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Internal Memo

From: COD, ANIMAL SCIENCES **Date: 2nd March 2021**

To: PRINCIPAL CONRE) **Ref: JKU/2/130/25/VOL 1**

SUBJECT: DEPARTMENT OF ANIMAL SCIENCES PUBLICATIONS [2019-2021]

As requested, attached please receive the Animal Sciences Department Publications and Abstracts for the last 2 years [2019-2021].

Thank you.

Dr. J.M. Kagira, Ph.D
COD, ANIMAL SCIENCES

DEPARTMENT OF ANIMAL SCIENCES PUBLICATIONS [2019-2021]

1. Tangomo A.N., **Mathew Gitau Gicheha, John Maina Kagira** and Christian Keambou Tiambo, 2021. Apparent Digestibility and Gut Integrity of Chicken Fed a Diet Supplemented with African Safou (Dacryodes edulis). International Journal of Poultry Science, 20: 13-26. DOI: 10.3923/ijps.2021.13.26

Background and Objective: In the present study, which is the second in a series of three publications on a project aimed at evaluating the efficacy and safety of utilizing African Safou (Dacryodes edulis) in poultry feeds as an additive, the goal was to determine the apparent digestibility and gut integrity of chicken fed a diet supplemented with Dacryodes edulis parts. The first paper explored the impact of the plant parts on growth traits, ceca microbiota and blood parameters in dual-purpose indigenous chicken. Materials and Methods: In the current study, a total of 288 male dual-purpose indigenous chicken were fed six experimental diets. The diets differed in terms of the D. edulis part that was included plus its inclusion level. Data on the growth performance of the chicken fed the experimental diets were compared to chicken fed a positive (T+) and a negative (T^-) control diet. The chickens were fed the diets for a period of 14 weeks. The apparent digestibility variability of various nutrients and gut morphometric variables were measured using standard methods. Data were collected and analyzed. Results: All the experimental diets improved the apparent digestibility of metabolizable energy (AME), dry matter (DM), fat, crude protein (CP), crude fiber (CF) and calcium. Conversely, the values for zinc, magnesium and phosphorus were negative. The AME, DM content and fat digestibility differed significantly between and among treatment diets. The gut morphometric variables were not significantly different across the treatment groups. Conclusion: The findings obtained in this study showed that parts of D. edulis plant positively impacted the apparent digestibility of the feed.

2. **Effect of feed supplementation of *Dacryodes edulis* parts' powder as prebiotic on the growth traits, ceca microbiota and blood parameters of local chickens.** A.N. Tangomo, C.T. Keambou, **M.G. Gicheha, J.M. Kagira** (2020). Translational Animal Science, Volume 4, Issue 2, April 2020, txaa069, **https://doi.org/10.1093/tas/txaa069**

This study aimed at testing the efficacy and safety of *Dacryodes edulis* plant parts in diets fed to chicken. The plant has potential for use as a natural prebiotic to substitute the conventionally used antibiotic growth promoters in poultry production. Phytochemical analyses of the plant leaves, stem and bark combination (stembark) and seed powders from the *D. edulis* were carried out. The powder from the three *D. edulis* plant parts were used as supplement in formulating six experimental diets tested in this study. The diets were TL_{0Ed} (0.5% leaves powder), TL_{1Ed} (1.0% leaves powder), TB_{0Ed} (0.5% stembark powder), TB_{1Ed} (1.0% stembark powder), TS_{0Ed} (0.5% seeds powder) and TS_{1Ed} (1.0% seeds powder). Besides, a positive (T_+ positive control; 0.5g oxytetracycline as recommended by the manufacturer) and a negative (T_- negative control; having no commercial antibiotic and no plant supplement) diets were prepared for comparison purposes. The diets were fed to a total of 288 dual-purpose chicken for a period of 14 weeks. The chicken

