *et al* [18] have calculated

the Bulk modulus of cubic Boron Nitride to be 403.4 *GPa* while that of Diamond was calculated to be 463.4 *GPa* and that of BC_2N was calculated to be 409 Gpa. In Zhang *et al*'s [19] work based reported results that showed that BC_2N is not harder than BN from first principles energy calculations. Later Guo et al [20] published findings on the theoretical Vickers hardness of BC_2N, obtained from first principles, that supported the hardness of being higher than c-BN. Solozhenko *et al* [2] found the Vickers hardness of BC_2N to be higher than c-BN, results that are consistent with [21, 20,17]. Bando *et al* [22] experimentally characterized using high resolution analytical electron microscopy specimens of BC_2N. Their results revealed that B-C-N crystal had a cubic symmetry having diamond-type structure. Furthermore, the fine structure of the spectra indicated that the crystal was not graphitic but a diamond-type. Dong *et al* [23] studied the stress behavior of nanocrystalline BC_2N experimentally, using axial x-ray diffraction in the diamond-anvil cell. The results gave a pressure derivative of $K_o^{'}$ =3.4, and a bulk modulus of 420 Gpa. Knittle *et al* [24] experimentally found from comparison of the spectrum of BN, diamond and BC_2N that the bonding in cubic is partially ionic, and the isothermal bulk modulus at about 355 GPa being lower than that of diamond and cubic BN. Knittle's results were not in agreement with those of Solozenkho *et al* [13]. In spite of the fact that some cubic B-C-N materials have been successfully synthesized, the crystal structure of superhard BC_2N has still not been conclusively determined [25] and some of its properties are still not well understood. Therefore there is a need for more to be done to understand fully the mechanical properties of BC_2N, as well as its electronic characteristics.

Materials and Methods.

First principles calculations starting from an eight atom supercell of a superhard phase with the Zincblende (B3) structure [26], identified in the literature by Guo *et al* [20], and independently by others [27] was identified as the most likely structure. Carbon boron nitride was then studied in this diamond like structure, with the ratio of B:C:N being 1:2:1 in the eight atom super-cell. First principles calculations were done on BC_2N using the methods of DFT using both LDA and GGA exchange correlation functionals as implemented in Quantum Espresso [28]. Work on c-BN was done using Quantum Monte Carlo Methods as implemented in CASINO [29] as well as using DFT methods in QE using LDA and GGA correlation functionals.

Results

Mechanical Properties

Figure 1(a) and (b) show the optimized electronic structures of c-BN and BC_2N. The bond lengths for BC_2N especially for the B-C, N-C , and C-C bonds were found to be very short, shorter than the corresponding B-N bonds in the crystal lattice. The bonds involving carbon, being shorter indicated evidence that the presence of carbon in the lattice did increase the strength of the forces binding the atoms in the crystal lattice. Tables 1, 2 and 3 summarize the results obtained. The results for the bulk modulus for BC_2N was found to be lower in this work than that reported by others, slightly lower than that of c-BN, in spite of the bond lengths in BC_2N implying stronger bonding. This may be attributes to the underestimation of bulk properties by the exchange correlation functional used in D.F.T.

Table 1: *Lattice Parameters for BN and BCN*

		BN (Å)	Exp[a]. (Å)	% Err	BC_2N (Å)	Exp[b]. (Å)	% Err	Diamond Exp. (Å)
D.F.T.	L.D.A.	3.58	3.61	-0.8 %	3.56	3.57	-1.6%	3.53
	GGA	3.65		1.1%	3.62		1.4%	
VMC			3.59	-0.5%				

[a][2] [b][30]

Table 2*: Bulk modulus (GPa) for BN and BCN*

		BN	Exp.[d]	% Err	Others[c]	BC_2N	Others[c]	Diamond (others)[c]
D.F.T.	L.D.A	405	409	-0.9%	403.4	401	438,432	463
	G.G.A	398		-2.6%		368		
VMC		408.1		-0.2%				

[c][17] [d][31]

Table 3: *Bond Lengths between the respective atoms in the unit cell*

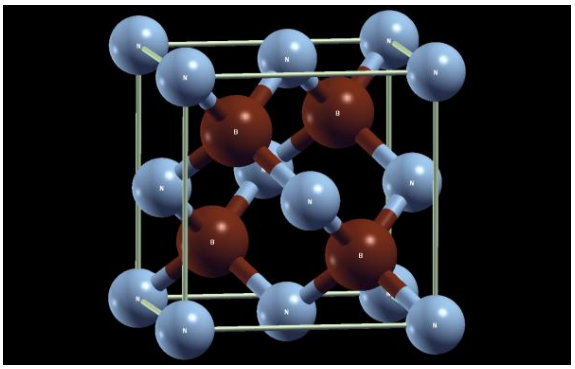
BN	Calc (Å)	Others (Å)[e]	(Å)	Calc (Å)	Others (Å)[f]
B-N	1.55	1.56	C-C	1.547	1.537
			B-C	1.566	1.559
			B-N	1.57	1.546
			C-N	1.539	1.542

[e][5] [f] [27]

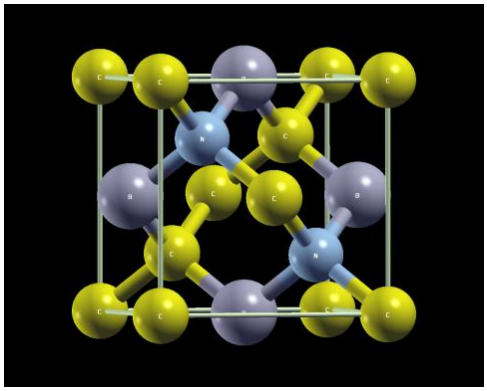
The bond lengths in BC_2N involving Carbon and another atom are predicted to be shorter than those involving the other two atoms, implying strong bonding in the crystal attributable to the presence of the carbon atom.

Electronic Properties

Figure 2 shows the plots of the band structure and the density of states for boron nitride, showing the band gap and the occupied states of the structure. From the band structure in figure 2a, the indirect band-gap for BN was identified as 4.4 eV from Γ to X.

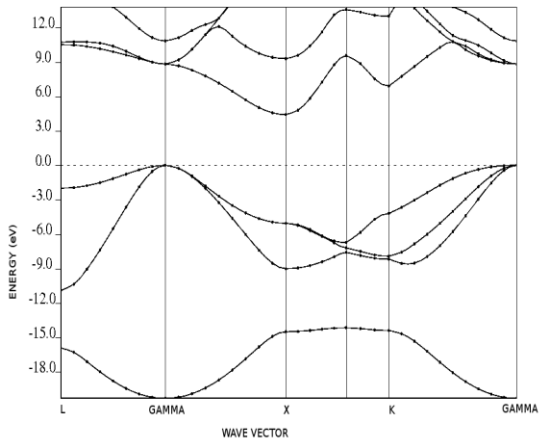


(a) Optimized Structure of BN, N-Nitrogen, B-Boron

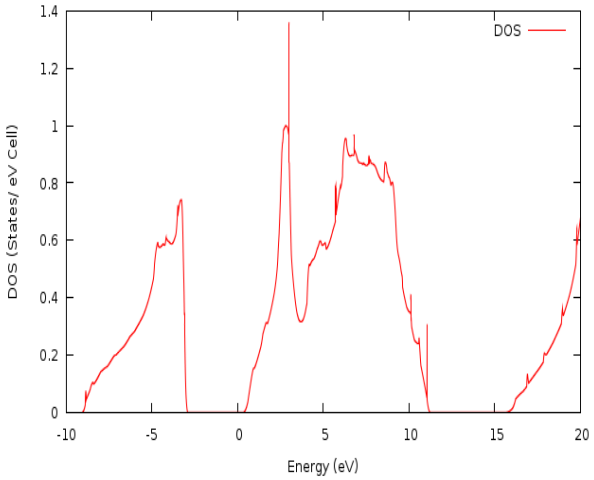


(b) Optimized Structure of BCN, C-Carbon, B- Boron, N-Nitrogen

Figure 1: *Optimized Structures*



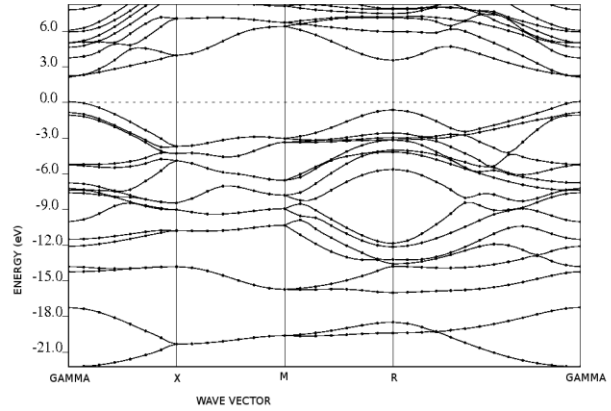
(a) Band structure for BN



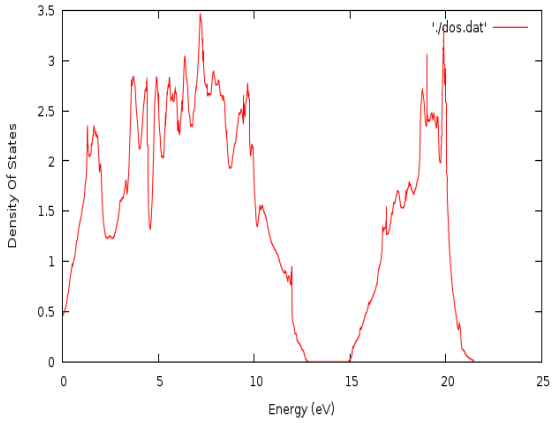
(b) The DOS for BN

Figure 2: *Electronic properties of BN*

The corresponding diagrams for Carbon Boron Nitride are shown in figures 3(a) and 3(b). Carbon boron nitride's direct band-gap can also be identified from its band structure diagram in figure 3(a).



(a) Band structure for BC_2N



(b) The DOS for BC_2N

Figure 3: *Electronic properties of Carbon Boron Nitride*

Conclusions and Recommendations

From the results of the bond lengths of BC_2N, the material shows evidence of being superhard, as well as giving evidence consistent with being harder than BN, since the short bond lengths in BC_2N are evidence of stronger bonds between the atoms in BC_2N compared to BN. From the electronic properties of both c-BN and BC_2N, we have found that while c-BN shows a discontinuous valence band, with a very narrow conduction band, BC_2N has a continuous valence band and a fairly wider conduction band. The wide band-gap of BN means it has excellent insulating properties, while BC_2N, with the small band-gap of about 2.5 eV, may allow excitation of electrons to the conduction band at lower energies than BN with its band gap of about 4.4 eV.

Acknowledgement

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19. ASSESSMENT OF RESIDENT FARMER GAMMA DOSE RATE LEVELS IN HOMA MOUNTAIN, HOMA BAY COUNTY, KENYA USING RESIDUAL RADIOACTIVITY COMPUTER CODE

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Abstract

This study assessed the level of background radiation for Homa Mountain region (between Kendu Bay and Homa Bay) in Homa Bay County of Kenya. Natural radionuclide activity concentrations in rock and soil samples were determined using high purity Germanium (HpGe) and Sodium Iodide (NaI) gamma spectroscopy. Both consequences from field and laboratory measurements were analyzed. The obtained results of Uranium (^{238}U) and Thorium (^{232}Th) series as well as Potassium (^{40}K) are discussed. By means of RESidual RADioacivity (RESRAD) computer code dose computation and environmental modeling was done providing an accurate baseline radiation dose assessment for Homa Mountain areas that are unaffected by mining but whose landscape is inhabited and used for both grazing cattle and growing food crops. The RESRAD code enabled modeling of ^{40}K, ^{232}Th and ^{238}U environmental pathways, particularly ground, plants, meat, milk, water and soil leading to exposure pathways of external radiation, inhalation and ingestion resulting in Total Effectivet Dose (TED) equivalent to exposed individuals.

Introduction

Natural Occuring Radioactive Materials (NORM) are wide spread in the earth's environment and they exist in enhanced forms in geological formations in soil, rocks, plants, water and air in certain areas (Otansev et al. 2012). Rocks are used for various purposes, mainly building and construction of houses and roads. Soils that are in the surrounding areas are also used for building but additional food crops and cattle graze on grass that grow from the soil. Human activities involving the use of radiation and radioactive substances cause radiation exposure in addition to the natural exposure, with the consequence of enhancing the exposure from natural radiation sources. Mining and use of ores containing naturally radioactive substances and the production of energy, applications in industry, medical, food and water are some examples as depicted in Table 1 and Fig.2 (UNSCEAR 2000).

Materials and Methods

Using conventional experimental procedures the surface dose rate was measured using hand held Sodium Iodide (NaI) meters. Calibration of hand held survey meters was done by comparing them to similar equipment kept at the Secondary Standards Dosimetry Laboratory (SSDL) at Kenya Bureau of Standards. Rock and soil samples were taken prepared in standard procedures and measured in laboratories using hyper pure Germanium detectors for activity concentrations.

Data of the samples were from and around Homa Mountain and for measurements of K, Ra and Th the predominant materials were soil and rock samples which were measured with hyper pure Germanium (HpGe) detectors at the Institute of Nuclear Science and Technology (INST) of the University of Nairobi and National Radiation Protection Laboratory of the Radiation Protection Board (RPB). Yu at al. (2001) has explained the RESisual RADioactivity code which was used, with the inputs being primarily the activity concentrations of K, Ra and Th in samples as deduced from equipment from INST and RPB, to model the resident farmer scenario TED.

Table 1: *Exposure dose rates as mSv from natural and artficial sources in the world*

Radiation		UNSCEAR	
Type	Source	World Average (mSv)	Typical Range (mSv)
Natural	Air	1.26	0.2-10.0
	Internal	0.29	0.2-1.0
	Terrestrial	0.48	0.3-1.0
	Cosmic	0.39	0.3-1.0
	Total	2.40	1.0-13.0
Man Made	Medical	0.60	0.03-2.0
	Fallout	0.007	0-1+
	others	0.0052	0-20

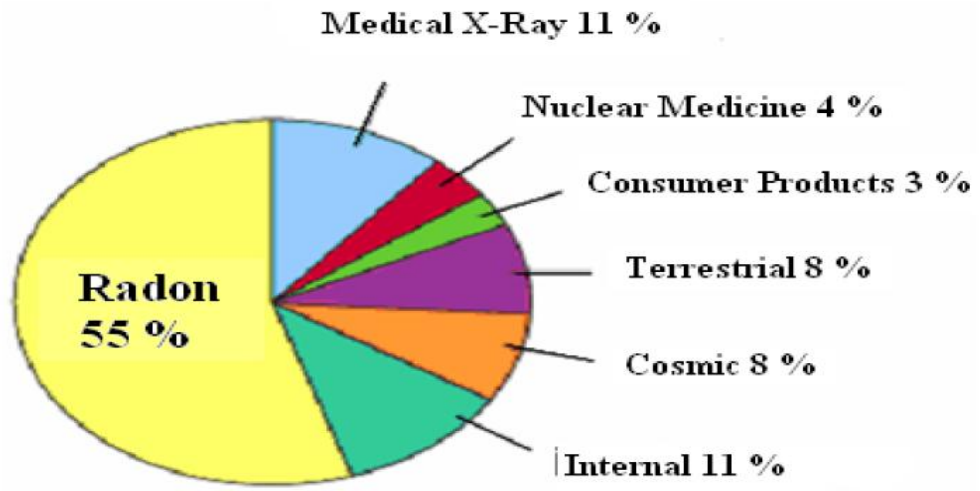

Fig. 2. Exposure dose percentage from natural and artificial radiation sources

Results, Discussions and Conclusions

From Table 2 the mean correction factor value of 1.027, for NaI hand held dose rate meter, implies very good metrological traceability. The latter is a property of a measurement result whereby the result can be related to a reference (PTW) through a documented unbroken chain of calibrations (SSDL). Each (RPB, SSDL and PTW) contributed to the measurement uncertainty.

Table 2: *Comparison of Radiagem used (RPB), at SSDL (IAEA) and ion chambers (PTW)*

SSDL	PTW	RPB				
TRUE		Indication	N=c.f.	Response	% differ	
H*(10)		H*(10)		1/N		Mean
µSv/h		µSv/h				N =c.f.
5.2	5.01	6.6	0.79	1.27	31.74%	
8.3	8.02	7.71	1.08	0.93	-3.87%	
20.7	20.04	21.12	0.98	1.02	5.39%	1.027
51.9	50.2	49.93	1.04	0.96	-0.54%	
82.9	80.26	81.39	1.02	0.98	1.41%	
206.6	199.9	198.4	1.04	0.96	-0.75%	
518.9	502.1	516.5	1.00	0.99	2.87%	

The NaI hand held mean dose rate of 474.1 nSv h^{-1} translated to external equivalent dose of 4.15 mSv y^{-1}. The measured mean radioactivity concentrations using HpGe were 915.6, 188.0 and 405.0 Bq Kg^{-1} of ^{40}K, ^{238}U and ^{232}Th, respectively. Results of TED contributions for infant (0 to 1 year old), 1 (from 1 to 2 year old), 5 (more than 2 to 7 years old), 10 (more than 7 to 12 year old), 15 (more than 12 to 17 year old) year olds and adult (more than 17 year old) were obtained for resident farmer or/and fisherman, industrial worker and recreationist. For the resident farmer scenario, the most vulnerable member of the exposed population assumed to grow own food on the contaminated site, collect own water from contaminated site and lives there, the mean annual dose received was 4.93 mSv y^{-1} which exceeded the dose constraint of 0.25 mSv y^{-1}. Infant and 1 year old child cases received significant contribution of up to 1.0 mSv y^{-1} due to ^{40}K, while above 5 years old ^{232}Th became the dominant source of exposures. Where ^{232}Th concentration was highest total annual dose from age 12 was deduced to be around 6 mSv y^{-1}.

As expected, the pattern of high values of the radiological indices followed those of the corresponding activity concentrations. The latter were initially derived from high dose rates measured with hand held NaI meters. The Homa Mountain vicinity study has established data on radiation dose to the population qualifies the region as a high background radiation area due to

dominance of carbonatite rocks. International recommendations which our own Radiation Protection Board (Kenya Government 1982) adopts and in particular the International Atomic Energy Agency's (1996) Basic Safety Standard 115, states that the use of building materials containing enhanced concentrations of natural occurring radioactive materials should be controlled and restricted. The investigation of the health hazards of radiation and the impacts of high levels of background radiation on local inhabitants needs to be done in epidemiological studies. Rare Earth Elements, in particular Nb and Th associated with the carbonatite rocks deposits for economic benefits should be investigated further.

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Environmental Assessment Division Argonne National Laboratory, United States Department of Energy.