growth and body composition characteristics, blood chemistry, and microbiota count were collected and used as indicators of the plant parts efficacy and safety. The analysis of the *D. edulis* plant parts significantly differed ($p \leq 0.05$) in their phytochemical contents. The initial body weight and feed conversion efficiency ratios were not significantly different ($p \geq 0.05$) between and among treatment groups. However, significant differences ($p \leq 0.05$) were detected in the feed intake and body weight gain at 8th week. Live weight at 8th week was significantly different ($p \leq 0.05$) with its values ranging between 503.32g and 614.93 g for treatments TL_{1Ed} and $T_{Neg-,}$ respectively. The dietary treatment of *D. edulis* leaves, stembark and seed powder at the two inclusion levels significantly ($p \leq 0.05$) decreased the colonies forming unit of *Escherichia coli* and *Salmonella sp* as compared to negative control treatment in the 8th week phase. The level of glucose, total cholesterol, triglycerides, Aspartate aminotransferase (AST), Alanine amino transferase (ALT), alkaline phosphatase (ALP), and the packed cell volume (PCV) did not differ significantly ($p \geq 0.05$) between and among dietary *D. edulis* treatments. The findings from this research provide crucial information on the efficacy and safety of *D. edulis* plant parts. This is an important step in testing the potential of the plant in use as a prebiotic in chicken feeds production.

3. **Breeding dairy goats for disease resistance is profitable in smallholder production systems.** Amayi A.A., Okeno T.O., **Gicheha M.G.** & Kahi A.K. **2020**. Small Ruminant Research [accepted]

Abstract

We tested hypothesis that, inclusion of the disease resistance indicator traits in the breeding goal of the dairy goats would result to increased response to selection and consequently profitability of smallholder farmers. Using deterministic simulation, we compared response to selection realised in breeding schemes without (Scheme I) and with (Schemes II, III and IV) disease resistance in the breeding goal. We used faecal egg count (FEC) and somatic cell score (SCS) as the indicator traits for helminthosis and mastitis in goats, respectively. We also investigated the effect of risk aversion among the smallholder farmers on response to selection. The breeding structure consisted of a two-tier closed nucleus system, with recording and genetic evaluations being undertaken in the nucleus. The breeding schemes, differed based on the number of traits in the selection criteria and number of records used to estimate their breeding values. For instance, in Scheme I, traits in the breeding goal included milk yield (MY), live weight (LW), average daily gain (ADG), doe mature weight (DMW), number of kids weaned (NKW) and survival rate (SR). Scheme II was similar to Scheme I, but included records of FEC and SCS measured immediately after weaning and during early lactation, respectively. Scheme III was similar to II, but with additional information on SCS recorded at mid-lactation, while Scheme IV was similar to III with more SCS information recorded in late-lactation. Our findings, indicate that, schemes that included disease resistance indicator traits in the selection criteria (Schemes II, III and IV) were 28, 24 and 19%, respectively, superior in profitability to Scheme I, which ignored the disease resistance in the breeding goal. Scheme II was the best as it realised additional 3.5 and 7.6% profitability compared

to Schemes III and IV, respectively. The response to selection, was maximized when nucleus size consisted of 4-5% of the does' effective population size and 20% of them phenotyped for SCS. The breeding schemes, with high risk aversion realised low profitably compared to low risk aversion schemes. This demonstrates that, use of economic values obtained using low risk aversion models, could overestimate the economic worth of a breeding program especially in smallholder production systems, where farmers are risk averse.

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

4. **Production and fertility performance of Barka cattle breed in different agro-ecological zones of Eritrea.** Goitom S., **Gicheha M.G. &** Tsegay T. 2020. African Journal of Rural development. 4: 212 – 216. www.afjrd.org›index.php › afjrd›article›download

Abstract

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

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

5. Maindi N.C. **Osuga I.M.** & ***Gicheha M.G.*** **2020**. **Advancing Climate Smart Agriculture: Adoption Potential of Multiple On-Farm Dairy Production Strategies among Farmers in Murang'a County, Kenya.** Livestock Research for Rural Development. 32. Accessible at: http://www.lrrd.org/lrrd32/4/izzac32063.html

Abstract

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

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

6. **Genome-wide genetic diversity, population structure and admixture analysis in Eritrean indigenous cattle.** Goitom S., **Gicheha M. G., Francis K. Njonge** & N'geno K. 2019. *South Africa* Journal of Animal Science, South Africa. 49: 1083 - 1092. https://www.researchgate.net/publication/338716586_Genome-wide_genetic_diversity_population_structure_and_admixture_analysis_in_Eritrean_Indigenous_Cattle