20. RELATIONSHIPS BETWEEN THE PHYSICAL PROPERTIES OF ACTIVATED CARBONS AND THEIR ROLE IN THE DECOLORIZATION OF SUGAR SYRUP WITH A COMPARISON BETWEEN THE COMMERCIAL ACTIVATED CARBONS AND THE BEET PULP ACTIVATED CARBONS

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Abstract

Activated carbons produced from sugarbeet pulp and commercial activated carbons were characterised for their physical (bulk density), chemical (ash, pH, conductivity) properties. Their surface area, pore size and micro pore volume were determined. They were also evaluated for their color adsorption properties (Iodine, molasses color removal and also sugarbeet syrup and raw sugar decolorization efficiency), Beet pulp carbon prepared at temperature of 750 0C and activated for 5 hours had decolorization efficiency close to the best of the commercial activated carbons used. The low decolorization results observed in most of the beet pulp carbons, apart from the low surface area, could be due to the high ash content present. From the results, it is evident that the activated carbons from beet pulp hold an inexpensive potential for use in the sugar refining.

Keywords*: Sugar syrup, Activated carbon, Decolorization.*

Introduction

Decolorization by using activated carbon as the adsorbent in the factory has been used as a final purification step in the manufacture of white sugar.The decolorization process actually removes more than color because colorants that interact with colour precursors, colloidal materials, organic nonsugars, are also taken out. Ours was to find out the relationships between the physical properties of activated carbons and the role in the decolorization of sugar syrup while giving a comparison between the commercial activated carbons and the locally produced beet pulp activated carbons.

Materials and Methods

1. Syrup
2. Beet/Cane Molasses and Raw Cane Sugar
3. Commercial Carbons
4. Beet pulp carbons

Iodine, Molasses, and syrup decolorization tests were conducted using the method described by Ahmedna et al., (1997b) with some modification as described in the following sections. While in the cases of sugar color determination, ICUMSA Method 4 was applied.

Characterization of Activated Carbon Samples

Bulk Density

pH.

Moisture and Ash Content

Determination of Surface Area, Pore Volume and Pore Size

Electrical Conductivity

Iodine Test

Molasses Test

Results and Discussion

The Characteristics of Activated Carbons

The numerical surface area values in relation to their beet syrup decolorization efficiencies of the activated carbons are shown in Table 4.

Table 4: *Physical and Chemical Properties of the Activated Carbons with their Iodine and Molasses Numbers*

Carbon	Surface area m^2/g	pore volume m^3/g	Pore size (Å)	Density g/cm^3	Ash %	Conductivity (μs) 25.6 ^0C	pH	Moisture %	Iodine No	Molasses No
COMMERCIAL CARBONS										
DCL 320	1327.4	1.30	36.0	0.28	3.61	285.0	4.5	7.72	956	292

DCL 200	858.5	0.54	25.6	0.35	16.82	17.1	6.7	5.31	1052	298
207 AP	955.1	0.51	21.4	0.40	13.9	87.9	7.9	1.11	1080	287

BEET PULP CARBONS

5/750	875.2	0.65	21.88	0.28	18.30	24.8	6.0	18.60	1052	271
5/500	658.0	0.55	33.20	0.67	20.96	3200.0	2.8	21.10	512	262
3/500	388.2	0.27	27.33	0.60	18.32	2600.0	2.8	18.93	483	240
5/300	314.9	0.28	35.06	0.62	19.69	1820.0	2.8	20.45	512	231
1.5/500	328.8	0.22	26.44	0.58	19.29	2410.0	2.8	19.98	571	244
3/300	327.5	0.28	33.94	0.71	19.21	2320.0	2.8	19.93	512	74
1.5/300	187.9	0.20	42.75	0.61	20.21	1870.0	2.8	20.83	365	56
2/750	377.2	0.25	38.20	0.25	34.75	972000.0	10.2	8.67	144	90

Freundlich Plot

The Freundlich equation in logarithmic form appears as

$$\log \frac{X}{M} = \log K + \frac{1}{n} \log C$$

In this equation, X is the units of impurity held by M units of carbon with which such adsorption was affected. X equals C_O–C; that is the difference between the original and final concentration impurity. C_o is the concentration of impurity remaining unadsorbed at equilibrium. The two constants K and 1/n a particular to the system, and depend on the carbon used and the nature of the impurity. C, the concentration of impurity may be expressed in color units. Plotting X/M verses C, the residual color concentration, on a logarithmic scale yields a straight line graphs as shown in Fig.1

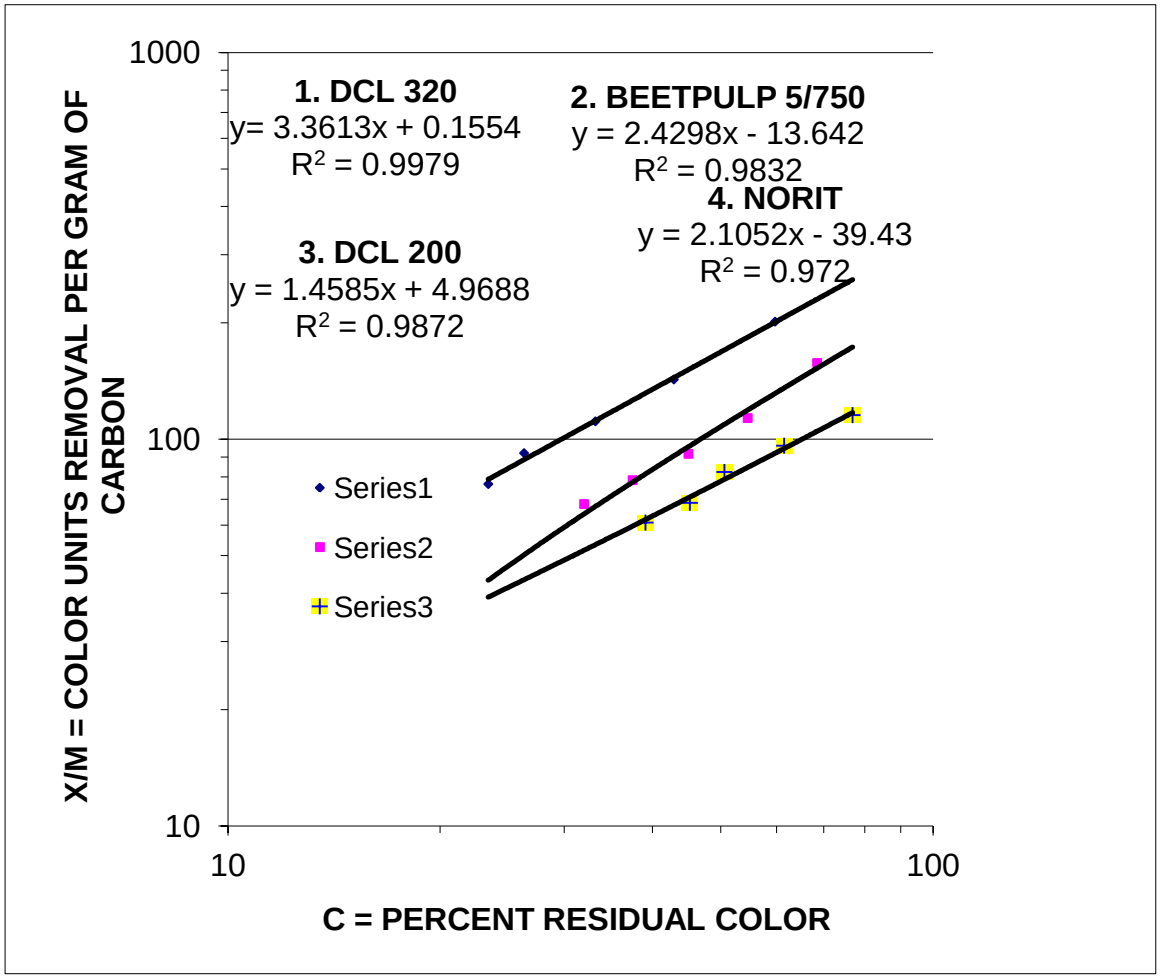

Fig. 1: *Freundlich plot isotherms for the carbons*

Conclusion

This work has demonstrated that activated carbons DCL 320 and beet pulp 5/750 are suitable for sugar syrup decolorization as compared to the rest of the other activated carbons.

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The authors sincerely thank the Sutcliffe Speakman Carbons Ltd for providing the commercial activated carbons and for reviewing the paper, the beetpulp research group of Dr. Ahmet Özer of Chemical Engineering Department at University of Fırat in Turkey for providing the beet pulp activated carbons Ankara Sugar Factory who provided the syrup. We gratefully acknowledge the embassy of The Republic of South Africa to Turkey through Ambassador Thomas Wheeler for providing the raw crystal sugar from cane.

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21. WATER RELATIONS AND NOVEL CYTOKININ-GIBBERELLIN SYNERGISM IN HARVESTED LISIANTHUS (*EUSTOMA GRANDIFLORUM* SHINN.) FLOWERS

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Abstract

Kenya is the largest exporter of cut flowers to European Union and other international markets, earning large share of foreign exchange. Lisianthus is among top-ten cut-flowers exported from Kenya, and in the international markets. Bent-neck condition, which is caused by water-stress is the leading cause of loss of quality in harvested lisianthus. The objective of this study was to investigate the responses to exogenous benzylaminopurine (BA) (0, 70, 140 and 210 µM) and gibberellic acid (GA_3) (0, 5, 10, and 15 µM) solo or combined in complete factorial of dosages, applied via xylem, on physiological changes of lisianthus shoots. The rationale was to develop hormonal pre-treatment to boost and maintain favourable water balance. Ethylene and gibberellin

action inhibitors: silver-thiosulphate (STS) and maleic hydrazide (MH), respectively, indole-acetic acid (IAA), abscisic acid (ABA) and deionised water were used as controls for hormonal cross-talk. The interaction between BA and GA_3 significantly influenced: cumulative water balance (P = 0.002), floret opening rate (P< 0.001), and bent-neck rate (P< 0.001). Synergistic effects between 70 µM BA plus 5 or 15 µM GA_3 gave the most ideal water balance trend, recording overall highest cumulative water balance peak during old age of the cut shoot and thereafter maintaining relatively high cumulative water balance till the end of the 19 days experiment. Existence of negative and positive responses to combined cytokinin and gibberellin doses suggests interplay between hormonal and developmental signaling. However, regardless of the modes of action, data obtained from this study reveal novel potent environmentally safe technique for maintaining turgor and boosting display quality in lisianthus cut flowers even in old age. This is the first report of synergism between cytokinins and gibberellins, which are only known to interact antagonistically. The modes of action are discussed.

Introduction

One key vase-life-limiting parameter in lisianthus cut flowers is the bent-neck condition, which is as a result of loss of turgor in the pedicels (Cho *et al.*, 2001; Musembi, 2008). The process of senescence is genetically programmed and its execution is mediated through hormonal- and developmental-signaling pathways (Musembi *et al*., 2012). Weiss and Ori (2007) reported that GA interacts with all other plant hormones, in some cases reciprocally. Interactions between cytokinins and other hormones have been less studied (Chang *et al*., 2003). Nevertheless, the effects of cytokinins and gibberellins differ greatly among plant species (Mutui *et al*., 2001). Musembi (2008) has reported that, combined dosage of cytokinin and gibberellin results in both positive and negative interactions with regard to water balance. The present study focuses on water relations and hormonal interactions in lisianthus, one of the top ten cut flowers in the market internationally in recent times (Harbaugh, 2007).

Materials and Methods

This study was carried out in the Crop Physiology Laboratories, University of Nairobi, Nairobi, Kenya; using materials obtained from a commercial grower (Charm Flowers Kenya Ltd) in Kajiado County of Kenya. The laboratory was lighted for a 12 hour photoperiod throughout the

experimental duration; using cool white fluorescent tubes (24 µmol m^{-2} s^{-1} PPFD above the cut shoots) while the ambient temperature was maintained at 23.5 ± 0.1^{o}C and 65 ± 1% relative humidity. 'Flamenco Series' and 'Magic series' lisianthus cultivars of single and double flower forms, respectively, were used in these experiments. This experiment was set as a complete factorial: with the type of growth regulator as the fixed effect treatment; and the various levels of the growth regulators as the random effect treatments. Equally spaced random effect treatments were chosen to enable analysis of the nature of response surface. The experiments were laid out as Randomized Complete Block Design (RCBD) with 3 replicates (blocks) using stem calliper as the blocking factor. Analysis of variance was performed on the data, using the general linear model procedure of statistical analysis, using GENSTAT Statistical Package (Lane and Payne, 1996). Linear, quadratic and cubic orthogonal polynomials were carried out and appropriate regression models were used to examine the nature of the response to the various equally spaced random effect treatments such as GA_3 and BA (Myers, *et al*., 2009). Multiple comparisons among means were done using Tukey's Honestly Significant Difference (HSD) at 5% level of significance (Steel and Torrie, 1980).

Results

Synergistic effects between BA and GA_3 treatment combinations (70 µM BA plus 5 or 15 µM GA_3) resulted in the most exemplary cumulative water balance trends (Figure 1 A – D). These treatments recorded the overall highest cumulative water balance peak rate at approximately 800 mg h^{-1} $shoot^{-1}$ on day 15 of holding then maintained a relatively high cumulative water balance to the end of the 19 days of experimental duration. Other treatments displayed trends with generally, lower and/or earlier peaks followed by a drastic decline in the cumulative water balance rates. Prevention of bent-neck condition followed a similar trend of synergism (Table 1) with the best treatments (70 µM BA plus 5 or 15 µM GA_3) doubling the duration to bent neck. These synergistic effects seem to spread along BA:GA_3 ratio of 35:1 though weaker downstream. Inhibitory effects occurred outside this ratio e.g. 140 µM BA plus 5 µM GA_3. Stage-wise opening of primary florets, followed by secondary florets, thereafter followed by tertiary florets was displayed by the placebo, BA and GA_3 solo treatments (Figure 2). There was long dormancy duration between the stages whereby many florets would wilt before the next stage. This dormancy period was longest in the placebo and shortest in BA treated lisianthus cut flowers.

However, combined BA and GA_3 treatments displayed an impressive continuous opening of florets thus improving the display quality.

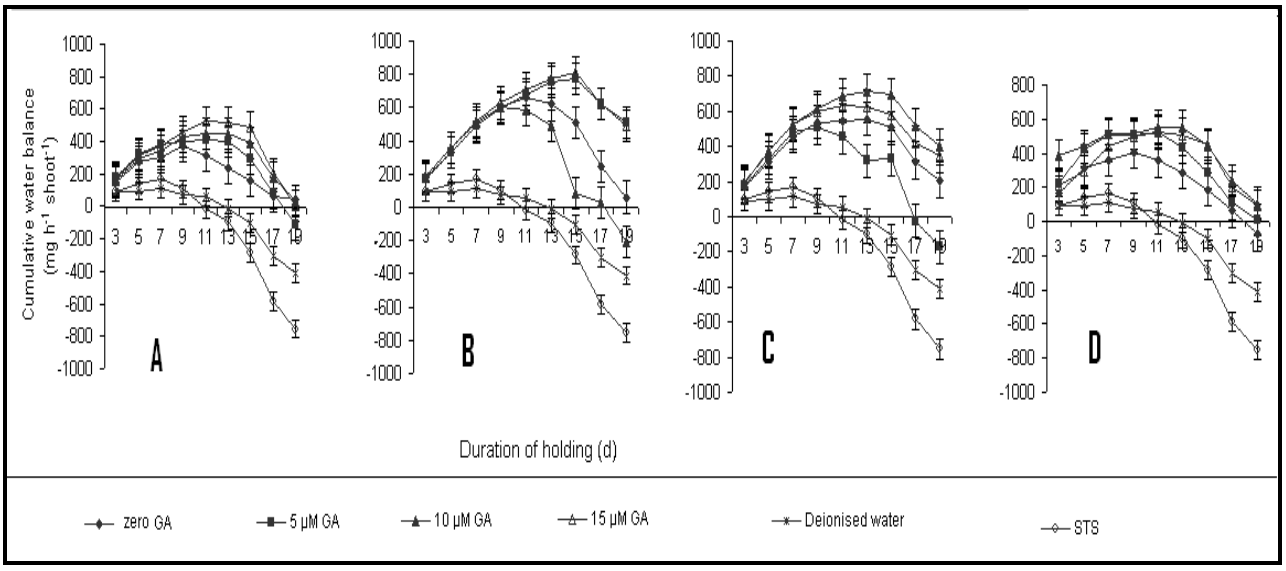

Figure 1: *Interaction effect between BA and GA_3 on cumulative water balance of cut lisianthus shoots*

Data from first and repeat experiments were pooled. Level of significance: $P = 0.002$.

Y – Error bars represent Tukey's Honestly Significant Differences (HSD) at $P = 0.05$. Figure 1: A) GA_3 alone treatments; B) 70 µM BA combined with the levels of GA_3; C) 140 µM BA combined with the levels of GA_3; D) 210 µM BA combined with the levels of GA_3. The nature of the response surface to BA and GA_3 combinations was significantly cubic.

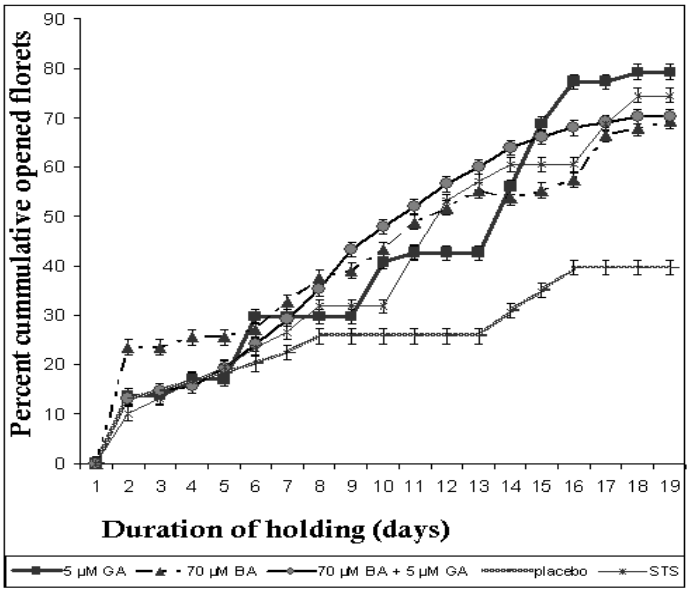

Figure 2: *Interaction effect between BA and GA_3 on percent cumulative opened florets of cut lisianthus inflorescences*

Data from first and repeat experiments were pooled. Level of significance: $P < 0.001$.

Y – Error bars represent Tukey's Honestly Significant Differences (HSD) at $P = 0.05$. The nature of the response surface to BA and GA_3 combinations was significantly cubic.