Abstract

Indigenous cattle play a vital role in subsistence and livelihood of pastoral producers in Eritrea. In order to optimally utilize and conserve these valuable indigenous cattle genetic resources, the need to carry out an inventory of their genetic diversity was recognized. This study assessed the genetic variability, population structure and admixture of the indigenous cattle populations (ICPs) of Eritrea using a genotype by sequencing (GBS) approach. The authors genotyped 188 animals, which were sampled from 27 cattle populations in three diverse agro-ecological zones (western lowlands, highlands and eastern lowlands). The genome-wide analysis results from this study revealed genetic diversity, population structure and admixture among the ICPs. Averages of the

minor allele frequency (AF), observed heterozygosity (HO), expected heterozygosity (HE), and inbreeding coefficient (FIS) were 0.157, 0.255, 0.218, and -0.089, respectively. Nei's genetic distance (Ds) between populations ranged from 0.24 to 0.27. Mean population differentiation (FST) ranged from 0.01 to 0.30. Analysis of molecular variance revealed high genetic variation between the populations. Principal component analysis and the distance-based unweighted pair group method and arithmetic mean analyses revealed weak substructure among the populations, separating them into three genetic clusters. However, multi-locus clustering had the lowest cross-validation error when two genetically distinct groups were modelled. This information about genetic diversity and population structure of Eritrean ICPs provided a basis for establishing their conservation and genetic improvement programmes.

Keywords: genetic variability; molecular characterization; population differentiation.

7. **Morphological Characterisation of Indigenous Cattle Breeds in Eritrea.** Goitom S., **Gicheha M.G.** Ng'eno, K., **Njonge, F.K.** 2019. Advances in Animal and Veterinary Sciences**.** 7: 848-857. http://dx.doi.org/10.17582/journal.aavs/2019/7.10.848.857

Abstract

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

Keywords: Eritrea, Barka, Arado, Classification, Morphometric

8. **Effects of yeast and yeast cell wall polysaccharides supplementation on beef cattle growth performance, rumen microbial populations and lipopolysaccharides production.** Peng Quan-hui, Cheng Long, Kan Kun, Gang Tian, **Gicheha Mathew,** Xue Bai, Wang Lizhi, Zou Hua-wei1, Al-Mamun Mohamud, Wang Zhi-sheng. 2019. Journal of Integrative Agriculture. 18: 2–11

Abstract

This experiment was conducted to investigate the effects of live yeast and yeast cell wall polysaccharides on growth performance, rumen function and plasma lipopolysaccharides (LPS) content and immunity parameters of beef cattle. Forty Qinchuan cattle were randomly assigned to one of four treatments with 10 replicates in each treatment. The dietary treatments were: control diet (CTR), CTR supplemented with 1 g live yeast (2×1010 live cell g–1 per cattle per day (YST1), CTR supplemented with 2 g live yeast per cattle per day (YST2) and CTR supplemented with 20 g of yeast cell wall polysaccharides (30.0%≤β-glucan≤35.0%, and 28.0%≤mannanoligosaccharide≤32.0%) per cattle per day (YCW). The average daily gain was higher (P=0.023) and feed conversion ratio was lower (P=0.042) for the YST2 than the CTR. The digestibility of neutral detergent fiber (P=0.039) and acid detergent fiber (P=0.016) were higher in yeast supplemented groups. The acetic acid:propionic acid of the YST2 was lower compared with the CTR (P=0.033). Plasma LPS (P=0.032), acute phase protein haptoglobin (P=0.033), plasma amyloid A (P=0.015) and histamine (P=0.038) were lower in the YST2 compared with the CTR. The copies of fibrolytic microbial populations such as Fibrobacter succinogenes S85, Ruminococcus albus 7 and Ruminococcus flavefaciens FD-1 of the YST2 were higher (P<0.001), while the copies of typical lactate producing bacteria Streptococcus bovis JB1 was lower (P<0.001) compared with the CTR. Little differences were observed between the CTR, YST1 and YCW in growth performance, ruminal fermentation characteristics, microbial populations, immunity indices and total tract nutrient digestibility. It is concluded that the YST2 could promote fibrolytic microbial populations, decrease starch-utilizing bacteria, reduce LPS production in the rumen and LPS absorption into plasma and decrease inflammatory parameters, which can lead to an improvement in growth performance in beef cattle.