Table I: *The interaction effect between BA and GA_3 on the number of days to loss of pedicel turgor of cut lisianthus inflorescences*

BA (µM)	GA_3 (µM)			
	0	5	10	15
0	12.33^{de}	13.00^{def}	12.33^{ef}	13.67^{cde}
70	15.00^{bcd}	24.00^{a}	13.67^{cde}	23.67^{a}
140	13.00^{def}	11.00^{f}	15.67^{bc}	13.67^{cde}
210	13.00^{def}	13.67^{cde}	14.33^{cd}	13.67^{cde}
Nature of response surface	L (ns) Q (ns) C (ns)	L (ns) Q (**) C (***)	L (ns) Q (ns) C (ns)	L (ns) Q (**) C (***)
Negative control (Deionised water)				11.66^{e}
Positive control (STS)				12.33^{de}

Data from the first and the repeat experiments were pooled. Level of significance: $P< 0.001$. Mean separation was by Tukey's Honestly significant Difference (HSD = 2.574 days, at $P = 0.05$). Means with the same superscript are not significantly different. More shading represent synergistic effect zone, medium shading represent 'additive effect' zone, and light-shading represent inhibitory effect zone. The responses to BA and GA_3 were found to be significantly nonlinear.

Discussion

The hormonal relative ratio mode of action could be related to the recent reports by Tworkoski and Miller (2007) on apple tree buds break behaviour and Razem *et al*. (2006) on seed germination behaviour. Cytokinin and gibberellin have been shown to interact antagonistically (Greenboim-Wainberg *et al*., 2005; Weiss and Ori, 2007); therefore, the positive interaction unveiled in this study is novel. The occurrence of both positive and negative interaction in water balance maintenance of cut lisianthus shoots suggests existence of novel positive hormonal crosstalk mechanism between cytokinin and gibberellin. The stage-wise opening of lisianthus cyme-like florets seems to be regulated by hormonal and developmental singling for the survival of the plant in the wild under varying environmental conditions. Interplay between the hormonal and developmental signaling seems to promote this stage-wise opening of florets: with cytokinins promoting cell division in the tiny buds, thereafter gibberellins elongating the cells, and finally cytokinins preventing onset of senescence. Thus solo applications result to antagonism between the exogenous and endogenous counterpart. This view is supported by recent reports on interplay between hormonal and developmental signaling in maintenance of apical dominance in rose (Musembi *et al*., 2012). On the contrary, combined applications of cytokinin and gibberellin would maintain a balance of the processes of floret bud opening. The high rate of florets opening in cut shoots treated with STS compared to the placebo implicates ethylene in the failure of majority of florets to open; a major postharvest problem in lisianthus cut flowers.

Conclusions and Recommendations

This is the first report of synergism between cytokinins and gibberellins. In conclusion, in spite of the modes of action, data obtained from this study reveal novel potent environmentally

friendly technique to maintain turgor in cut flowers and improve the display quality through use of the combined of cytokinin and gibberellin, thus preventing the occurrence of senescence symptoms associated with water stress such as bent-neck and petal wilting as exemplified in lisianthus.

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22. CYTOKININ-TO-GIBBERELLIN RATIO REGULATES WATER STATUS, ETHYLENE EVOLUTION AND SENESCENCE IN LISIANTHUS FLOWERS VIA NOVEL SIGNALING PATHWAY

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Abstract

Cut flowers earn Kenya more foreign exchange than fruits and vegetables combined. Lisianthus is among top ten cut flowers in popularity nationally and internationally. The hormone, ethylene triggers senescence. Lisianthus is ethylene-sensitive. The current anti-ethylene pre-treatment silver-thiosulphate (STS) is a potent environmental pollutant under phase-out. The alternative 1-MCP is weak owing to its volatile nature. The objective of this study was to investigate responses to exogenous benzylaminopurine (BA) (0, 70, 140, and 210 µM) and gibberellic acid (GA_3) (0, 5, 10, and 15 µM) applied solo or combined in complete factorial of dosages via

xylem, on physiological and histological changes in lisianthus shoots. The rationale was to develop an effective hormonal pre-treatment to counter the detrimental effects of ethylene in lisianthus flowers. Ethylene and gibberellin action inhibitors: STS and maleic hydrazide (MH), respectively, indole acetic acid (IAA), abscisic acid (ABA) and deionised water were used as controls for hormonal cross-talk. Novel direct *in situ* stomatal aperture imaging and measurement method was used to examine and measure stomata on intact leaves. Significantly different alternating zones of inhibitory and synergistic effects, which depended on the ratio and dosage of the applied hormones, characterized the responses to the combined BA and GA_3 treatments in: water balance ($P = 0.002$), floret wilting ($P< 0.001$), ethylene evolution ($P< 0.001$) and stomatal aperture ($P< 0.001$). Data obtained from this study suggest existence of novel positive cross-talk between gibberellin and cytokinin that prevents water stress and florets wilting in lisianthus. The behaviour of stomata under the influence of cytokinin-to-gibberellin ratio presented in this study, suggests existence of novel long-distance signaling, given that these hormones are normally synthesized at the root tips. However, regardless of modes of action, this study presents novel environmentally-friendly pre-treatment, which is more effective than STS for lisianthus cut flowers.

Introduction

Horticulture is among the leading foreign exchange earners in Kenya. Cut flowers earn Kenya more foreign exchange than fruits and vegetables combined (Musembi *et al*., 2012). Lisianthus cut flowers are among the top ten in popularity locally and internationally (Harbaugh, 2007; HCDA 2011). Ethylene is a gaseous hormone that triggers senescence and programmed cell death (Hurr *et al*., 2010; Shahri and Tahir, 2011; Lombardi *et al*., 2012). Lisianthus is ethylene sensitive (Musembi, 2008). The current anti-ethylene pre-treatment silver-thiosulphate (STS) is a potent environmental pollutant under phase-out (Ichimura, 2005). The alternative 1-MCP is weak owing to its volatile nature (Serek and Sisler, 2001). Recently, Musembi (2008) reported that pre-treatment of lisianthus cut flowers with combined cytokinin and gibberellin via xylem resulted in either synergistic or inhibitory effects in water balance and vase life. However, the modes of action and the predictability of this potent pre-treatment remained unknown. The present study focuses on the modes of action of the hormonal interaction during senescence of lisianthus cut flowers. This is the first report of predictable synergism between hormonal pre-treatments in cut flowers.

Materials and Methods

This study was carried out in the Crop Physiology Laboratories, University of Nairobi, Nairobi, Kenya; using materials obtained from a commercial grower (Charm Flowers Kenya Ltd) in Kajiado County of Kenya. The laboratory was lighted for a 12 hour photoperiod throughout the experimental duration; using cool white fluorescent tubes (24 µmol m^{-2} s^{-1} PPFD above the cut shoots) while the ambient temperature was maintained at 23.5 ± 0.1^{o}C and 65 ± 1% relative humidity. 'Flamenco Series' and 'Magic series' lisianthus cultivars, of single and double flower forms respectively, were used in these experiments. Stomatal aperture measurement was done according to the procedure developed by Musembi (2011). This experiment was set as a complete factorial: with the type of growth regulator as the fixed effect treatment; and the various levels of the growth regulators as the random effect treatments. Equally spaced random effect treatments were chosen to enable analysis of the nature of response surface. The experiments were laid out as Randomized Complete Block Design (RCBD) with 3 replicates (blocks) using stem calliper as the blocking factor. Analysis of variance was performed on the data, using the general linear model procedure of statistical analysis, using GENSTAT Statistical Package (Lane and Payne, 1996). Linear, quadratic and cubic orthogonal polynomials were carried out and appropriate regression models were used to examine the nature of the response to the various equally spaced random effect treatments such as GA_3 and BA (Myers, *et al*., 2009). Multiple comparisons among means were done using Tukey's Honestly Significant Difference (HSD) at 5% level of significance (Steel and Torrie, 1980).

Results

The combination of BA and GA_3 treatment levels resulted in an array of alternating synergistic effect zones and inhibitory effect zones of potency: in the improvement of water balance (Table I), delay of florets wilting (Table II), prevention of autocatalytic ethylene evolution (Table III) and triggering permanent partial closure (PPC) of the stomata (Figure 1) in cut lisianthus shoots. Synergistic and inhibitory effect zones were diagonally oriented in the complete factorial treatment combination grid. This behaviour of the response surface suggests interplay between additive mode of action, and inhibitory or synergistic effects within each zone (shown by shading in Table I). This alternating nature coupled with the fact that the peak value of the synergistic effect zone was represented by specific cytokinin-to-gibberellin ratio suggests

existence of novel long-distance (root-to-shoot) signaling pathway given that these hormones are mainly synthesised at the root tips and induce PPC of stomata.

Table 1: *Interaction effects of BA and GA_3 on the mean cumulative water balance of cut lisianthus inflorescences (mg h^{-1} $stem^{-1}$.)*

BA (μM)	GA_3 (μM)			
	0	5	10	15
0	$204.^{h}$	$352.^{efg}$	$410.^{de}$	$383.^{def}$
70	$410.^{de}$	$548.^{ab}$	$294.^{fg}$	$568.^{a}$
140	$452.^{bcd}$	$268.^{g}$	$528.^{abc}$	$477.^{abc}$
210	$284.^{g}$	$452.^{bcd}$	$460.^{abcd}$	$447.^{cde}$
Nature of Response surface	L (**) Q (***) C (***)	L (ns) Q (ns) C (***)	L (ns) Q (***) C (***)	L (ns) Q (***) C (*)
Deionised water (negative control)				$-10.^{i}$
Silver thiosulphate (STS) (positive control)				$-137.^{j}$

Data from the first and the repeat experiments were pooled. Level of significance: $P = 0.002$. Mean separation was by Tukey's Honestly significant Difference (HSD = 98.2 mg h^{-1} $stem^{-1}$ at $P = 0.05$). Means with the same superscript are not significantly different. Less shading represent additive or inhibitory effect zone while more shading represent synergistic effect zone. The responses to BA and GA_3 were found to be significantly nonlinear.

Table 2**:** *The interaction effects of BA and GA_3 on the days to 50% florets wilting per shoot of cut lisianthus*

BA (μM)	GA_3 (μM)			
	0	5	10	15
0	15.67^{c}	17.33^{bc}	17.67^{b}	17.33^{bc}
70	17.33^{bc}	22.50^{a}	14.67^{d}	21.50^{a}
140	18.00^{b}	15.67^{c}	21.50^{a}	18.33^{b}

210	16.67^{c}	18.67^{b}	18.00^{b}	16.67^{c}
Nature of response surface	L (ns) Q (ns) C (ns)	L (ns) Q (ns) C (***)	L (ns) Q (*) C (**)	L (ns) Q (**) C (***)
Negative control (Deionised water)				13.66^{e}
Positive control (STS)				15.00^{d}

Data from the first and the repeat experiments were pooled. Level of significance: $P< 0.001$. Mean separation was by Tukey's Honestly significant Difference (HSD = 1.705 days at $P = 0.05$). Means with the same superscript are not significantly different. Less shading represent additive effect zone. More shading represent synergistic effect zone. The responses to the BA and GA_3 levels were significantly nonlinear.

Table 3: *The interaction effect of BA and GA_3 on the mean ethylene production rate of excised lisianthus florets for five days of holding (nl s^{-1} $floret^{-1}$)*

BA (µM)	GA_3 (µM)			
	0	5	10	15
0	1.515^{gh}	0.996^{bcde}	1.552^{h}	1.144^{def}
70	1.219^{ef}	0.422^{a}	0.867^{bc}	0.885^{bcd}
140	1.274^{fg}	0.830^{b}	0.568^{a}	0.904^{bcd}
210	0.737^{b}	1.274^{fg}	1.5149^{gh}	1.108^{cdef}
Nature of response surface	L (ns) Q (ns) C (*)	L (ns) Q (**) C (**)	L (ns) Q (***) C (ns)	L (ns) Q (*) C (ns)
Negative control (Deionised water)				1.868^{i}
Maleic hydrazide				1.870^{i}
IAA				1.881^{i}
ABA				1.798^{i}
Positive control (STS)				0.773^{b}

Data from first and second experiments were pooled. Level of significance: $P< 0.001$. Mean separation is by Tukey's Honestly significant Difference (HSD = 0.273 nl s^{-1} $floret^{-1}$ at $P = 0.05$). Means with the same superscript are not significantly different. Less shading represent synergistic effect zone, while more shading represent inhibitory effect zone. The responses to BA and GA_3 were significantly linear and nonlinear.

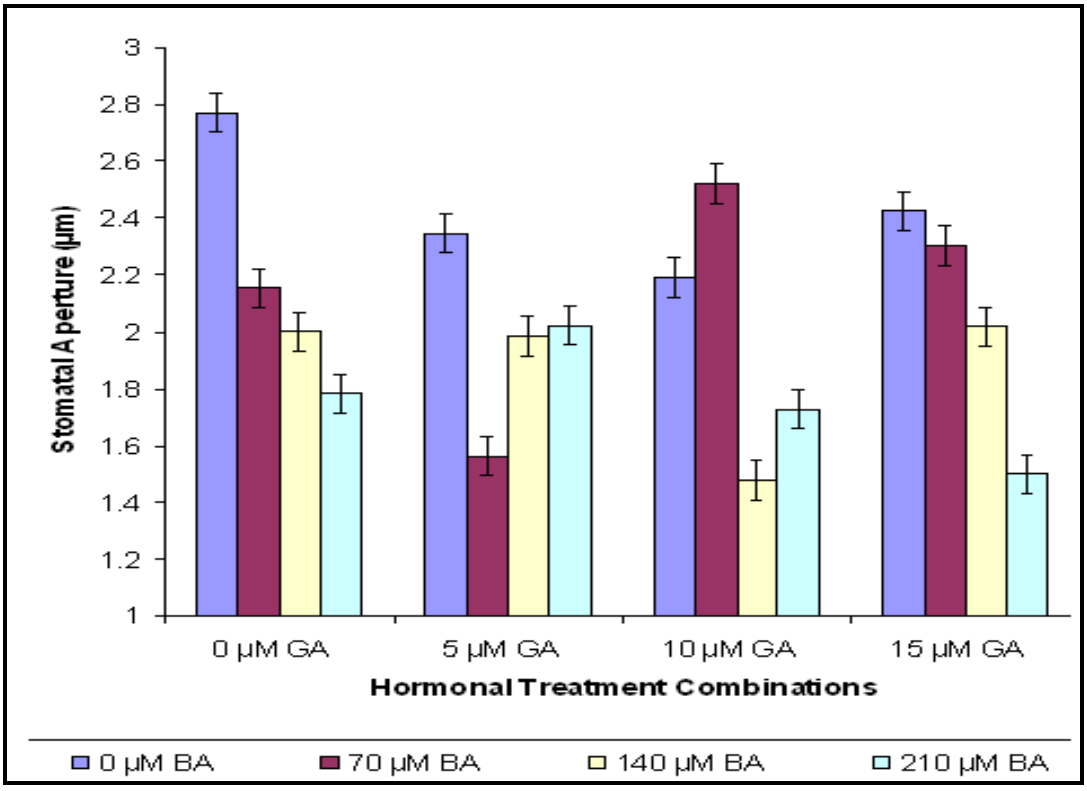

***Figure 1*:** *Interaction effect between treatment combinations on the stomatal aperture of the youngest fully expanded leaf of cut lisianthus shoots*

Y-error bars represent Tukey's Honestly Significant Difference (HSD) for BA×GA_3 interaction effect.

Discussion

The observation that, STS, which is an ethylene inhibitor had no significant efficacy compared to the deionised water control, seemed to rule out any serious involvement of ethylene in water status regulation in lisianthus cut shoots. The hormonal ratio mode of action could be related to the reports by Tworkoski and Miller (2007) on apple tree buds break behaviour and Razem *et al*. (2006) on seed germination behaviour. The observation of synergistic effect zones as a result of cytokinin and gibberellin interaction suggests existence of novel hormonal crosstalk as these

hormones were shown to only interact antagonistically in *Arabidopsis* and other plant systems (Greenboim-Wainberg *et al*., 2005; Weiss and Ori, 2007). However, regardless of the modes of action, the hormonal combination therapy revealed novel effective technique of boosting water status in harvested lisianthus flowers.

Conclusions and Recommendations

Data obtained in this study suggests existence of novel positive crosstalk between ethylene, cytokinin and gibberellin signaling pathways. The fact that specific cytokinin-to-gibberellin ratios triggered permanent partial closure (PPC) of the stomata suggests existence of novel long-distance (root-to-shoot) signaling pathway given that cytokinins and gibberellins are mainly synthesized at the root tips. However, regardless of modes of action, this study presents novel environmentally-friendly pre-treatment, which is more effective than STS for lisianthus cut flowers.

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23. REVIEW OF FACTORS AFFECTING COMPOSITION AND USE OF SLURRY MANURE IN SMALLHOLDER DAIRY FARMS OF KENYA

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Abstract

A review of factors affecting quality and use of slurry manure on fodder crops in smallholder dairy farms of Kenya was undertaken to explore the challenges, options and opportunities of implementing improved methods of manure management in smallholder mixed dairy farms of Kenya. The use of inorganic fertilizers to mitigate soil fertility decline by farmers in Kenya is limited by high costs, low producer prices (of both food crops and milk) and erratic availability. The physical and chemical properties of animal manure are affected by the physiology of the animal, the feed ration, and the environment. The use of organic manure to increase crop production is a viable option to the smallholder resource poor farmers of Kenya. However, farmers have limited skills of preserving the available nutrients in the manure and training them will increase farm yields. Napier grass is the most important feed resource used by farmers practicing zero grazing systems. The results of a study conducted in KARI-Naivasha revealed that when dairy cows are properly fed, they would produce good quality manure. The composition of such manure contained the following nutrients: Dry matter 11.6%, with 0.24% nitrogen, 0.05% ammonium nitrates, 5.2% ash, 0.07% phosphates, 0.5% potassium, 0.1% calcium and 0.07% magnesium. The flow of nitrogen in most smallholder farming systems indicates negative balance. This observation is mainly attributed to high nitrogen losses due to poor manure management within the farming system. It is a known fact that in small scale mixed farms dairy cattle recycles biomass into manure and urine which is used to fertilize the soil. Proper manure handling requires that cows are housed in a stable (unit) with properly constructed dunging area whereby it is easy to collect manure as efficiently as possible and cleaned at least thrice daily. Proper manure management to improve quality require proper feeding of the animals with good quality feeds, proper harvesting (collection) techniques, good storage, and improved application methods.

Introduction

Soil fertility status in Kenya especially in smallholder mixed farms has been observed to be on the decline in a number of areas presenting a serious threat to foodsecurity (Utiger *et al* 2000).

This decline is attributed to over cultivation coupled with monocroping with limited replenishments.

Proper soil fertility management is essential for improving productivity of the crops. In Kenya, the low soil fertility is a major biophysical constraint to increased agricultural productivity amongst smallholder farmers (Hiddink, 1987 and Onduru *et al* 1999). The use of inorganic fertilizers to mitigate soil fertility decline is limited by mainly high costs, low producer prices (of both food crops and milk) and erratic availability (Odendo, *et al* 2000). Due to high fertilizer prices, currently approximated at Kshs.50 per Kg , most farmers practicing intensive dairy production are unable to apply the recommended levels (100kg N/hectare /year) of fertilizer at the rates of 200 Kg NPK and 100 Kg of CAN per hectare per year on Napier grass (Snijders, 1992). Consequently, the yields of Napier grass has significantly declined from and average of 15 tons dry matter/ha/year (DM) to 5 tons DM/ha/year.