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

9. Kagucia A.W., **John Maina Kagira**, Naomi Maina, Simon Muturi Karanja, Francis Kimani Njonge (2020). Characterisation of productivity and diseases a ecting dairy goats in smallholder systems of Greater Thika Region, Kenya. Journal of Agriculture and Rural Development in the Tropics and Subtropics, Vol. 121 No. 2 (2020) 243–249, https://doi.org/10.17170/kobra-202010191972

The current cross-sectional study aimed at characterising the productivity and diseases affecting dairy goats kept by smallholder farmers in three sub-counties in Thika Region, Kenya. Standard questionnaires were administered to 240 farmers through face-to-face interviews and the outputs were analysed using descriptive and inferential statistics. The farmers mainly kept crosses of Toggenburg (45.9%), Kenyan Alpine (29.5%) and Saanen (17.4%) dairy goats. The average dairy goat flock size was 4.5 (range 1-23) and 77.5% of the goats were kept for production of milk for domestic consumption. The average milk production per goat per day was 1.26 litres (range 0.5 to 3.5 litres) and was significantly ($p<0.05$) associated with sub-county of origin, main occupation of the owner, breed, and lactation stages. Goats were mainly fed on napier grass, maize stovers, natural grass and hay; and these feeds did not influence ($p>0.05$) the milk production levels. The farmers identified helminthosis (84.6%), pneumonia (32.9%), coccidiosis (25.8%) and mastitis (25%), as the most prevalent goat diseases. In conclusion, the study showed that dairy goat farming in greater Thika Region was characterised by low-input with an objective of provision of milk for home consumption. The observed challenges of low milk productivity and diseases should be addressed by the local extension workers through training on improved husbandry, nutrition and health management of the dairy goats.

Key words: Dairy goats, milk production, feed, diseases, small ruminants

10. **Organ Pathology and Associated IFN-γ Variations in Mice Infected with Toxoplasma gondii Isolate from Kenya.** Mose J.M, Kamau D.M., **Kagira J.M.,** Maina N., Ngotho M., Mutharia L. and Karanja S.M. (2019). **In: Gilberto Antonio Bastidas (ed). Parasites and Parasitic Diseases.** Pg 58-62. IntechOpen, New York. ISBN: 978-1-83880-128-1. Print ISBN: 978-1-83880-127-4.

Abstract

Toxoplasma gondii is an important foodborne opportunistic pathogen that causes a severe disease in immunocompromised patients. The pathology and immune responses associated with the ensuing disease have not been well described in strains from different parts of the world. The aim of the present study is to determine the IFN-γ and IL-10 variations and organ pathology in immunocompetent and immunocompromised mice infected with T. gondii isolated from a Kenyan chicken. Two groups of BALB/c mice were infected with T. gondii cysts and administered with dexamethasone (DXM) in drinking water. Other two groups: infected untreated and uninfected mice were kept as controls. The mice were euthanized at various time points: blood collected for serum and assayed for IFN-γ and IL-10 variations. After infection, significant ($p<0.05$) elevated levels of IFN-γ and IL-10 were observed. A significant decline in IFN-γ and IL-10 levels ($p<0.05$) was observed after dexamethasone treatment. Histological sections in the liver, heart, and spleen of the mice administered with DXM revealed various degrees of inflammation characterized by infiltration of inflammatory cells. The dexamethasone-treated mice presented with progressively increased ($p<0.001$) inflammatory responses is compared with the infected untreated mice.

11. **In-vitro Anthelmintic Activity of Chitosan Encapsulated Bromelain against eggs, larval and adult stages of Haemonchus contortus.** Hunduza A., **John Kagira**, Naomi Maina, Dickson Andala, Kipyegon Cheruiyot, Shadrack Kahiro (2020). Journal of Applied Life Sciences International 23(3): 28-38.