In many smallholder systems in Kenya as well as other developing countries, manure is considered as important as milk, meat or draught power. A study by Romney *et al* (1994) in Zimbabwe recorded that farmers reduced grazing time by keeping cattle longer in the pens in order to collect more manure even though this meant reduced feed intake thereby adversely affecting production. In the Kenyan highlands where smallholder dairying is common, use of livestock manure has been on the increase among smallholder farmers due to its substitutability for inorganic fertilizer as the cost of the latter rises due to market distortions, resulting from physical constraints such as poor roads infrastructure (Omamo *et al* 2002).

Manure is a general term applied to describe different forms of organic materials used to improve soil fertility. They include, cow dung/slurry, compost etc. This review has emphasized on slurry as a form of organic manure and its application to Napier grass under smallholder intensive crop/livestock integrated system.

The objective of this review is to explore the challenges, options and benefits of improved methods of manure management systems in smallholder mixed dairy farms of Kenya

Methodology

This review paper was based on the secondary sources on relevant work done others. The review has discussed data as presented by other authors mainly to determine and validate the missing gap among factors which influence manure quality composition with a view to improve the manure quality to enhance improved fodder production and fodder quality for improved performance of dairy cattle under smallholder conditions in Kenya.

Effect of trade liberalization policy on the use of inorganic fertilizer

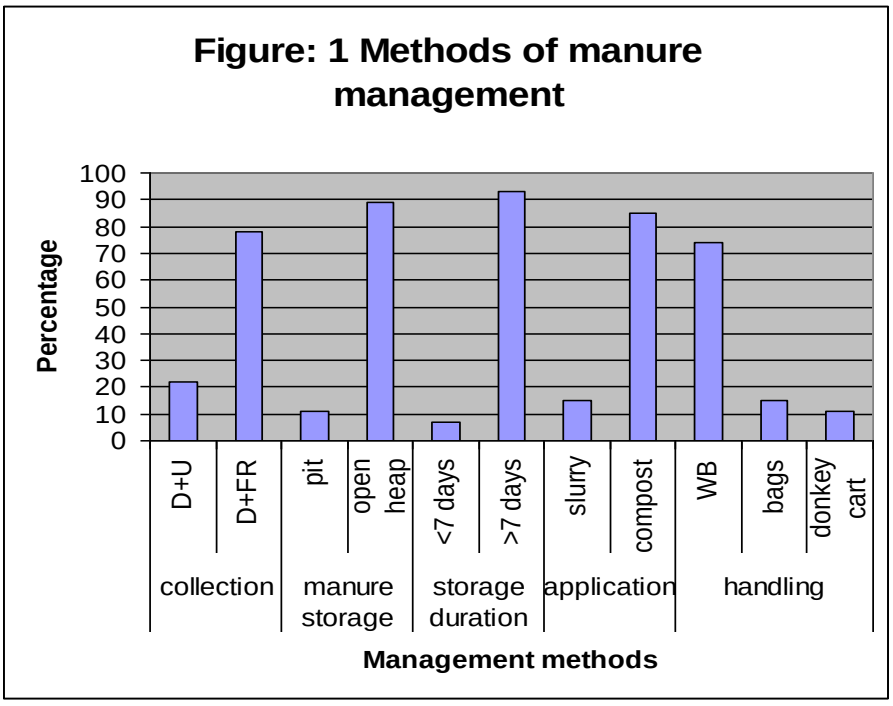
Smallholder farming including dairy sub sector in many parts of Kenya is constrained by declining soil fertility. There are about one million small scale dairy farmers in the country practicing mixed crop livestock farming who produce about 80% of the total milk in Kenya. The removal of government subsidies on agricultural inputs has contributed to the increase in price of farm inputs to levels beyond the reach of most farmers. Lack of price support policy to encourage smallholder farmers further discourages the farmers hence they do not apply high external inputs to boost production. The use of inorganic fertilizers to alleviate constraints of fodder production is limited mainly by its high cost, untimely availability and low producer prices. Other than lack of market and policy support, principal constraints to dairying in Kenya are of technical nature. Lack of broad knowledge on fodder production, conservation and utilization, poor reproductive health management and poor milk handling are recognised as major technical challenges facing smallholder dairy farmers in Kenya.

The use of organic manure to increase crop production is a viable option to the smallholder resource poor farmers of Kenya. However, farmers have limited skills of preserving the available nutrients in the manure and training them will increase farm yields.

Lack of appropriate manure management skills and tools as a limitation to smallholder farmers

Proper manure handling requires that cows are housed in a stable (unit) with properly constructed concrete dunging area which makes it is easy to collect manure. In addition, there should be provisions of a well constructed concrete or trench manure pit for daily storage and immediate application to minimize nutrient loss especially nitrogen. The application goes along

with proper crop husbandry practices e.g. weeding. In practice, slurry should be applied on daily basis in dug farrows and covered with soil to maximize Nitrogen utilization. A study by Ayako in Bahati- Nakuru revealed that most smallholder farmers used convenient manure management methods perhaps due to lack of knowledge and resources. A majority of farmers did not collect dung with urine (figure 1) whereas over 80% of the farmers did not store manure in a manure pit. Over 90% of the smallholder farmers heaped manure on open heaps and only applied it on crops in dry form. Less than 20% of the farmers used manure in wet slurry form. Majority of the farmers used a wheelbarrow to transport manure to the field. The use of donkey was uncommon perhaps due to cultural reasons or lack of feeds to maintain them.



Key: D+U = Daily dung collection together with urine, D+FR=Daily dung collection together with feed refuse, WB=Wheelbarrow (Source: Ayako, 2005)

The same study by Ayako revealed a negative nitrogen balance under smallholder farms of Bahati table 1. This observation was mainly attributed to high nitrogen losses due to poor manure management within the farming system.

Table 1: *In-flow and out-flow of nitrogen from smallholder dairy farm*

In-flow	**(kg)**	**Out-flow**	**(kg)**
Dairy meal	93.3	Sold Milk Sold animals Losses	23.6 7.7 64.1
Total	93.3		95.4
Balance	**-2.1**		

Source: Ayako, 2005

Under well managed average smallholder farms of Kenya, farmers keep 2.5 cows and the average yield of Napier grass is 14 tons dry matter per hectare per year. The average milk production is 2400 litres per cow per year. This amount of milk translates to 6000 litres per hectare of land. Due to low income and reduced profit margin, farmers feed 1000 kg concentrate per hectare. Manure production in such farms is estimated at 50 tons per hectare and therefore slurry use in those farms indicates improvement in soil nutrients.

The mineral balance observed in such farms based on the input and output indicates a negative Nitrogen balance while the balance for Phosphates and Potassium are positive. This common feature in smallholder farms depicts that the cycle for Potassium and Phosphates is more closed than that of Nitrogen (Kenyan soils are K surplus). It therefore points out that in the short term the farming system under smallholder dairy farms is self sustaining for the two elements (Potassium and Phosphate) while in the long term, it indicates the dangers of environmental (ground water) pollution if excess manure is applied to crops.

It is generally deduced that if manure nutrients are well conserved and recycled back to the soil there is a better residual effect on fodder productivity in the short run. However in the long run a combined use of both inorganic fertilizer and organic manure would provide better yields and feed quality of Napier grass. The impact of improved feeding of dairy cows would boost milk production and thus increase profitability for smallholder farmers.

Effect of inadequate feeding on quantity and chemical composition of manure

It has been confirmed by several studies that the amount and composition of manure, especially Nitrogen content in the dung and urine is determined by such factors as ration digestibility, animal intake and urine production. Jarvis (1989) found a direct relation between Nitrogen content of the grass and Nitrogen concentration in Urine. It is noted that farmers with higher milk production tended to have higher Nitrogen content in Manure which could either be attributed to better feed intake or the influence of high protein feeds in the offered rations. Valk (1992) however found that higher excretion of urine was influenced by higher urine production rather than high Nitrogen concentration in urine in experiments where protein rich grass was supplemented with low protein feeds.

Dung from un-supplemented, extensively grazed Sahiwal cows in Naivasha, contained about 1.5% Nitrogen (on dry mater basis), while dung of Sahiwal in India contained about 2% Nitrogen (Gaur *et al*, 1977). Dung of supplemented Friesian cows in Kenya and in Europe contained higher Nitrogen than un-supplemented cows(Valk, 1992).

According to Lekasi *et al* (2001a) the live weight of ruminants can be used to estimate the maximum quantity of manure produced expressed at 0.8 % percent of live weight as the theoretical maximum amount of fecal DM daily. However this calculation assumed that there are no losses in DM. In another experiment conducted using steers, Lekasi *et al* (2001b) estimated urine production of 25 grams/kg live weight. The urine is assumed to contain 10 and 12 grams of Nitrogen and potassium per liter of urine respectively (SundstØl and Owen 1993).

Table 2: *Slurry compositions in Kenya, Netherlands and United states*

Slurry type	**DM %**	**%N**	**%NH3-N**	**% ash**	**% P**	**% K**	**%Ca**	**%Mg**
Naivasha Kenya	12	0.26	0.6	5.7	0.06	0.50	0.12	0.07
Kakamega Kenya	7.7	0.17	0.6	2.1	0.03	0.21	0.03	0.04
Netherlands	9.5	0.44	-	3.5	0.08	0.46	0.15	0.06
United states	9.0	0.20	-	-	0.05	0.02	-	-

Source: adapted and modified from Snijders 1992

Due to different feeding and management of animals, the quality of slurry manure in Kenya and The Netherlands showed different qualities in composition as shown in the table 1.
The physical and chemical properties of animal manure are affected by the physiology of the animal, the feed ration, and the environment. Size of the animal, as measured by its live weight, is perhaps the most important physiological factor. Sex, breed, and activity of the animal affect manure properties to the extent that they partially determine the feed conversion efficiency under a given environment. The digestibility of the feed ration, the protein and fiber content, and the nature of the other feed elements also affect the physical composition of manure. Temperature appears to be the most important factor.

Feed quality influences not only the amount the animal eats daily, but also the chemical composition of the manure. Proteins, which contain most of the nitrogen of the feed, vary in digestibility. Nitrogen in undigested protein is excreted in the solid feces, in the digested proteins; it is absorbed and later excreted in the urine except for the portion that is used to build the muscles and the flesh in the animal. Potassium is absorbed during digestion, but practically all is excreted.

Part of the phosphorous content of the feed is absorbed in the animal body system, but most is excreted in the feaces. The portion of feed spilled on pen floors, or left as feed refuse is included undigested in the manure collected from the animal pens. Consequently, manure from animals fed in confinement contains almost all the ingredients of feed some in their original form, others in chemically simpler forms.

Slurry composition

The results of a study conducted by Snijders *et al* (1992) at KARI-Naivasha revealed that dairy cows fed with adequate Napier grass and supplemented with concentrates, produced good quality manure. The composition of such manure contained the following nutrients: Dry matter 11.6%, with 0.24% nitrogen, 0.05% ammonium nitrates, 5.2% ash, 0.07% phosphates, 0.5% potassium, 0.1% calcium and 0.07% magnesium.

Napier grass as a feed resource to smallholder zero grazing farmers

Although Napier grass is the most important feed resource used by farmers practicing zero grazing systems, it requires high soil fertility and precipitation of about 1000 mm and temperature range of 10°C-40°C for optimum growth. The popularity of Napier grass is attributed to its high dry matter production and suitability as cut and carry feed. It also has a reasonable quality if well managed to sustain production of up to 7 litres milk per day above maintenance requirements of the cow without supplementation with concentrates.

A study done by Snijders et al 1992 at KARI, Naivasha revealed that soil analysis from Napier grass plots before and five years after experimentation with slurry manure applied as covered manure in the soil compared with inorganic (nitrogen) fertilizer. The results from those trials further pointed that calcium, phosphorous, potassium, carbon and nitrogen contents in soil increased five years later on slurry treated plots.

Soil fertility management for Napier grass

Napier grass is a demanding fodder crop in terms of soil fertility management. It requires high external input to maintain high output per unit area of land. Most small scale farmers cannot afford to apply the required levels of external inputs and therefore resort to manure use. The National Dairy Development Project (NDDP) recommended that all manure produced by the cows in the farm should be recycled back to the Napier fields in order to maintain high yields. It was further recommended that the manure should be worked in the soil for better utilization. It is against this backdrop that farmers should adopt a system of improved manure management to sustain high Napier yield, milk production and increase income.

The optimum benefit of manure use requires that the slurry manure (urine plus dung) is efficiently collected, stored and applied to minimize nutrient losses.

Benefits of slurry manure to smallholder farmers

Lekasi *et al* (2001 a) found that the value of manure produced in smallholder dairy farms in Kenya may be approximately 30 % of the value of milk produced if the value is captured on farm through increased value of crop production resulting from manure application to crops.

Livestock manure has been identified as an important farm input in small-scale mixed crop-livestock farms. Manure provides essential soil nutrients, especially Nitrogen, Phosphates and Potassium. Other benefits that have been demonstrated include increase in cation exchange capacity (CEC), pH, water holding capacity, infiltration rate and decrease in bulk density. Ninety five percent of all smallholder farmers in Kenyan highlands use manure. Utilization of cattle manure as a soil amendment is an integral of smallholder crop-livestock farming systems of the Kenyan highlands and East Africa. Manure produced in these systems is usually applied prior to planting of field crops such as maize, beans, and potatoes as well as vegetables like kale, cabbages and tomatoes, and cash crops such as coffee and tea in the form of compost.

Conclusion

This study confirms the fact that in small scale mixed farms dairy cattle recycles biomass into manure and urine which is used to fertilize the soil. Efforts put into these systems may be wasted if manure obtained from the system is not adequately managed. Proper manure management to improve quality require proper feeding of the animals with good quality feeds, application of proper manure harvesting (collection) techniques, good storage, and improved application methods.

Recommendations

In order to improve the nitrogen content in the slurry manure, it is advisable to feed dairy cows with fodder tree legumes such as Calliandra, Leucaena and Lucerne together with Napier grass. The effect of improved feeding is lacking in many smallholder farms since most farmers are unaware of the benefits.

It is also important to invest on manure storage pits to preserve nutrients in slurry.

It is equally important to reduce the storage duration to increase the frequency of application to be able to capture more nutrients by closing the open gap in the Nitrogen cycle.

Manure collection should be done as soon as the dung and urine are deposited by the animal.

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24.THE ESTABLISHMENT OF NATIONAL INNOVATION CENTRES IN KENYA

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Abstract

The Micro and Small Enterprise (MSE) sector in Kenya is an important source of employment to a large proportion of the working population as well as products and services to the country. The sector is however faced with numerous challenges which limit their growth. The premise of the paper is to introduce an innovative mechanism that will address some of the challenges faced by MSEs though the development of a national inventory where innovations or intellectual property developed by MSEs can be archived and made accessible to investors for commercialization and market penetration. The paper puts forward three strategies to promote the MSEs and national inventory. To facilitate these strategies a National Innovation Centre would have to be established; which would have the multiple functions of hosting and maintaining the innovation inventory; facilitating access to finance; linking inventors and investors; providing marketing support (of the produce available in the innovation inventory); and facilitating the acquisition of IP and valuations of IP assets.

The expected outcome; if such a mechanism was established, include; improved competitiveness and technological capacity amongst MSEs who would embrace intellectual property rights and develop, commercialise and promote their innovate products.

Introduction

Micro and Small Enterprises (MSEs)[1] in Kenya have been in existence for over two decades and have been a major source of employment, goods and services. According to the *National Micro and Small Enterprise Baseline Survey 1999; Survey Results*[2], which is the most comprehensive survey of MSEs undertaken in Kenya to date, MSEs contribute approximately 18.9% of GDP and provide employment for 2.3 million people. This accounts for approximately 48%[3] of the total employed persons in Kenya in 1999 (the year the survey was conducted). Despite this, MSEs face a number of challenges which limit their growth opportunities[4]. They are faced with inefficient market information; poor market access; low technological capability; limited access to finance and capital and limited awareness or use of Intellectual Property Rights (IPR).

One major advantage that MSEs have is that; they are innovative, flexible, and willing to experiment and exploit new markets compared to larger enterprises[5]. This is evidenced in Kenya where number of MSEs and young entrepreneurs develop and offer unique innovative products and services. Incubation centers to harness relevant talent in ICT have also emerged which include iHub, NaiLab, University of Nairobi's FabLab, and Strathmore University's iLab which are Innovation Hubs for entrepreneurs and technologists in the ICT sector.

[1]MSEs here are defined as formal or informal non-primary enterprises employing 1-50 workers. This therefore includes sole-proprietors and/or single entrepreneurs.

[2]CBS, ICEG and K-Rep Holdings ltd (1999), *National Micro and Small Enterprise Baseline Survey 1999; Survey Results.* Central Bureau of Statistics (CBS), InternationalCenter for Economic Growth (ICEG), K-Rep Holdings Ltd, Kenya

[3] This percentage is obtained from the 2000 Economic Survey, which estimates that the total recorded employment (excluding the public sector) on 1999 was 4.79 million and the 1999 National MSE Baseline Survey estimates that 2.3 million persons are employed in the MSE sector, therefore the MSE sector accounted for 48% of the total number of employed persons

[4] Gitonga, A (2008), *Factors Affecting Growth of Micro and Small Enterprises in Kenya* KIPPRA Discussion Paper no. 88, finds that MSEs that contract; market; and those with larger capital base achieve higher levels of growth. The study recommends that growth oriented MSEs be provided with marketing, financial and business support and be encouraged to network and form linkages

[5]Fafchamps, M. (1994), Industrial Structure and Mircoenterprises in Africa.*The Journal of Developing Areas*, Vol. 29 (October 1994), pp. 1-30.

Theoretically the objective of intellectual property rights is to provide the inventor with incentives to recoup the costs associated with developing the invention[6]. This however may not be the case in Kenya as innovators may not be effectively utilising IPRs systems. The low uptake of IPR in Kenya is attributable to limited awareness of IPR. The MSEs that do develop Intellectual Property (IP) products often face challenges in commercialising them. Kenyan inventors often misunderstand how to commercialise and protect their inventions. A large number of them have high expectations for rewards from their inventions. Some expect Kenya Industrial Property Institute (KIPI) and the Government to provide them with financial assistance to commercialise their products. Most however think that self exploitation is the only way for them to be able to commercialize their products[7].

There are important developments in the country for instance the government of Kenya has drafted a Science Technology and Innovation Bill and Science Technology and Innovation policy. Further to this efforts to support start-ups through innovation hubs as mentioned earlier are also being intensified; however IP awareness uptake, commercialization and even market access are key challenges that still plague MSEs. Furthermore, MSEs still face the challenge of lack of collateral despite the growth in the Micro Finance Institutions (MFIs) over the last few years.

The Approach

To develop an innovative mechanism that will address the challenges faced MSEs and gaps though the development of a National Innovation Centre to host and maintain an innovation inventory; facilitate access to finance; link inventors and investors; provide marketing support (of the products available in the innovation inventory); and facilitate the acquisition of IP and valuations of IP assets.