Abstract

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

12. **In vitro antibacterial activity of nanoencapsulated bromelain against bacteria isolated from milk of dairy goats with sub-clinical mastitis in Kenya**. Mahlangu Precious, **Kagira John**, Maina Naomi (2020). Asian Journal of Research in Animal and Veterinary Sciences 5(3): 33-40.

Abstract

Mastitis in dairy goats is managed by a variety of antibiotics. Due to the emergence of antibiotic resistance, there is need for development of new antimicrobial agents. In the current study, the *in vitro* activity of nanoencapsulated bromelain, using bromelain extracted from the pineapple fruit, *Annanus comosus* was investigated against bacteria isolated from milk of dairy goats with sub-clinical mastitis. Nanoencapsulation of bromelain was done using the ionic gelation method of chitosan nanoparticles with sodium trypolyphosphate as the cross linking agent. In this study, the agar well diffusion method was used to test for antimicrobial activity while the broth microdilution method was used to test for the Minimum Inhibitory Concentration (MIC). The isolates used were *Staphylococcus aureus*, Coagulase Negative *Staphylococci, Serratia* spp., *Klebsiella* spp., *Enterobacter* spp., *Citrobacter* spp. and *Escherichia coli* isolated from milk of dairy goats with sub-clinical mastitis in Thika East Sub-county, Kenya. The agar well diffusion method showed that bromelain and nanoencapsulated bromelain had antimicrobial activity. All of the tested

bacteria were sensitive to extracted bromelain at 5mg/ml and less. The tested bacteria were less sensitive to commercial bromelain (57.1%) at 5mg/ml and less. The MIC of nanoencapsulated bromelain against *Enterobacter* spp., *Citrobacter* spp., *Serratia* spp. and Coagulase Negative *Staphylococci* was 25µg/ml, while that of *Escherichia coli* was 50µg/ml. The MIC of nanoencapsulated bromelain against *Klebsiella* spp. and *Staphylococcus aureus* was 200µg/ml. The low MICs recorded in this study shows that nanoencapsulated bromelain has high antimicrobial potential which warrants further *in vivo* studies in dairy goats to determine its efficacy against sub-clinical mastitis.

13. **Toxicity and anthelmintic efficacy of chitosan encapsulated bromelain against gastrointestinal strongyles in Small East African goats in Kenya**. Wasso W., Naomi Maina and **John Kagira** (2019). Veterinary World, 13(1): 177-183.

Abstract

Background and Aim: The development of resistance to anthelmintic drugs has prompted research into alternative methods of controlling intestinal nematodes in ruminants. This study aimed at evaluating the in vitro and in vivo anthelmintic efficacy and toxicity of chitosan encapsulated bromelain in Small East African goats in Kenya.

Materials and Methods: Adult mortality assay was performed using live Haemonchus contortus worms treated with encapsulated bromelain solution ranging from 0.125 mg/ml to 2 mg/ml. Percentage mortality of worms was calculated after 24 h and the lethal concentration 50% (LC50) determined. For the in vivo study, 18 healthy male indigenous goats were divided into six groups of three goats each. The encapsulated bromelain was orally administered in increasing dosages (3-30 mg kg) once daily, for 14 days. The packed cell volume (PCV), aspartate aminotransferase (AST), alanine aminotransferase (ALT), urea, creatinine, and fecal egg count (FEC) were determined on a weekly basis. At the end of the study, the goats were sacrificed and gross pathology and histopathology of main organs assessed.

Results: Albendazole had the highest ($p<0.05$) anthelmintic effect on the worms. An LC50 of 0.05 mg/ml, 0.445 mg/ml, and 0.155 mg/ml was observed for albendazole, plain bromelain, and encapsulated bromelain, respectively. The PCV of treated and untreated goats did not show any significant difference ($p>0.05$), varied from 29.3% to 35.1%, and was within the normal range of the animal. Likewise, no significant differences ($p>0.05$) were observed between the AST, ALT, urea, and creatinine levels of treated and the control (non-treated) goats. No adverse clinical symptoms, toxicity of the main organs, and mortality in goats were associated with the chitosan encapsulated bromelain after administration of dose up to 30 mg/kg for 14 days. Therefore, the lethal dose 50 of encapsulated bromelain may be considered to be >30 mg/kg. On day 28 posttreatment, the encapsulated bromelain showed a higher in vivo FEC reduction (68.8%) as compared to the plain bromelain (32.4%).