Methods and Materials

The stages and methods of actualizing this idea include the following;

[6]See Besen M. S. and Raskind L. J. (1991), 'An Introduction to the Law and Economics of Intellectual Property' The Journal of Economic Perspectives Vol. 5 No. 1 pp. 3-27

[7] See Ogada, T., Nyangun K, Njuguna D., Mwasi M., Sange S., Gituku B., Mbayaki A., Waweru I. (2004), *Report on National Intellectual Property Audit*. Prepared on behalf of the World Intellectual Property Organization (WIPO)

Inception stage: The activities to be carried out during this stage include;(1)the dissemination of the idea to potential stakeholders for buy-in; through roundtable meetings, policy brief, media articles and conference presentations; and (2) the setting up of a multidisciplinary implementation team (3) the developments budget and (4) staffing and funding.

Phase 1: Digital stage: During this stage, a virtual National Innovation Centre will be established which will host the online national innovation inventory and the MSE product catalogue. During this phase, effort shall be made to generate interest in the Virtual Centre and to develop the (1) innovation directory which describes the innovation and the financial support necessary and the (2) inventory providing details of the products and price which is availed the public.

Phase 2: Physical National Innovation Centre: Once the database has been established, Phase 2 will commence which will involve institutionalizing the National Innovation Centre physically. The Centre will operate like a one stop shop linking relevant players such as innovators, investors and financing agents.

Discussions

The National Innovation Centre envisioned above will utilise the following three strategies;

The inventor-investor strategy: under this strategy, an investor looking for investment opportunities can come together with inventors in need of financial assistance to develop their product under the National Innovation Centre. The MSEs with an innovation will identified by the potential investor from a database which is maintained by this institution. The investors can then identify and invest in the innovations they desire, inject some capital and the MSE can then develop, protect (using IPR) and commercialize it using the additional resources. The revenue and/or royalties generated from the commercialization of this product can then be used to pay back the investor.

The inventor-financier strategy: In this strategy, financial agents affiliated to the Centre would develop a financial solution for MSEs who have an innovative IP product and require financial support to commercialise and market the product. The uniqueness of this financial solution would be that the innovation would serve as collateral. A license agreement for instance can be

drawn between the inventor and the financing agent[8]. This will also act as a form of security and the repayment plan. Royalties and income generated from the products are then utilised to repay the financier. This is an important consideration because IP assets are often not considered as collateral in the Kenyan financial market.

Marketing strategy: as indicated earlier, market access is a major challenge for MSEs. The National Innovation Centre will therefore be mandated to provide a database of the innovative products available in the market. This second database would be a catalogue providing details of the products and price which is availed the public including potential investors and buyers (depending on the database).

Conclusion

The establishment of National Innovation Centres requires by-in by players involved in the Kenyan innovation and commercialization cluster as well as players in the financial sector. The key expected outcome is the establishment of a National Innovation Centre hosting products by local MSEs which can be accessed by local and foreign investors. The potential benefits of such a model are however many; they include; improved use of intellectual property rights amongst MSEs, increased commercialization and marketing of local products and consequently improved local technological capability.

It is therefore necessary to start bringing together relevant stakeholders during this inception stage to identify their contribution and strategize on the way forward.

25.THE POTENTIAL IN SOLAR DRIVEN COOLING SYSTEM FOR DOMESTIC AND INDUSTRIAL USE IN KENYA

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Introduction

This paper explores the potential of solar driven cooling systems for home, office and industrial premises. Kenya is situated along the tropics and temperatures range between 28-33^{o}c during the day. Solar driven cooling fans would be idea for cooling room space because solar energy is free and renewable. According to the Vision 2030, Kenya's development project will increase the demand of energy supply; these calls for new sources of energy through the exploitation of geothermal power, coal, renewable energy sources, and connecting Kenya to energy surplus countries in the region. Solar energy is one of the sources of renewable energy.

[8]One can legally assign their licence to a third party through different modalities such as license agreements for instance. The Industrial Property Act (2001) of Kenya, for instance, has this provision for patent license holders.

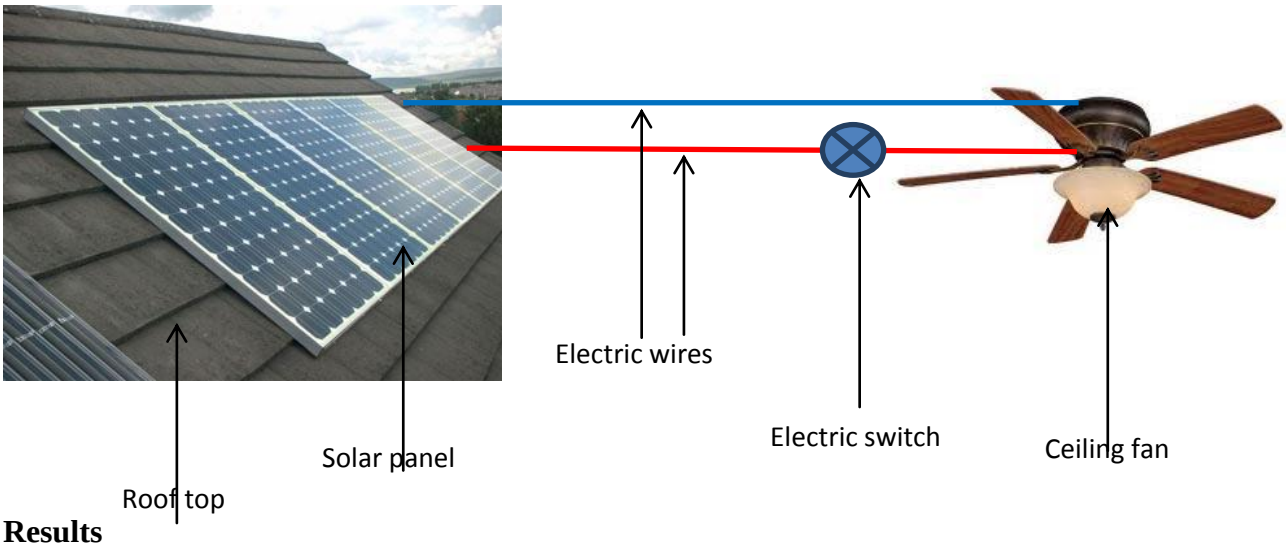
Solar power is the conversion of sunlight into electricity, either directly using photovoltaics(PV), or indirectly using concentrated solar power (CSP); PV converts light into electric current using the photoelectric effect.The early developments of solar technologies were started after the Industrial Revolution which was accompanied by increased use of coal, this saw the transition of energy consumption from wood and biomass to fossil fuels. These early developments of solar technologies were started in the 1860s and were driven by an expectation that coal would becomedepleted. However the development of solar technologies stagnated in the early 20th century in the face of the increasing availability, economy, and utility of coal and petroleum. In 1973,the oil embargo and 1979 energy crisis caused a reorganization of energy policies around the world and brought renewed attention to developing solar technologies. The International Energy Agency has pointed out that solar energy can make considerable contributions to solving some of the most urgent problems the world is facing.The development of affordable, inexhaustible and clean solar energy technologies will have huge longer-term benefits. It will increase countries' energy security through reliance on an indigenous, inexhaustible and mostly import-independent resource, enhance sustainability, reduce pollution, lower the costs of mitigating climate change, and keep fossil fuel prices lower. These advantages are global. Hence the additional costs of the incentives for early deployment should be considered learning investments; they must be wisely spent and need to be widely shared.In 2011, the International Energy Agency said that solar energy technologies such as photovoltaic panels, solar water heaters and power stations built with mirrors could provide a third of the world's energy by 2060 if governmentsare committed to limiting climate change. The energy from the sun could play a key role in de-carbonizing the global economy alongside improvements in energy efficiency and imposing costs on greenhouse gas emitters.

Materials and methods

The following materials will used for this study;

- Solar panel electricity systems, also known as solar photovoltaics (PV)
- Electric motor (DC)
- Old fan
- 10 meters of electric wire (1.5mm)
- Power socket

A solar panel will be fixed on the roofing of the desired building and directly connected to an electric motor using the 1.5mm electric wire which is integrated to a cooling fan. A power switch will then be connected to control the running of the fan.



Results

The expected results are that; this cooling system will work efficiently reducing reliance on electric power from the major grids in cooling premises.

Discussions

From the expected results it is expected that this idea will reduce reliance on electric power from the main grid lines. Since cooling is mostly required during the day when the temperatures are high due to abundant sunshine this system should be reliable for the purpose it is designed for. Storage battery can as well be installed to store excess energy which can later be used when there is no sunshine or for other purpose such as lighting.The substitution of solar energy in Kenya will be in line with Vision 2030 agenda on the exploration of renewable energy as well as the economic pillars agenda on industrialization and employment.

Conclusions and Recommendations

From the expected results this system will confer to The International Energy Agency which said that solar energy can make considerable contributions to solving some of most urgent problems the world is facing today. The adoption of affordable, inexhaustible and clean solar energy technologies will have huge longer-term benefits; It will increase countries' energy security through reliance on an indigenous, inexhaustible and mostly import-independent resource, enhance sustainability, reduce pollution, lower the costs of mitigating climate change, and keep fossil fuel prices lower. This project will be in line with Vision 2030's chapter on Economic Development on industrialization. It is also aims towards the attainment of green economy in Kenya. My recommendation is that Kenya should embrace the adoption of renewable sources of energy because they are cheaper and friendly to our environment.

Reference

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The Vision 2030: http://www.vision2030.go.ke/index.php/pillars

26.TUNGIASIS AS A RISK FACTOR FOR HIV/AIDS IN ECONOMICALLY DISADVANTAGED COMMUNITIES IN MURANG'A NORTH

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Abstract

This research endeavored to determine the prevalence values of tungiasis as well as HIV/AIDS among the economically disadvantaged communities in Murang'a County. The risk factors have been identified and jigger specimens taken for laboratory analysis. To reduce stigma among the infested, meetings with school heads and teachers were held and discussions on how to socially live and accept the infested realized. Brochures were also issued to enlighten both non infested and infested. Visits to schools by the researchers and the medical personnel were made where interviews and questionnaires were administered to both infested and non-infested. This was done in class 4-8 in the schools visited. The infested were identified, counseled and treated. Blattanex, potassium permanganate and Hydrogen peroxide were chemical used in treatment of tungiasis. Two mls blood was also taken for antibody and CD4 analysis. Infested people were counseled and well guided towards Voluntary Testing. The homes of the infested pupils were indentified and the pupils were followed in to their homes to reach out for infested relatives. In all the 5 primary schools visited, 37 pupils are infested. Boys are more infested (4.47%) compared to girls (2.17%). Only 2 adults out of 27 interviewed were infested. Most of the children infested fall between ages of 3 years to 13 years.

Introduction

Tungiasis is a disease caused by jigger infestation which currently does not have properly defined specific, effective cure or therapy(Heukelbach *et al*., 2001). Use and sharing of unsterilized sharp objects such as safety pins, isrisk factor for HIV transmission. Tungiasis is characterized by high transmission rate due to poor housing conditions, social neglect and inadequate health care (Pigler *et al*., 2008). The pathophysiological and immunological

characteristic of this ectoparasite are not well understood and therefore no effective therapy is currently available.(Fieldmeier*et al*., 2004).The epidemiological data on tungiasis in Kenya is scarce; lack of in-depth understanding of the biological behavior of these parasites and characteristic of its antigens have led to ineffective intervention strategies. Severe itching, pain, difficulty in walking to school and stigma are some of the factors that make it hard for pupils to concentrate in class. In tungiasis, clinical pathology is frequently accompanied by a pathological alteration of the epidermis and dermis. (Ugbomoiko *et al*; 2007.)Therefore this project aimed atreducing the risk factor for HIV/AIDS in economically disadvantaged communities in Murang'a and characterization of the most immunodominant antigen in *Tunga penetrans*which can be used to improve on preventive/curative strategies .To realize vision 2030, urgent solution to tungiasis must therefore be found.

Materials and methods

Study Site

This project was carried out in Murang'a North District. This area is a part of Murang'a County with a population density of about 942,581 people according to 2009 population census. The area receives about 900mls of rainfall per annum and day temperatures are between 28-30^{o}c during dry seasons.

Study Population and Study Design

The study population comprised of primary school children and their relatives at home. Kiharu districtsand Gaturi division were covered. Purposive sampling was used to select three primary schools in each division. In each school classes 4-8 were sampled and members recruited in the study. Interviews as well as questionnaires were administered to both infested and non-infested. Health officers and Community health workers extracted jiggers specimens and treated tungiasis.Extracted jiggerswere preserved in absolute alcohol for lab analysis. At least 2mls blood was removed for assessing CD4 cells as well as obtaining serum for antigen – antibody reaction analysis. A veterinary was engaged in assessing the domestic animals at home for the presence of flea intermediate stages to determine their role as reservoirs. Two hundred samples were collected.

Results

Economically challenged communities are prone to jigger infestation. In forty homesteads visited so far have houses either made of bricks or mud walls. In all of the houses, the floor were earthened and dusty; a conducive environment for fleas that causes tungiasis to breed. Dogs, cats and chicken which were not frequently treated against fleas and were found to harbor flea larval stages. The prevalence rates for the various primary schools were found to be as follows; In Gaturi primary was 1.5% girls were infested, compared to 6.1% in boys; a total percentage of 4.0% of pupils infested. In Kiamuri primary, 3.1% girls and 1.9% boys were infested; a total percentage of 2.4%.In Nyakihai, 1.6% girls were infested compared to 2.9% boy; a total of 2.3% pupils infested. In Gakuyu primary, 4.3% girls were infested while 7.2% boys were infested; a total percentage of 5.8% of the pupils infested. In Ititu primary, only onepupils was insfested; prevalence rate of 0.03%. In all the 5 schools so far visited, 37 pupils are infested.Boys are more infested (4.47%) compared to girls (2.17%) which translates in to 2.44%.

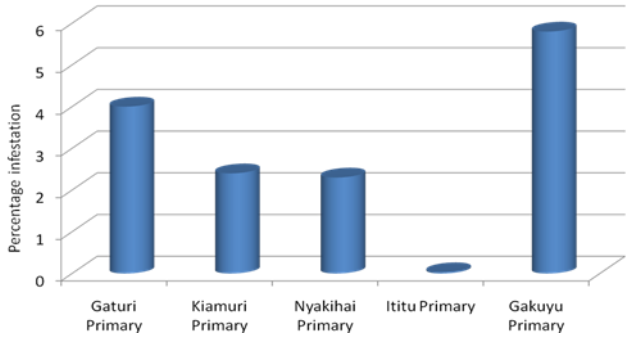

Fig 1: *Percentage infestation rates in primary school visited*

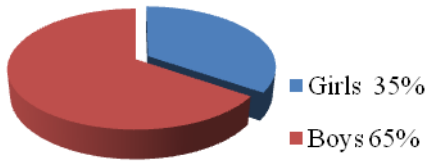

Fig 2: *Jigger infestation in relation to Gender*

It was noted that children of between 3-12 years are the most venerable.Only 2 out of 27 adults interviewed were observed to have jiggers.In all the 37children and 27adults studied so far, none of the jigger infested individual was found to be HIV +ve. A case of HIV +ve parent was identified but was not jigger infested, though the children were jigger infested. However the parent is under ARVs and has closely monitored her children HIV–ve status to prevent infection.

Discussion

Stigmatization was one of the factors that have lead to sustained jigger infestation in Murang'a. In at least two homes the parent hind their jigger infested children.Negligence was another factor; in some homes young mothers have abandoned their little children, and left for town. Their grandmothers were old and weary to maintain proper hygiene to protect themselves against jigger infestation.Domestic animals like dog, cats and chicken were found to harbor flea larval stages.Poverty and poor housing facility was a major factor in jigger infestation. Most of jigger infested families earned less than 3000/- per month. They were unable to feed themselves properly or build proper housing facility.Dusty floor in schools and homes were good breeding places for jigger larva fleas.These results were found comparable to result of a similar study done in Brazil,(Fieldmeir *et al*., 2004; Heukelbach *et al*., 2001) andin Erekit, a rural community in Lagos state of Nigeria (Ugbomoiko *et al*., 2007) whereby domestic animals such as dogs and cats were found to harbor larval stages of the fleas, while dusty floors acted as breeding places for jigger fleas. It was noted that public health officers were providing some chemicals such as blattanex, potassium permanganate, Hydrogen peroxide as well as dusting houses with sevin dust to reduce jigger infestation. Community awareness campaigns at school and meeting places were stepped up, greatly reducing stigmatization.

Conclusion

Jigger infestation(tungiasis) is a health issue that can be won. Sustained campaigns will eliminate stigmatization and allow acceptance of the infested in the society. Combined effort by researchers and medical practitioners can come up with proper treatment for tungiasis and bring down jigger infestation to insignificant levels.

Recommendations

The government should supply enough chemicals such as potassium permanganate to jigger infested through local leaders. CDF funds should be utilized in cementing of floor of classes in jigger prone areas, to reduce risk if getting infested. HIV/AIDS awareness should be intensified in such areas to reduce chances of HIV transmission through use of sharp objects to extract jiggers. VCTs should be increased in areas prone to jiggers.

Acknowledgements

This work is being supported by NCST, Kenyatta University, Department of Zoological sciences, Department of Tropical and Infectious Diseases, Institute of Primate Research (IPR), and Ministry of Health, Murang'a District Hospital. We thank Public Health officers, Clinical officers and Community Health Workers attached to local dispensaries. Also acknowledged are area District Education Officers in as well as Head teachers in primary schools visited.

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ABSTRACTS FOR INNOVATIONS

AND EXHIBITIONS

Table of Contents

1. CAR TRACKING SYSTEM

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This is a safe car tracking and anti-theft system. Using a mobile phone this tracking system tracks and delivers the actual geographical position of the vehicle which will be very useful in recovery of stolen vehicles. The tracking system accurately indicate the actual location, speed at which the vehicle and travel direction. The innovation integrated in-build GPRS/GPS/GSM which helps users to locate local landmarks. Using the Mobile phone from any location switch on and off the engine of the vehicle. The owner of the car does not need to understand or study complicated maps and coordinates simply because the device will configure the feedback information into an understood language.

2. 3G REMOTE CAMERA

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The 3G Mobile Remote camera detects the presence of an intruder in one's house or property then sends live video to home owner through a 3G enabled mobile phone. Before sending the live video, it sends one an option of raising the alarm for an emergency response. If one does not respond to the call, it is forwarded to another number that the owner of the property had asked to be installed into the system. "The device works well with a 3G enabled mobile phone due to its high speed Internet. This 3G Remote Camera can live video to mobile phones as well as communicate directly to the intruder via the alarm external speakers. The device can be used in homes, garages, shops, banks and even in cars. The alarm also uses several sensors e.g. smoke detector, heat detector, gas leakage detector, glass breaking detector, motion and rain. If any sensor is triggered, an SMS notification will be sent to the mobile phone of the owner. It can also detect power cut off and power recovery then sends SMS alarms to ones mobile phone.

3. MULTIPURPOSE SEED BASED ABSORBER

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This project is based on the unique behavior of the seeds of a local weed that is traditionally used for cleaning eyes among the Kamba community of Eastern Kenya. The seeds take up to 20 times their weight of water in 30 minutes. In the process they swell and become sticky. This property has been exploited in this Innovation Project for making the following: Soil conditioner for planting maize in nurseries before onset of rains. Secondary absorber for cotton Sanitary towels. Teaching and Learning materials in the form of tactile diagrams for blind learners. This innovation is going to produce affordable sanitary towels for school girls from poor rural and urban communities. It will also address the problem of food security by having maize nurseries that consume little water transplanted to counter problem of the ever reducing rainfalls. The innovation will provide alternative source of affordable and easy to make teaching/learning materials for the visually impaired. The plant is going to be introduced to farmer as a new cash crop in the Arid and Semi Arid Lands (ASALs).

4. 'TOMATOR' TEA MAKER MACHINE

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This is an automated tea making machine which make tea on its own, it's mixes water, milk and tea leaves switch on the heater and when the brew is due the machine switches off automatically, as it does filter tea leaves residues pouring tea to a thermal flask and finally cork thermal flask to maintain the heat. First you need to pre-arrange the tea making ingredients (tea leaves, milk, water and thermal flask. The cooking pot is the one containing water, stainless cup 500ml capacity contain milk and tea leaves cup is hooked on top of the milk cup adjacent with tilting direction. 'TOMATOR' makes 1500ml of tea within 3 minutes. This is a innovation makes its cheap to make, will create employment and saves time for busy people who need to take tea.

5. ELISA-BASED KIT FOR DETECTION OF HEPATITIS B SURFACE ANTIGEN IN BLOOD MATRIX AND IMMUNOCHROMATOGRAPHIC TEST KITS FOR DETECTION OF HEPATITIS C VIRUSES

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Hepatitis B infection is caused by Hepatitis B Virus (HBV) which is a double-stranded DNA virus coated with an envelope containing Hepatitis B surface antigens (HBsAg). The presence of HBsAg in blood matrix is an important marker for HBV infection and it form the basis the Enzyme-linked Immunosorbent Assay (ELISA) and Immunochromatographic strips (ICS) kits currently in the market. This innovation project has developed a cost-effective ELISA kit for detection of HBsAg in plasma and serum using polyclonal antibodies produced locally in Kenya at KEMRI. The study also prepared a Hepatitis C Virus (HCV) test kits based on ICS platform. The experience gained in the use of the two technology platforms could be used to develop more diagnostic products based on the same technologies. The developed kit has diagnostic sensitivity of 96.1%, diagnostic specificity of 100%, positive predictive value of 100% and negative predictive value of 95.7% with Hepanostika Ultra HBsAg kit as a gold standard. This innovation will make available affordable kits for screening and diagnosis both of Hepatitis B and Hepatitis C Viruses to the national health system with the ultimate goal of improving human health in the country and beyond

6. BICYCLE MOBILE PHONE CHARGER

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A bicycle charger innovation was made following a prolonged spell of dry season in 2007 that saw electricity rationing and even permanent cut of electricity supply in some parts of the country, subsequently forcing the government to seek other alternative source of energy including wind. Rural parts of Kenya do not have electricity at all and residents have to pay for at least Ksh 5 for charging their phones. Most people in rural Kenya use bicycles for transport with an estimate of over 5 million people owning bicycles. The bicycle innovation was out of an idea to use rotation motion of a bicycle wheel to generate electricity using a dynamo. The charger make use of recycled materials e.g. radio parts computer electronic components etc.

notably helping in e-waste management. The market cost of the kit was estimated at Ksh 150, however this would be lowered by economies of scale in mass production. The innovation will generates employment and revenue, boosting connectivity of the affected areas. Reduces over-reliance on electricity to charge phones. Eliminates the regular cost of charging phones. it can boost consumption of local products and innovations.

7. DYEING WITH *Tagetes Minuta* INFLORESCENCE EXTRACTS AT INDUSTRIAL LEVEL

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In this invention, the inventors disclose a dye developed from inflorescences of *Tagetes minuta* which bonds with cellulose-based fabrics just as well as synthetic dyes do. The invention also seeks to go a step further to make industrial application of the dye in dyeing cellulose-based fabric on large scales for local consumption. Preliminary results revealed that the dye primarily produces various shades of yellow shade on cellulose-based fabrics depending on dying conditions and other colours when subjected to different fabric mordants. Following high market prices of artificial dyes and the negative effects they have on the environment, the applications of *Tagetes minuta* dyestuff at industrial scales is expected to phenomenally reduce production prices of finished products thereby making fabric produce cheap for the majority and as well reducing the environmental impacts that have been brought about by the artificial dyestuffs.

Adoption of this innovation by players in the industry will improve the living standards of the citizenry as a result of massive reduction in money used for one of the three basic human needs—clothes. Saved money could be used for other essential and secondary needs. Future industrial scale manufacturing with local participation.

8. AN ELECTRO-COAGULATION METHOD OF COLOR REMOVAL IN WASTEWATER

LazareEtiégni[1]; Mr. Bernard O. Orori[1] and Professor Mohammed S. Rajab[2]

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Email: lazetiegni@amatala.org

The present invention discloses a method for removing color from industrial wastewater or raw water for discharge into rivers or to be recirculated for industrial use. Wastewater/water to be treated is first mixed with wood ash at a ratio of 0.278 kg of ash per m^3 of wastewater/water. The resulting wood ash leachate is first allowed to settle to remove larger debris before it is subjected to electro-coagulation to remove color. The detention time of leachate during electro-coagulation is kept at a maximum of one minute to ensure minimal power consumption. Further to this, the ratio of electrode surface area to volume of water is kept close to 0.0645 m^2/m^3.

9. IMPROVED WICK STOVE

Feabrine S Asiachi and Enos Ambale, Kenya Fender Engineering Works, Box 7895 00200, Nairobi

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Improved Wick Stove is an Innovation born out of the shortcomings identified in the operating efficiencies of the existing wick stove. This is addressed by, Having a detached reservoir tank to enable refueling while in use without the risk of explosion, Increased surface area for the flame increasing cooking efficiency and fuel economy, Increased non-luminous flame surface area from the ring design of the sleeve, Water not required putting off the flame. A wick holder dipped in the paraffin is used is lit & placed back in the clip, the stove is blown out and a smoke collector placed on top to burn the fuel vapour from the wicks. The benefits include reduced Kerosene Budget hence more disposable income, refueling while cooking, reduced Risk of Explosion, faster Cooking, easier to operate e.g. adjusting wicks macro benefits (Country/Region).

10. HAND-WINCH WATER PUMP

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The innovation presents a cranked shaft rotating hand actuator with pulsating torque that rocks twin plungers inside a system of two sealed pump barrels. This action forces water from resulting four virtual cylinders to flow through one way valves assembly to the top of any deep well. The produce which designed in two parts eliminates the used of heavy craw bar systems used in most commercial manual water pumps. The pump barrels are suspended inside the well by delivery GI pipe and pumping action transmitted by a winch steel cable from surface mount hand actuator assembly.

11. DEVELOPMENT OF FOOD SUPPLEMENT COMPRISING OF ALGAE AND ALOE

Justus Mong'are Ongus and Anne Kamunge; Box 62,000 Nairobi
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Pleurotus species or oyster mushrooms are edible macro fungi which are highly valued for their nutritional and medicinal properties. Limited studies on the genetic diversity and phylogentic relationships within *Pleurotus* species have been done in other regions of the world. However, no work has been on the genetic diversity and phylogentic relationships within the wild and cultivated *Pleurotus* species in Kenya. The study of additional genes is still needed to fully understand speciation processes in this group of fungi since use of ITS gene alone to construct phylogenetic trees may not result in true representation of the phylogeny of the taxa under consideration.

12. PRODUCTION OF OIL RICH IN OMEGA-3 FATTY ACIDS FROM NILE PERCH PROCESSING WASTE

Joseph O. Aloo; Prof. Jasper K. Imungi and Prof. Michael W. Okoth; UoN; Box 29053 – 00625, Kangemi, Nairobi.
Email: joaloo@hotmail.com

The work was carried out to optimize the wet acidic rendering for extracting oil from Nile perch viscera, with a view to possible mass production. Viscera were obtained from locally processed Nile perch stock. Oil was extracted from the viscera at 93^{o}C by acidified fishmeal process, varying the acid concentration from 0 to 10% and heating at 5 minute intervals from 5 to 25 minutes. The oil yield, lipolytic, oxidative and color qualities were determined to compare the effect of acid and time using a factorial layout in completely randomized design. Statistical analysis of data was done at $p \leq 0.05$ using GenStat software. There was significant difference in yield, with interaction between acid concentrations and heating time. This will add by-product to the fishery industry through optimization; Improved nutrition for local communities and reduced wastage and effluent in the fishery industry

13. GSM-SIM ONLY PAYPHONE

Richard A. Ondiek; Inventors and Innovators Association of Kenya

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Many first time visitors to Africa are surprised to see the increasing demand of mobile phone services even in the smallest villages. Estimates suggest that by 2010 half of Africa's population will have access and benefit from mobile phone related services and more than 90 per cent of communities will be covered by a signal. But the biggest question remains: how can this access be a successful channel for development with the high technological cost? GSM-SIM ONLY Payphone, is a potential solution to SIMCARD holders who will be able to access quality services offered by Mobile Operator Networks (MONs) without the need to OWN a cellphone.The initiative aims at bridging the digital divide, creating jobs, training, deployment of e-government services, business processing and outsourcing services and other services to be envisioned.

14. ELECTRONIC MILK DISPENSER

Julius Kirugumi Kinyua; Edward Mwangi Buruand Boniface Kanja; Box 61013 – 00200, Nairobi

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Kenya has over 40,000 informal milk vendors whose operations are a great concern to the public health authorities this invention we believe has the potential to eliminate these hazards another benefit is that packaging will be eliminated since consumers will ferry their purchases with their own containers. The project addresses this challenge. A liquid weighing dispenser comprising a dual aperture container fitted on one end [bottom] with an outlet that is fitted with a ball valve to allow the evacuation of the contents and on the top fitted with an air vent filter to ensure that the contents are not contaminated with airborne microbiological, chemical and even 'light' foreign bodies, such as dust, straw-type debris and insects. A weighing module comprising a PCB housing the micro controller and associated electronics that execute the machine readable programs on the respective peripherals [i.e. load cell and actuated valves] as inputted in the multi-functional keypad to achieve the desired objective i.e. dispensing the amounts as required by the customers or calibration functions or even the cleaning the system at the close/onset of operations [cleaning in place]. The power module which comprises the electrical elements and the respective wiring harnesses to deliver the requirements of the system with respect to quality, quantum and sequence. The system can also be configured to retail hygienically all liquids [sunflower oil, palm wine, juices] in the same way cereals or flour are retailed with unparalleled flexibility .

15. HOME WATER PURIFIER

Charles Ndege Mogaka and Mogaka Omesa Ismail; Chancez technologies, Kisii
Email: ndegecharles@yahoo.com or homewaterpurifier@gmail.com

Accessing clean water in Kenyan is a challenge. Water purifier has been invented locally to curb such situations. The innovation is based on the locally available materials two P.V.C with small tap designed unique way to fit the system using the innovation skill this will supplier there for solution to the unsolved problem making it easy to have the clean water at homes. The technology used will employ the natural purification capacity of ceramic stone materials combined with sterilizing effect of silver that kill the germs and carbonated to improve the test of the H_20 the pipe also used is high quality which will connect from the first container are galvanized to avoid corrosion. In the second phase of the process, the ark welding and gas will

take place when connecting the joints to give enough Water. The third phase is where the water will be received by to the dispenser making it available for drinking the stand will be needed to make it stable. It will assist in accessing clean water in cheap way, reduce waterborne diseases, environmental impact, since boiling of the water will not be required. Impact on hygienic awareness, social impact and low cost of safe water will be available for people.

16. SIBETO ALARM SYSTEMS (PHONE OPERATED ALARM)

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Alarm system of this innovation incorporates a simple and efficient principle that employs the use of phone/caller interface to alert the home/business owner of any intrusion within his/her premise(s). Different embodiments have been incorporated to meet the workability, safety and production of the alarm system. The workability of the garget is essential in ensuring the safety of our homes and business premises. When an area is breached, the sensors detect and send the signal to the system which then automatically switches on the siren and the flashing light at the top of the roof. The breached area is also indicated on a screen. The system then makes a call to the owner of the house/business premise through his/her handset. The owner can remotely switch on a defense mechanism through his/her handset by dialing a given number to take action against the intruder by either sealing all the available exits or releasing a gas that will make the enemy unconscious for a while until the owner arrives or passing an electric currents on the perimeter fence or pressing the panic button through his/her handset wherever he/she is to alert the security agencies working in partnership with the alarm provider.

17. BIODEGRADATION OF PLASTIC USING KENYAN BACTERIAL ISOLATES

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Plastics have synthetic polymers of carbon, hydrogen and oxygen that are derived from petrochemicals. There are versatile family of materials, which are suitable for a wide range of

applications. Plastics being xenobiotic compounds, resistant to degradation, constituting about 5-8 per cent of dry weight of municipal solid waste. The effects of these polymers on the environment, range from ozone depletion to the environmental toxicology of agriculture and aquatic ecosystem. There various methods for the disposal of plastics such as incinerating, recycling, landfills and biodegradation. The ability of microorganisms to degrade extracellular polymers depends on the secretion of specific depolymerases that hydrolyze the polymer to water soluble products. The research above entails the use of a specific bacteria that is to be researched and can be found in landfills and areas that contain plastic in plenty. Plastic and soil samples will be collected from the environment rich in plastic waste as well as soil samples around oil refineries. The bacteria to be studied will be isolated from the soil. The bacteria will then be identified by differential and selective, morphorlogical, cultural and biochemical tests.
The expected result of this innovation would be to selectively attain a specific bacteria strain that will be able to degrade plastic in an eco-friendly manner, free from pollutions and environmental hazards.

18. DESIGN AND PERFORMANCE OPTIMIZATION OF A CABINET KITCHEN INCUBATOR

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Collaborators: Mr. Fred Nakhale and Mr. Patrick Kamau

This project intends to design, fabricate and optimize a cabinet incubator using locally available materials with a capacity of 300 to 500 eggs. Historically, the natural brooding cycle of the hen has dictated the numbers of chicken a homestead can rear at any given time. Added to this, the number of eggs that a brooding chicken can successfully hatch into chickens is limited by the hens own capacity to successfully incubate all the eggs added onto this is the fact that a single hen can lay only a certain number of eggs before going broody. By introducing an incubator in this natural process, the productivity will be improved hence economic viability of the local chicken can be substantially enhanced while at the same time allowing the entrepreneur to selectively improve the stock of chicken. The benefits of this chicken incubator will be increase

poultry farming productivity hence generating income for rural households and provide employment opportunities for a cross section of Kenyans.

19. THE CELL PHONE AND REMOTE CONTROLLED LOCK

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The cellphone and remote controlled lock hereby stated refers to a mechanized normal mortise lock that apart from gaining legal entry through keying has been given the power of wireless control through a mobile phone and a RF remote control .To unlock apart from using the key whose functionally is also limited to system failure and settings one just has to press the remote control or send a command through a registered mobile number .if the mobile number and the password is verified to be true then the lock unlocks and sends back an sms that so has happened . If an intruder taps the door with great force or tries to break in a call and sms will reach the lock owner as per the settings .Incase of fire outbreak the system will engage auto unlock and send a message to lock owner if not for the call from the same system. The lock also boasts an inbuilt notification system that allows guests make their presence known and if response is delayed an sms notification will allow you know a guest is in the waiting acquiring your attention system also prides itself of the electronic sprung latch control that takes away handles out of doors and bringing fun into door opening as only a press of a button is required. The project upon completion will have a lot of impacts. Under normal assumptions the project is expected to spur employment opportunities as hands and brains will be utilized to realize finished products. Security level will also receive a thumbs up as thugs will have induced fear in breaking into houses having the system installed .The business industry too will record a positive change in way simple to explain.

20. LOW-COST LOW-ALTITUDE WEATHER BALLOON EXPERIMENT FOR KENYAN SCHOOLS

Allan Okoth Akwiri
Collaborator: Peter Kubai

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The innovation is a practical experiment designed to be used in proving the concept taught in schools that '*The Higher You Go the Cooler It Becomes*'. At the present time the payload has been assembled utilizing Atmel AVR-8 32-bit microcontroller with thermostat and LED indicators for active and passive modes. It has been demonstrated to a team of technical experts at the Kenya Meteorological Department for additional input on design and gas safety aspects. A flight was undertaken on Wednesday 23rd November 2011. Feedback is being utilized in making needed adjustments. It is expected that it will be used within schools to add practical element when students are taught the concept of weather research. The Kenya Meteorological Department is interested in having measurements made by schools all over Kenya uploaded into a central database for use by low flying pilots.

21. MECHANIZED PAINTING MACHINE

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The inventive subject matter herein relates to mechanized manual painting which can be adapted in structural painting (walls, roofs, floors and such like surfaces) addressing the challenges on heights, roofs, spillage and the cost aspect involved in structures to prop-up painters, time and materials used in cleaning the spillage and smudges, the extra manpower required and compromising work standards. The mechanized manual painting machine is intended for structural painting (walls, roofs and floors). The machine consists of a circular band that rotates around two shafts of different dimensions with a cylinder that holds paint. The paint is gradually released to the band as it revolves around the shafts as it paints the surface. The paint cylinder has a spout that is adjustable depending on the situation. The painting machine has a handle that is adjustable and can be fitted with handles, a shoulder mounting for roof painting and an adjustable blade to suit roof painting. The innovation will eliminate spillage, reduce cost of labour in terms of time taken and manpower, increase efficiency in terms of standard coating and reduce or eliminate risk of falling while working on prop-ups.

22. IMMUNE BOOSTER AND IMMUNE MODULATOR (SUNGUPROT AND CANOMA)

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Sunguprot is an immune booster used by immune-compromised persons malnourished due to HIV/AIDS, poor nutrition and old age. The supper food is made from natural plant extracts vitamins and minerals en-reaching it as a protease inhibitor; it elevates the CD4 count and lowers the viral load. Canoma, an immune modulator rejuvenates the cells protects and prevents cancer cell invasion, due to suc-action it is applied sublingually received easily at the glands then transmitted to the cells. The innovation will reduce death rate of HIV/AID patients hence will supplement HIV/AIDS remedy as well as improve health standards of the 800m malnourished Africa Sub-Sahara region, the project will create job opportunities and open more research avenues for further innovations geared towards the achievement of vision 2030.