Conclusion: Our results show that bromelain encapsulated in chitosan may be safe and effective in reducing the burden of gastrointestinal tract strongyle nematodes in goats. However, there is a need for further studies to establish the dosage of the encapsulated bromelain to be administered

in a single dose for the treatment of goats against gastrointestinal strongyles. In addition, species-specific studies on the efficacy of encapsulated bromelain on strongyles are necessary to evaluate its effectiveness against the entire Strongyloididae family.

14. P**revalence and monetary loss due to cystic echinococcosis in slaughter house livestock: A case study of Migori County, Kenya**. **Kere O.J**., E. Joeph, B.L. Jessika, B.L., **Kagira J.M.** (2019). Parasite Epidemiology and Control, https://doi.org/10.1016/j.parepi.2019.e00105

Abstract

Cystic Echinococcosis (CE) is a parasitic zoonotic disease of public health importance that causes considerable economic loss worldwide. The aim of this study was to assess the prevalence and monetary loss of CE in livestock slaughtered in Migori County, Kenya. The study was conducted by retrieving and analyzing secondary data over a ten year period (2007-2016) and; these were annual meat inspection reports from the sub county veterinary offices within Migori County, Kenya. The data included species of slaughter animals, number of each species slaughtered and number of animal organs condemned due to presence of hydatid cysts recorded. The results showed CE prevalence was highest in cattle (5.3%) followed by goats (2.0%) and the least affected were sheep (0.1%). The overall direct monetary loss of $152,003/year. The study results confirms occurrence of CE in Migori County and demonstrates emerging new foci of the zoonosis in other non-endemic regions of Kenya with a significant direct monetary loss, a phenomenon that require serious attention to prevent and control the zoonosis in Kenya.

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

Abstract

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

16. **Zoonotic Hemoparasites of Baboons (*Papio Anubis*) at the Human-Wildlife Interface in Kenya.** Maloba F., Mwangi D., **Kagira J. M**, Kivai S., Ndeereh D., Ngotho J., Gicheru M., Mbaruk S., Akinyi M. (2019). International Journal of Zoology and Animal Biology 2 (7) DOI: 10.23880/izab-16000172

Abstract

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

17. **Effects of *Mondia Whitei* 'Mukombero' on Sperm Parameters in Male Albino Rats**. Mabonga C., D. Kamau, **J. Kagira**, F. Alkizim and Nandwa A. (2019). Africa Environmental review Journal 3 (2) 58-69.

Infertility affects about 8 to 12% of the world's population and, in about half of cases, men are either the single cause or contribute to the couple's infertility. Many indigenous plants have been reported to be effective in male fertility regulation. Mondia whitei is a widely used medicinal plant across Africa for treatment of sexual dysfunction yet minimal empirical data exists to support its therapeutic value. The aim of this study was to evaluate the effects of aqueous extract of Mondia

whitei on sperm characteristics in male albino rats following oral administration. 36 albino male rats weighing between 200mg-400mg were divided into 4 groups, each of nine rats. Group I comprised untreated controls while Groups II, III, and IV were treated with 100, 200 and 400mg/kg body weight respectively using the aqueous extract of Mondia whitei via oral gavage. At the end of experiment, rats were humanely sacrificed using Carbon dioxide, the testes and epididymis, dissected for sperm collection. Sperm count, total motility, vitality and morphology were determined using a microscope and a neubaeurs chamber. Data was analyzed using Statistical Package for Social Sciences (SPSS) -Version 20.0). Kruskal wallis test was employed in the analysis. $P < 0.05$ was considered statistically significant. The median (IQR) sperm count of group I, II, III and IV at 10th day were 100.03 (100.03, 100.04) 10398 (98, 101), 96.66 (96.65, 96.68) and 100.98 (100.88, 101.47) cells/ml respectively. The difference was statistically significant (chi=8.157, p=0.043). Trend analysis indicated that within the groups, sperm count decreased significantly with increase in time (all $p<0.05$). The median (IQR) total sperm motility (percentage) of group I, II, III and IV at 10th day were 91 (90, 92 84 (81, 85), 86 (84, 88) and 88 (84, 89) respectively and the difference was statistically significant (chi=7.686, p=0.049). The median (IQR) sperm vitality in percentage of group I, II, III and IV at 10th day were 91 990, 91), 85 (82, 86), 87 (85, 89) and 89 (86, 90) respectively. The difference was statistically significant (chi=8.286, p=0.040). Though trend analysis indicated that it did not vary significantly within the groups (all $p>0.05$). Normal morphology percentage declined in different test groups as compared to the control groups. A statistically significant decline in normal morphology was observed within the groups with respect to time interval (p=0.027). Trend analysis indicated that within the groups, normal morphology decreased significantly with time (all $p<0.05$) while abnormal head morphology and tail increased with time p=0.05. This study concludes that Mondia whitei may alter male fertility by affecting sperm quality; it causes a decline in sperm count, morphology, motility and vitality. This shows that M. whitei might be cytotoxic and can result in hypogonadotrophic hypogonadism and oligoasthenoteratozoospermia.