23. DEVELOPMENT OF ANTI-ALCOHOLIC WIPES AND MOUTH WASH FROM CASSAVA LEAVES

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Collaborators: Dr. Moses Makayoto and Mr. Fredrick O. Otswong'o
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Several death cases due to excessive alcohol consumption have been reported mainly in urban and peri-urban areas since 2010. Some communities in Kenya e.g. Mijikenda in the Coastal region of Kenya uses cassava extracts to reduce alcoholic effects. The scientific rationale behind the mechanism however remains unknown. The innovation is about developing anti alcoholic wipes and mouth wash from cassava that would reduce the effects of excessive alcohol consumption that result into blackouts, slumber, stupor, coma among other effects. These

products will help in alcoholism management by making the individuals alert using natural products. In preliminary studies the anti-alcoholic effect of cassava extracts from leaves and stem demonstrated individuals being free from drunkenness after 2 - 5 minutes of application of the crude cassava extracts. The economic benefits of the innovation if commercialize will include the following: If the production plant is established then, the local farmers will be the primary suppliers of the raw material; it will create employment for the youth and wealth generation; more farmers will be involved due to increase in cassava production; Full acknowledgment of traditional knowledge, identification, documentation and validation would have been established; Harnessing of bi-economy of the area ;The community will be trained on cassava value addition; Decrease in the death rate as a result of excessive alcohol consumption; Knowledge creation in terms of patent publications and potential benefits for the academia and others.

24. BIOMETRIC INTELLIGENT CASH MACHINE

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An instant cash deposits through the ATM machine using the bill validator and acceptors, this will enable machine to recognize the bills once inserted inside the acceptor, it will differentiate between a thousand and hundred bob. Cash deposits without a phone or a bank accounts. Cash recycler, no need of cash transportation from central bank to the ATM machine because with computer banker, it can use the money deposited for withdrawal Special fraud and fake bills detector, it stores the fake bill inserted in the machine in a special vault together with depositor details for tracking. Finger vein authentication method which works together with the ATM cards, its added method of authentication due to high crime and fraud in the country its estimated commercial bankers in Kenya looses over 500million to fraud every year mainly through ATM card and bank transfer so apart from normal identification method we introduce the FINGER VEIN SCANNER to be used on the counter and ATM machines. International and local money transfer to locations with our machines. The innovation will create employment opportunity; Create 100% security to the banks and its customers; Bring Kenya and Africa into spotlight as technological Hub; Create revenue; Make it easier and faster to send and receive money 24/7;

Make it easier for none account holders to have depository box that they can access anytime; Safer and faster method of money transfer for Kenyans in Diaspora, and business men and women; Future method of banking.

25. HOUSE AUTOMATION SYSTEM

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The project is based on automating house remotely with the use of SMS once someone needs to control any electronic device within the house he/she can uses his cell phone to control devices e.g TV set, lightings, opening or closing the doors etc. During programming the commands are already installed in the database of the micro-chip used and when you send the command from your phone inform of SMS to the system sim card then it's searches for the command that has arrived and compare with the existing command in the database of the chip and when the command correspond with the database command it execute the tasked based on that specific command. Once the system detects intrusion with the area where sensors are located with the house it trigger the units thus send SMS to the admin number assigned confirming the alert for intrusion. Tasks can be performed simultaneously even when one is away from the house. Security is assured because the system will alert you in-case there will be intrusion in the house.

26. PRESSURE BASED MOBILE PHONE CHARGER

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In rural areas availability of electricity is much more limited not only to the local inhabitants but also to the low income earners living in the urban and peri-urban areas. There is therefore urgent need for the development of a less costly and more reliable form of energy to charge and ensure proper and maximum usage of mobile phone gadget as an important tool of socio-economic interaction and information exchange besides its contribution as an income generating tool for wealth creation. This long-term goal is in line with the tenets of Kenya's vision 2030 of

becoming a middle income economy capable of supporting quality living standards Pressure Based Mobile Phone Charger is an innovation which not only charges mobile phone, but ensures long lasting of mobile phone battery utility. In pressure based mobile phone charger, energy is produced by piezo- electric crystals which are pressure based transducers with the capacity to produce electrical energy when a pre-determined pressure is applied vertically on its positive/ negative plates. It has been proven through the usage of the developed prototype that piezo-crystal based electrical power is an alternative form of renewable energy with the potential of powering mobile phones and other low-power requiring gadgets in the rural set-ups where electrical grid connectivity is inaccessible. The transducer has proved to be an alternative form of renewable energy as a matter of fact and the technology can be a useful form of energy production not only to the rural area, but also to city dwellers who have less or no access to the national grid or any other form of energy as is common in urban and peri-urban areas. Unlike other forms of charging system, this method is integrated into an intelligent perspective where the charger switches its self ON when a mobile phone is connected along its terminals, or a battery is connected to the universal battery charging slot. Unlike the common universal charging systems, which damage the battery thus reducing its life span, pressure based charger isolates the system when the battery charges attain a maximum voltage at the same time alerting the user when it is fully charged and does not require further voltage uptake. Safety is ensured as voltage is transmitted in low direct current form and very minimal frequency is maintained. Piezo crystals being soft metallic aluminum flat plates coated with ceramic clay to act as the anode arranged in such that they prevent any form of injury to the user's foot. Their shapes and sizes are also suitably designed so as to avoid any form of discomfort when sandwiched between the inner shoe sole and the user's foot.

27. INTELLIGENT ATM MACHINE

An intelligent Automated Teller Machine (ATM) that does not require users to produce bank cards for any transactions is proposed. Instead the application uses Machine learning and pattern matching techniques to adequately identify a customer. In Kenya insecurity around ATMs is a serious issue that inhibits full usage of banking services. Machine learning provides a process for constructing computer programs that automatically improve with experience. In recent years

many successful machine learning applications have been developed ranging from data mining programs that learn to detect fraudulent credit card transactions to autonomous vehicles that learn how to drive on public highways. This project seeks to develop an intelligent ATM interface using Machine learning and matching some user traits.

28. EXPERIMENTAL SET-UP FOR PRODUCING EMBOSSED HOLOGRAMS

The challenge of differentiating authentic documents from counterfeit supplies has recently increased. The rapid growth and development of modern technology in our markets has made fake currency notes, fake bank credit cards, fake university certificates and other fake government documents to find their way into our markets. Holography which is a technique that records both the phase and the intensity variations of a light beam is demonstrated as a unique way of countering these forgeries. An experimental set-up to implement holography for both laboratory and commercial use has since been designed and fabricated. Using this set-up, holograms of tailor made objects can now be made and attached onto documents to help any user verify the authenticity of the documents. A model of a real object is constructed and used as the object in the holographic recording. A unique feature, only known to a company or an institution can be embedded onto the object and used later in the hologram as a feature of checking authenticity. For the success of this research, a local custom made set-up was designed and fabricated. A successful advance was the designing and setting up of a tailor made optical table that fairly suits holographic applications as well as other future experiments in the laboratories. The optical table is made purely from steel and weighs about 325 kg. It is specially designed with good static rigidity and excellent stiffness. The table has a well damped structure with relatively low mass so that no low frequency resonances (<100 Hz) are present. Preliminary running of the holographic set-up was done and the best exposure times for efficient bright holograms were determined. It is worth mentioning that a custom made optical table designed for experiments that require excellent stability is necessary. Recording holograms in polymer materials require large exposure times compared to recording on silver halide holographic plates. With availability of funds to acquire necessary stamping machine, it will be possible to mass produce holograms and embed them onto real documents for security purposes. The holographic

technique demonstrated can be used in other areas such as, holographic interferometry, holographic optical elements, holographic data storage, and microscopy among others.

29. PROSOPIS (MATHENGE) VALUE ADDED PRODUCTS

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Tana-River County is covered by three major Districts, Tana-Delta, Hola District and North Tana District, with 38,694 square kilometers. The whole county was invested by Prosopis, which led even to collapse of scheme 'Mathenge' had colonized into several kilometers in Bura. It had colonized about 300 square kilometers by 1987. There was nothing being done into the scheme upto revival time in 2005. It is really costing the scheme millions of shillings disilting the canals. Scientists and NGOs have come up with mechanical system which has slowly lured the community into appreciating the products that can be made from the Mathenge. A number of innovative products have derived from this plant that has been considered destructive to promote its sustainable use and management. The displays in this exhibition will include products made from 'Mathenge' such as coffee table, carvings, animal feeds, food products pods and waved baskets.

30. VALUE ADDITION TO GOAT AND SHEEP SKINS THROUGH TIE AND DYE

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Animals have different gene make up and hence each individual skin has a unique combination with the dye giving a unique mixture at any given time. Therefore tanning of goat and sheep skin can be achieved by using organic methods and dyeing using basic dyes. The whole process is using environmental friendly materials. This innovative process involves ash to remove hair; Organic acid from citrus fruits; bating using enzymes from raw pawpaws and tanning using wattle extract and lemon juice for fixing dyes.

31. AUTOMATED EGG INCUBATORS

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This innovation is about fully automatic egg incubators fitted with a solar system that is used together with a Liquefied Petroleum Gas (LPG) cylinder or Biogas as standby source of heat during power blackouts. The gas system is automatically regulated by the incubator operating temperature such that when temperature drops below a certain point the gas is ignited by a solar powered spark. The gas system is also self regulating such that when it attains the set temperature, it switches the gas off. As a result of this the LPG/Biogas system can be used in areas that do not have electricity. It is also fitted with a timed turning mechanism that turns the eggs as required and a moisture sensor that regulates the humidity of the incubation chamber as required.

32. AN INTELLIGENT TRAFFIC LIGHT CONTROL SYSTEM BASED ON FUZZY LOGIC ALGORITHM

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Traffic light control systems have increased in use on our roads particularly in the urban areas. Every year, more cities are starting to implement traffic light control systems to control traffic in and out of the city. Much of this increase is due to the increasing number of motorists and pedestrians in the cities and urban areas. This study aimed at showing how Fuzzy logic can be used in the development of an intelligent traffic light control system. Traffic light control algorithm plays a vital role in enhancing control of traffic flow in the cities , however despite the fact that traffic lights have been successfully used by many cities, little has been done to establish how fuzzy logic can be used to enhance traffic light control algorithm. Building on sparse literature regarding use of fuzzy logic in traffic light control algorithm, where motorists are allowed to interact collectively and intelligently with the environment, intelligent traffic light algorithm system based on fuzzy logic concept is appropriate and suited for our roads due to its adaptive nature. This research paper has adopted a cross sectional study targeting traffic control in the city of Nairobi Central Business District and its surroundings. The three junctions at Railways, Haile Salessie and General Post Office were used to collect data through observations

of traffic behavior at the intersection points. Data was analyzed and presented using descriptive statistics; tables and graphs by using Ms Excel 2003. For testing our adaptive traffic light controllers, we developed a simulation system using Qt, C++ software integrated with MATLAB tools. The simulation runs results showed that the adaptive algorithms can strongly reduce average waiting times of cars compared to the conventional traffic controllers.

33. ANALOGUE MOBILE ENGRAVING MACHINE FOR MOVEABLE ASSETS

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Assets identification for total security can be termed as "Neglected Technology" that has attracted less attention and development. Theft of institutional moveable assets is a serious common social problem that has pervaded societies for centuries. Millions to billions of shillings are lost each year to burglaries as stolen assets are hard to recover, hundreds of lives are lost during burglary incidents and some victims have been left living with permanent disabilities incurred during robbery incidents. Various methods of asset marking as a security marks are in the market, they include: letter / number punching, Branding, tagging, embossing organic carbon coding, etching & vinyl cuttings. But it is common knowledge that today's ICT & office equipment are manufactured from plastics & wooden, thus letter punching that applies mechanical energy is not applicable and other methods are easily delete-able by industrial solvents. From the foresaid challenges, a research for about five (5) years to reconstruct and re-engineer simple machine that is portable, versatile and efficient that produces analogue engraving inscriptions to all moveable equipment i:e metals, wood, plastics and hardened carbon steels was done. The innovation was to come up with portable mobile engraving machine weighing 2.82 kg, with variable motor speed and the capacity to engrave all moveable assets other than the convention ones with heavy stand alone flatbed platforms. The rigorous trial tests and local technology input produced an indigenous machine that uses traditional technology to generate analogue engraving directly onto assets for traceability. Several results have been tested and proved that the technology is non-destructive and eco-friendly above all an absolute

identification security solution to all moveable assets which cannot be replicated by any outside at the moment

34. ANTIAFLATOXIN AND GRAIN PRESERVATION APPARATUS (AGP)

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Food security in the republic is currently facing serious threats of aflatoxin contamination and weevils' infestation thereby posing many Kenyans to starvation and illness. Excitement by the life-threatening poison of aflatoxin has inspired me to undertake research on the matter and have successfully worked out a brilliant innovation to countermeasure the onset of aflatoxin in grains while in storage. The invention is an apparatus to be called antiaflatoxin and grain preservation apparatus (AGP). The technique is well based on the knowledge that complete dryness of grains, free movement of air within the packaging and mild temperatures are the preferred conditions for the prevention of aflatoxin formation and weevils infestation. This new apparatus is therefore comprised of three (3) key mechanisms in the working methodology namely: drying mechanism, aeration mechanism and temperature regulation. The apparatus is comprised of a porous tube, a closed metallic cylinder; flat chipboard rings and makes use of common salt and water for its performance. The porous tube is for the aeration mechanism, the closed cylinder for temperature regulation and salt for the drying mechanism. Laboratory tests have shown the technique is up to 90% effective in preventing food spoilage. The method is much better than the ordinary chemical dusting in the prevention of weevils' infestation and has the advantage of preventing the onset of aflatoxin if the initial conditions were un-preferred or have changed while in storage. The study predicts the new technique to be locally viable in the realm of the local farmers who have no access to the more sophisticated methods of food preservation. Examiners have recommended it cheaper to purchase (Kshs 500) due to its low cost of the raw materials. The method is also economical because it can be used for a long period with no costs being incurred and can last many years in use.

35. C-BIZAFRICA

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C-bizafrica is a proposed online system which is meant to ease the mode carbon trading through carbon sequestration. 'C' stands for carbon hence the name c-biz meaning carbon business. It is an online platform which provides the details of the planted forests whose data is stored on an online database. The details stored in the database include: country, location of forests, coverage, owner details and terms and conditions. C-bizafrica would provide the platform in which the potential buyer is able to find forests to offset carbon emissions. Forests coverage may vary from 5-20 hectares. C-bizafrica mainly would be aiming to support African and international land holders in growing plantations for carbon sequestration

36. POLYPROPYLENE RANDOM (PPR) PIPE WELDIG DEVICE

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Today, innovation is rapidly moving to the top of the political and administrative agenda in many advanced western democracies. Innovation can be termed as an intentional learning based practice that incorporates occasional chance discovery or it can be seen as a new idea or approach to an issue, which challenges the prevailing wisdom. The innovation of the current fire utilizing welding device was accidentally discovered while carrying out a different study that necessitated joinery of pipes. The discovered tool significantly reduced the number of fittings being used with subsequent reduction in the bill of quantities. Further, the cost of the device is pea nut as compared to the electric device that is currently in use. It was, therefore, concluded that the device be publicly exhibited for information sharing with an aim of commercializing and patenting it for purposes of economic development.

37. INNOVATION COMMUNICATION

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Innovation Communication is a symbolic interaction between organizations and the Stakeholders dealing with new products services and Technologies. The study examined access to research and focused on how Information contributes to enhance adaptation and Commercialization of technology among researchers and organizations. However, companies competing in global markets are facing the challenge to globalize their innovation processes to serve these markets they have to simultaneously identify access and develop new technological know-how all the globe. In models of innovation of communication, linear mode was inadequate because it only described one pathway to innovation, that of reducing new scientific discoveries and practice. i.e Research→Development→ | →Product→Marketing. The method in the study was oriented sampling where those in extreme, deviant or a typical reveal more information than the putatively representative case. Most materials used in innovation were digital computers, Nylons, bioengineering medicines, xerography in social networking sites. Technology Transfer Principal was used to commercialize whereby combination of manufacturing processes and engineering technology were used before the market release of the product through researched and developed technology transfer. The internet is at once a worldwide broadcasting capability, a mechanism for information dissemination and a medium for collaboration and interaction between individuals and their computers without regard for geographic locations. The Internet represents one of the most successful examples of the benefits of sustained and commitment to research and development of information infrastructure. As a result, commercialization of the information technology involves not only the development of competitive network service but also the development of commercial of products implementing the technology. The competence of global innovation management requires many different skills. Companies must develop strategies and organizational structures to investigate ethnic diversity and geographical disparity to maximize global sensing of information and mobilizing of technology know how and market needs to its users. Innovation in communication suffers as a result of;-poor communication materials and methods, lack of clarity, time, less than honest content, lack of technologies/habits and market

38. ALTERNATIVE MEDICINES

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Through our own research we have involved 30 pertanable herbal formulations for such hard nut diseases like asthma, arthritis, stomach ulcers, venereal diseases, brucellosis, typhoid, malaria, epilepsy, diabetes etc. These products have been widely used through a network of our 15 clinics across Kenya for over 30 years from now. They are dispensed in different forms I.e. liquid, powders, capsule, tablets and syrups, depending on the patient`s need and status. We also have hot compresses, Rollers and Ointments. They also include specific herbal formulations for Rabies and Parvovirus in dogs, Newcastle and KDF diseases in poultry, East Coast fever and heart water diseases in cattle as well as a several diseases in sheep and goats, pigs and rabbits.- We also have developed herbal formulations for crop protection in plantations, orchards and kitchen gardening all of which promotes the emerging concepts and initiatives of organic farming.- Because of apparent scarcity of information, appropriate methods and techniques of propagating Indigenous African Medical Plants were forced by circumstances to innovate unconventional medicinal plants propagation methods some of which are applicable elsewhere with appropriate modifications. Some of the innovations methods that we have developed are also applicable in some indigenous and exotic crops in all of African and elsewhere.- Again because of apparent difficulties in holistic and impactful transmission of both traditional medicine and indigenous knowledge, we have also been compelled by circumstance to innovate and apply very successful participatory education methods and programmes in the wider spectrum of technological disciplines. In an endeavor to address the African epidemic crisis of poverty, an innovative and a holistic rural extension educational framework was developed with an aim to accomplish an impact by application of integrated sustainable technology in poverty alleviation, health and well being. This approach is both community and ecosystem based.

39. INTEGRATED NAVIGATION DIRECTOR (INS)

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The Integrated Navigation Director "IND" is basically a Global System which uses a combination of the Mobile Telephony and optionally Global Positioning System to provide a number of solutions. Top of the list is Aircraft Navigation among others. Even though this proposal only refers to Aircraft Navigation, its use in other moving vessels is deemed to have been covered. The Integrated Navigation Director is an instrument which is capable of receiving signals from Mobile Base Transceiver Station and use it to calculate and ascertain all the information required for a precision (Instrument Flight Regulations) IFR Flight. The same equipment can also be used to provide an augmentation system for the Global Navigation System. Considering the spread of the Base Transceiver Stations, the INS system will be able to give precision flight and landing on a global scale. The IND together with the Mobile Telephony Network and the Global Positioning System will form a global system where all aircraft dispatch data can ride on, Aircraft navigation can be achieved and aircraft flight management can be enhanced. In this publication however only aircraft will be referred to for two main reasons. The aviation industry depends on instruments for their navigation process than any other transport industry. Two the other transport industries will just adapt a lower version of the aviation model and work just fine. When set up and working, this system is poised to replace all the myriad fragmented navigation systems across the world with one integrated, efficient and cost effective system.

40. THE SMART-RIDER

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Traditionally signage on Matatus and other public service vehicles has been done using paintings. This included route numbers and the route names. This system is limited in that a vehicle that operates on many routes has to have multiple boards to indicate the various routes. The objectives of the innovations are: Open a new platform for adverting; Expand the zones within which the advertisements can be viewed; Provide more information to commuters about the the route and the fare being charged at any moment. SMART-RIDER on the other hand is an electronic sign that is dynamic. It can be used to indicate the route numbers as well as

advertisements. This will not only create catchy signage but also money generated from the advertising for the matatu crew as well as the adverting company.

41. HAND OPERATED CLOTHES WASHING MACHINE

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It was very difficult to identify any difficulties in laundry. Washing linen and the time consumed are factors that came up during the preliminary research. Since it is said to take much of time when washing it was found appropriate to introduce the machine because it is proved to clear-up more than one hundred (100) pieces of linen in less time. Hands are affected by the continuous friction caused by different courses of linens and they cause peel-off of skin on hands. Soaps and water from different sources also has had a negative effect on hands and continuous washing will cause harm and that is why we introduce the machine. The main objective of this programme is to make the laundry work friendly to all gender and age. Each sub community will have ownership to one machine. This simple machine is designed to help carry out the tasks of washing hence energy, time and fuel saving. All the genders have a role to play towards the use of the machine for the city-wide development hygienically; the initiative will cut the massive water usage in living apartments leading to overflow of sewerages along streets hence air pollution by installing community based machine.

42. SCIENCE CENTRE

Margareta Ocholla (DMRD), Mr. Kenneth Monjero (KARI Biotech), Ms. Elizabeth Odoyo (KARI Biotech), Dr. Edward Kariuki (KWS), Mr. Kibet Daniel Arap Mitei (NMK)

1. The Clucking Cup

It explains the concept of musical instruments. Sound is made when vibrations are set up. Sound travels through air and we hear it when the vibrations reach our eardrums. The cup is an

amplifying box of enclosed air surrounded by a solid (the cup) which produces a more effective sound.

2. The Electrified Table-Tennis Ball

It is easy to make plastic balloons and similar objects electrically charged with static electricity, by rubbing them on suitable surfaces eg. a neutral balloon acquires a surface electrical charge by rubbing it on a woollen sweater. Once the balloon is electrically charged, the charge cannot escape from the plastic surface. When the balloon is brought near the neutral table-tennis ball, it causes the plastic ball to acquire the opposite charge on its surface. Opposite charges attract and so the balloon and the ball attract each other. As long as they do not touch, the ball – afloat on a water-filled plastic container, can be made to follow the balloon around.

3. Making a Cloud

When a burning match is dropped into a 2-litre plastic bottle with a bit of water at the bottom and the cap screwed back immediately, the match goes off but the smoke it produces remains inside. If the bottle is squeezed and then released suddenly, a cloud will form! This is because the sudden release results in an increase in the volume and a decrease in the temperature of the air in the bottle. These two effects cause the water vapour in the air to condense and become visible forming a cloud – a result of the water vapour condensing around the small carbon particles released by the burning match in the smoke. When the bottle is squeezed again, the cloud clears very quickly. The experiment can be repeated many times.

4. Burning the Candle

The candle is a clear way of seeing all the three states of matter at the same time. When a candle is lit and allowed to burn for a few moments, the solid and the liquid states are easy to see. But where is the gaseous state? Quickly extinguish the candle between finger and thumb and bring a lighted candle into the vapour trail above the wick. The candle should immediately relight without the match touching the wick. This phenomenon is frequently possible for petrol fire accidents. One does not need to bring a lighted match into contact with the liquid petrol – it is sufficient to have a naked flame in the presence of petrol vapour for the whole lot to ignite.

5. "Guesstimation"

The challenge is to guess how many paper clips will fit into a small water bottle after it is full of water. This is best done as a guessing game since people do not believe the actual number that can fit in before it overflows. One should observe the water surface as the paper clips are added and the water rises. The shape of the water surface is a result of surface tension; a strong force that acts on the surface of a liquid. It allows insects to walk on the surface of water. It causes the liquid surface to occupy the minimum area – a sphere. The water above the neck of the bottle forms a hemispherical shape as it rises with the addition of paper clips into the bottle.

6. Musical Straws

The end of a straw is cut into a "V" shape and then flattened by chewing a bit on it. The tongue is put at the base of the "V" and then one blow as if blowing a musical instrument. As one blows, have the straw cut shorter and shorter with a pair of scissors. If one keeps blowing, the pitch of the sound gets higher and higher. Cut the ends of two straws with one half the length of the other. Blow and compare the sounds they make. Cut two other straws with one only slightly different from the other and blow them together. If these are blown together, one hears the beat frequency. The pitch produced by an open pipe is a function of its length. Longer pipes produce lower pitched notes while short ones produce higher notes. If among two pipes one is half the length of the other, the pitch of the shorter one is twice the pitch of the longer one that is double the frequency.

7. Balloon and Rotating Coin

A balloon is inflated, a coin inserted and the neck tied off. If the balloon is briskly rotated, the coin moves around on the inside. If one then holds the balloon still, the coin will continue to roll around on the inside surface. This illustrates the effect of friction; in this case, minimum friction.

8. The Ringing Fork

A fork is tied to the middle of a length of string. The ends of string are tied around the right and left index fingers. The fingers are then put in the ears and one leans forward so that the fork hangs down in front of ones face. Swing the fork such that it hits the edge of a table or get someone else to tap the fork with another piece of cutlery. One should hear a beautiful sound.

This illustrates how sound moves and is amplified by different media – the principle for different musical instruments.

9. The Musical Balloon

A balloon is inflated and then pinched at its neck allowing some air to escape. This produces an annoying sound. The sound can be altered by adjusting the hole in the neck through which the air escapes. This illustrates what happens to air passing through the larynx.

10. Folding Paper

A piece of paper eg. a table napkin, is folded into half. It is then folded into half again. The folding continues until it cannot be folded any more. This can be tried with a newspaper or another paper. After some experimentation one finds that, a piece of paper of any size, can only be folded in half seven times.

43. NOVEL DIRECT In-situ STOMATAL-APERTURE IMAGING AND MEASUREMENT METHOD

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Stomata are pores found on leaf surface for enabling gaseous exchange and transpiration. Each of the stomata is flanked by a pair of specialized epidermal cells known as the guard cells. Opening and closing of the stomata is an important activity in plants and is controlled by various external and internal factors. Monitoring of the response of the stomatal aperture to various interventions is important in plant science and agro-industry. Stomatal aperture was hitherto measured using microscopic observation of leaf epidermal peels in isotonic buffers. The existing method of stomatal aperture measurement interferes with the integrity of the specimen in that: a) the preparation of the leaf epidermal peels often changes the original shape, size and spatial location of the epidermal cells, thus causing changes on the stomatal aperture; b) the immersion of the epidermal peels in isotonic buffers could induce changes in the stomatal aperture due to physiological effects of the constituents of the said buffers, a phenomenon well known to the skilled person; c) altered external and internal environmental conditions following excision of

the plant tissue could influence stomatal aperture, for example carbon dioxide level, these effects are well known to the skilled person. This current invention provides a method and means for the measurement of stomatal aperture on real-time, in-situ basis. The measurement of the stomatal aperture is based on clear direct imaging of stomata. Furthermore, this invention describes a quick, low-cost and accurate method for stomatal aperture measurement, wherein the integrity of the specimen is safe-guarded.

INSTITUTIONS EXHIBITING

1. Ministry of Higher Education Science and Technology
2. University of Nairobi
3. Kenyatta University
4. Moi University
5. Egerton University
6. Chuka University College
7. Kenya Agricultural Research Institute
8. Kenya Medical Research Institute
9. Kenya Water Research Institute
10. Kenya Industrial Research Institute
11. Kenya Intellectual property Institute
12. Digital Age Institute
13. M-Lab

TIVET FAIR, 2012

COAST REGION - SELECTED ITEMS FOR TIVET FAIR

Hospitality and tourism exhibits

1. Coast Institute of Technology (CIT)
2. Mombasa Technical Training Institute (MTTI)

Nature and culture exhibits (clothing & textiles)

1 . Mombasa Technical Training Institute (MTTI)

Mechanical and Automotive Based Exhibits

1. Coast Institute of Technology (CIT)
2. Mombasa Technical Training Institute (MTTI)
3. Mombasa Polytechnic University College

Building and Civil Engineering Exhibits

1 Mombasa Polytechnic University College (MPUC)

Applied Sciences Exhibits

1. Mombasa Polytechnic UNIVERSITY College (MPUC)
2. Coast Institute of Technology (CIT)
3. Mombasa Technical Training Institute (MTTI)

Information and Communication Technology (ICT)

1. Coast Institute of Technology (CIT
2. Mombasa Technical Training Institute (MTTI)
3. Mombasa Polytechnic University College (MPUC)

Electrical and Electronics Exhibits

1. Mombasa Technical Training Institute (MTTI)
2. Mombasa Polytechnic University College (MPUC)

Overall Institutional Performance

1. Mombasa Polytechnic UNIVERSITY College (MPUC)
2. Coast Institute of Technology (CIT)
3. Mombasa Technical Training Institute (MTTI).

RIFT VALLEY REGION - SELECTED ITEMS FOR TIVET FAIR

Medical and Applied Sciences

1. RVTTI – Production of Bio-Diesel oil
2. Eldoret Polytechnic – Oil extraction from Mexican marigold plant for controlling mosquito larva
3. RVIST – Disinfectant made from Lemon juice, Borax and sodium Bicarbonate.

ICT/Business Studies/Liberal Studies

1. RVTTI – COLLEMIS
2. OL'LESSOS – Culture Net
3. KITALE T.T.I – Electoral Management Information System

Automotive/mechnical/agricultural engineering

1. KITALE T.T.I – Electric Generating Wind mill
2. RVIST - Bamboo Umbrella
3. ELDORET POLYTECHNIC – Stabilized soil block making machine.

Hospitality/Institutional Management/Tourism

1. RVT.T.I – Cultural Tourism
2. RVIST – Assorted cakes
3. RVTTI – Traditional power foods

Building and civil engineering

1. RVIST - Economical portable stool
2. KAIBOI – Folding stool/Table

3. OL'LESSOS –Bamboo Roof

Electrical and Electronics Engineering

1. KITALE T.T.I - Complete solar system
2. OL'LESSOS - Alarm intruder system
3. KAIBOI – Solar installation system

General Agriculture

1. KITALE T.T.I – Automatic poultry feeder
2. KAIBOI T.T.I – Kerosene incubator
3. ELDORET POLY – Improved organic farming

Mt. KENYA REGION - SELECTED ITEMS FOR TIVET FAIR

Electrical/Electronics Engineering

1. Rwika TTI with Kikuyu Homestead carrot and pumpkin cakes
2. Murang'a College with Banana wine production using Banana yeast
3. Kiirua TTI with Bead work bag

Business/ICT

1. Nkabune TTI with Use of internet to learn more about Kenyan culture
2. Kirinyaga TTI with Use of internet as a backbone network for communication
3. Meru TTI with Masai Community Website

Applied Science/ Agriculture

1. Rwika TTI with propagation of Artemisia annua to repel mosquitoes and to cure malaria
2. Murang'a college with Castor soap production

3. Nyeri TTI with Production of pruno capsule for prostate cancer cure

Electrical/Electronics Engineering

1. Rwika TTI with Kikuyu Homestead, carrot and pumpkin cakes
2. Murang'a College with Banana wine production using Banana yeast
3. Kiirua TTI with Bead work bag

Building & Civil Engineering

1. Kirinyaga TTI with Plumbing ram pump
2. Nyandarua TTI with anka plastic tiles
3. Meru TTI with Bricklayers combined with transport device

Mechanical Engineering

1. Kiirua TTI with Alternative Fuel Generator
2. Nyeri TTI with chuff cutter/ pot moulder/charcoal maker
3. Nyandarua TTI with Chain link machine

NAIROBI REGION - SELECTED ITEMS FOR TIVET FAIR

ICT & Business/ Entrepreneurship

1. Kabete Technical Training Institute
2. Kinyanjui Technical Training Institute
3. Nairobi Technical Training Institute

Applied Science

1. Nairobi Technical Training Institute
2. North Eastern Province Technical Training Institute
3. Technical Development Center (TDC)

Mechanical Engineering

1. North Eastern Province Technical Training Institute
2. Technical Development Center (TDC)
3. Joint: Machakos/Kinyanjui Technical Training Institutes

Electrical/Electronics Engineering

1. Railways Training Institute
2. Joint: Kabete and Nairobi Technical Training Institutes

3. Kenya Technical Teachers Institute

Building/Civil Engineering

1. Kiambu Institute of Science and Technology (KIST)
2. Maasai Technical Training Institute
3. Thika Institute of Technology

Institutional Management

1. Machakos School for the Blind
2. Wote Technical Training Institute
3. Machakos Technical Training Institute

WESTERN REGION - SELECTED ITEMS FOR TIVET FAIR

Department	Skill area	Institution	Description
Agriculture	Crop and Livestock production	Mawego T.T.I	Cooling pot(traditional); Maize Sheller and Artificial colostrums
	Horticulture value addition	Shamberere T.T.I	Value addition on mushroom using bettle larvae
Applied Science	Environmental Chemistry/hygiene	Kisumu Polytechnic	*Tiptap*- a foot operated hand washing machine
	Food Chemistry	Friends College Kaimosi	Tophee from mangoes; Crisps from pumpkin; Pumpkin drink, pumpkin jam
		Siaya I.T	Making medicated soap
Building and Civil Engineering	Building materials	Kisumu Polytechnic	Rice husk fibre board
	Building materials	Siaya I.T	Manual interlocking stabilizer block and fixed dome biogas plant
	Carpentry and Joinery	Bumbe T.T.I	Peddlers dining table set
Business	Incubation & programming	Kisumu Polytechnic	*Suluhisho* virtual business incubator
	Programming	Mawego T.T.I	Bus booking MIS
Computer and	Programming	Kisumu Polytechnic	ICT and Business: Hotel and restaurant MIS

I.T	Programming	Bumbe T.T.I	MIS-Secondary schools
	Programming	Matili T.T.I	Timetabling programme
	Programming and knowledge management	Sigalagala T.T.I	Multipurpose solar drier Restoration of culture and technology ICT cultural reproduction (storage)
Electrical Engineering	Engineering and Electronics	Kisumu Polytechnic	Hand washing machine
	Engineering and Electronics	RIAT	Solar back up system
	Engineering and Electronics	BUMBE T.T.I	Computerized paint blending system
Mechanical Engineering	Fabrication &Production	Kisumu Polytechnic	Water pump
	Fabrication& Production	GUSII I.T	Water pump
	Fabrication /Production	MATILI T.T.I	Slider & Crank
	Fabrication /Production	BUMBE T.T.I	Hand wash machine
Institutional Management	Food production	Kisumu Polytechnic	Products preservation; Traditional African wedding cake. Solar drying of African indigenous vegetables
	Textiles	Moi Institute of Technology	Leather bags, Leather shoes,Leather bangles, African dress Kenyan dress, Improved office dustbins, Improved shopping baskets, Wedding crown (calabash) Soap dish (calabash, fish)
	Textiles	Gusii I.T	Banana fibre products for weaving from Waste banana bark products

	Food production	Mawego T.T.I	Amarantha bread Banana paste
	Textiles	RIAT	Recycled paper neck laces,Bangles from local materials Fabric and vanish, African authentic, Art and technology in modern society and African attires
	Food production	RIAT	Amarantha cake Amarantha biscuits Soya *mandazis*, Amarantha bread, Plum and mango jam, Occassional cake
	Textiles	Shamberere T.T.I	Traditional dancing costumes
Institutional Management	Food production	Keroka T.T.I	Soya facial scrub, Soya scones
Food Technology	Food production	Friends College Kaimosi	Sorghum *pilau*

BEST 3 EXHIBIT ENTRIES IN SCIENCE CONGRESS 2011 EACH OF THE 8 CATEGORIES

CATEGORY	RANK	PROVINCE	SCHOOL	PROJECT TITLE	NAME OF STUDENTS
Agriculture	**1**	Central	J.G. Kiereini High School	Coffee huller	Samuel Karanja Anthony Maingi
	2	Nyanza	Moteiribe Sec. School	Tithonia as animal feed	Aguta Boniface Douglas Mauti
	3	Eastern	Makivenzi Girls' Sec. School	Artificial hatching and brooding of chicks	Mirriam Mutheu Kezia Mwikali
Biology	**1**	Coast	Voi Sec. School	Hygienic Solar fish drier	David Masika Dan Matahana
	2	Nyanza	Jalaram Academy	The V.V. lamp sterilizer	Grace Odongo Devino Shah
	3	Nairobi	Oshwal Academy	Aquafilteration using Amaranth	Neha Nandkishore Nair Puja Maheshkumar

					Shah
Chemistry	**1**	Nairobi	Riruta Central	Making Simple Air Thermometer	Ernestine Bahati Agnes Akinyi
	2	Western	Nyakhobi Sec. School	Alternative fuel	Eunice Nafula Rowlay Awino
	3	Rift Valley	Katilu Boys'	Fuel crisis	Lomulen L. Isaac Ismail Ali

CATEGORY	**RANK**	**PROVINCE**	**SCHOOL**	**PROJECT TITLE**	**NAME OF STUDENTS**
Computer (ICT)	**1**	Nyanza	Jalaram Academy	Simplified classroom animations	Devina Shah Simran Dahiya
	2	Rift Valley	St. Anthony High School	Clinic management	Micheal Mukuria William Momanyi
	3	Western	Friends' School Kamusinga	Techno Fibre System	Mubarak Muyika Mwale Joel
Home Science	**1**	Nairobi	Oshwal Academy	Mushroom mania	Dana Jose Purvisha Hirani
	2	Nyanza	Jalaram	Jiko lighter	Aditya Dahiya Azaan Dhanji
	3	Western	Friends' School Kamusinga	Mechanical Loom	Kerima Isaac Muyoya Dennis
Mathematics	**1**	Central	St. Annes Lioki	Instrulication for sustainable environment	Gladys Abwao Leah Watetu
	2	Rift Valley	Katilu Boys'	Bird rotation	Etabo Julius Wafula Charles
	3	Nairobi	Oshwal Academy	Loggie Cash	Sonia Manish Shah Bansari Dilip Patel
Physics	**1**	Nairobi	S.C.L.P. Samaj School	Insulated Paraffin Stove	Vishal Halai Harshit Nanji
	2	Rift Valley	Bahati Girls'	Bethline product	Jaqueline Atieno Elizabeth Mwangi
	3	Nyanza	Jalaram	Wooden sockets	Drasti Kakkad Reeya Pabari
Technical	**1**	Central	Moi Girls' Kamangu	Automatic feeding and	Christine Ngugi Jane Kimani

				water troughs	
	2	Coast	Aga Khan High School	Radio alarm	Ronak Parmar Vismit Sangani
	3	Eastern	Kyangunga	Using remote to switch an irrigation pump	Fred Momanyi Stanley Mutuku