18. **Prevalence, Risk factors Associated with Brucellosis and Presence of Pathogenic Bacteria isolated from Camel Milk in Garissa County, Kenya**. Noor M., Rotich V., Kiarie J. W., Cheruiyot K. and **J. M. Kagira** (2020). South Asian Journal of Research in Microbiology6(4): 42-52.

Abstract

Aim: The current study was undertaken to assess the prevalence, risk factors of brucellosis and presence of pathogenic bacteria isolated from camel milk in Garrisa County, Kenya.
Methodology: The study design was cross-sectional where questionnaires were administered to farmers to assess the risk factors associated with brucellosis. The experimental study was also employed to identify bacteria in milk samples which were collected from 104 camels. Fifty milk samples were obtained from local farms while 54 were from sales point at Garissa market. Further test for brucellosis using milk ring test was also carried out.

Results: The overall prevalence of brucellosis in camel milk was 8%. Most (12.5%) of the positive samples were from Dadaab Sub-county while the rest of the positive samples were from Fafi (5.9%) and Balambala (5.9%) sub-counties. All the 54 samples obtained from Garissa market were negative of brucellosis. Of the total (118) bacteria isolates, those from the farm level were 68.6% and from market were 31.2%. The bacteria isolated from the 104 milk samples were Pseudomonas spp. (32.2%), Salmonella spp. (30.5%), Staphylococcus spp (21.2%), Eschericia coli (8.5%) and Shigella spp. (7.6%). The risk factors that were significantly ($p<0.05$) associated brucellosis were: age of lactating camels (higher in camels aged above 20 years), herd size (higher in camels from herd sizes of between 30-50 camels), and herding of camels with other livestock (higher in camels kept with other livestock).
Conclusion: In conclusion, a few milk samples from camels in Garissa County were found to have brucellosis and were heavily infected with bacteria which can cause mastitis. Considering that most people in the study area drank raw milk, spread of these bacteria to man is a high possibility and thus animal and public health officers should implement one health disease control strategies.

19. **Beta-Lactam Resistance in Bacteria Associated with Sub-Clinical Mastitis in Goats in Thika Sub-County, Kenya**. Okoko I.M., Maina N., Kiboi D., **Kagira J.** (2020). Veterinary World 13 (6). In Press.

Abstract

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

bacteria are of zoonotic importance and, thus, further studies should be carried to determine transmission dynamics between humans and livestock and suggest novel intervention strategies.

20. Mose J.M., ,**John Maina Kagira** , David Muchina Kamau, Naomi Wangari Maina , Maina Ngotho, and Simon Muturi Karanja (2020). A Review on the Present Advances on Studies of Toxoplasmosis in Eastern Africa. BioMed Research International, Volume 2020, Article ID 7135268, 12 pages, https://doi.org/10.1155/2020/7135268
    Toxoplasmosis is a zoonotic infection caused by the protozoan parasite, Toxoplasma gondii. It was discovered over 100 years ago and is credited as the most successful parasitic organism worldwide, able to infect and multiply in all warm blooded animals including an estimated 2.3 billion people. Toxoplasmosis is asymptomatic in immunocompetent individuals. Infection in the developing fetus and immunocompromised individuals can cause severe clinical disease. Toxoplasmosis is also a major cause of reproductive failure in livestock. The economic impact of toxoplasmosis is believed to be substantial. Factors associated with toxoplasmosis infection have been defined. Eastern Africa region is a high-risk area mainly due to the close association of humans and livestock as well as sociocultural practices, poor environmental hygiene, and poverty. The present paper provides a narrative review of published data on toxoplasmosis in Eastern Africa.

21. **Nutritional composition of black soldier fly larvae feeding on agro-industrial by-products.** Chia, S. Y., T. M. Chrysantus, **I. M. Osuga**, X. Cheseto, S. Ekesi, M. Dicke and J. J. van Loon. **2020**. Entomologia Experimentalis et Applicata Accepted Author Manuscript. doi:10.1111/eea.12940

Abstract

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

22. **Nutritional and Technological Characteristics of New Cowpea (Vigna unguiculata) Lines and Varieties Grown in Eastern Kenya**. Biama, P. K., A. K. Faraj, C. M. Mutungi, **I. M. Osuga** and R. W. Kuruma. **2020** Food and Nutrition Sciences, 11, 416-430. https://doi.org/10.4236/fns.2020.115030

Abstract

Protein sources in the diet of people living in semi-arid land of Kenya are lacking and if available it is costly to them. In terms of safe food and a healthy food supply, cowpeas (*Vigna unguiculata*) are a significant source of protein, carbohydrates, and minerals especially for poor populations in the Kenya, it is said to be poor man's meat. The aim of this study was to determine nutritional composition of newly bred ten cowpea lines and five varieties commonly grown in Eastern Kenya of Kitui, Machakos and Makueni counties to understand their potential utilization in curbing rising food and nutrition insecurity in arid and semi-arid lands ASALs and in any other food applications in Kenya. The experiment was arranged in Completely Randomized Design (CRD) whereby proximate composition and minerals were determined using standard AOAC and AACC methods and technological characteristics checked using modified methods used by other researchers. Collected data were subjected to Analysis of Variance (ANOVA) using SAS (2006) version 9.1, mean separation was done using Tukey's Honestly Significant Difference (HSD) method at 5% level of significance. Cowpeas composition ranged from 12.28% - 13.35% for moisture content, 49.37% - 55.74% for total carbohydrates, 2.99% - 3.34% for crude ash, 0.13% - 0.81% for crude lipids, 23.37% - 29.70% for crude protein and 1.40% - 4.34% for crude fibers. Cowpea samples recorded highest percentage of essential amino acids (60.71%) and non-essential amino acids (39.29%). Minerals ranged from 1.97 - 2.69 mg/100g for calcium, 3.23 - 3.90 mg/100g for magnesium, 205.53 - 223.30 mg/100g for sodium, 0.80 - 1.23 mg/100g for zinc, 1071.15 - 1152.62 mg/100g for potassium and 0.62 - 1.06 mg/100g for phosphorus. For technological properties, lines absorbed water equivalent to their weights and they were comparable to varieties grown in the region. From the results it showed that cowpea line IT97K-1042-3, TEXAN PINKIYE, TX123, IT85F-867-5, IT82D-889-1 and IT82D-889 have desirable attributes such as high crude protein contents, good water absorption capacities and volumetric expansion. They compared well with existing K80 variety. These cowpea lines could possibly be bred and combined into a single cowpea line and further improved by breeders to have other good properties such as higher levels of water absorption during soaking hence reduced cooking times. Therefore, this work has shown that cowpea lines developed can be used as food security crop, industrial food applications and enriching foods of low protein like in complementary foods for healthy food supply in Eastern Kenya.

23. **The Nutritive Value and Palatability of Selected Browse Forages Mixtures from Arid and Semi-Arid Area of Kenya When Fed to Growing Small East African Goats**. **Osuga I. M.**, D. G. Njeru, L. M.Musalia and S. A. Abdulrazak**. 2020**. IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS), 13 (3), 01-07. http://www.iosrjournals.org/iosr-javs/papers/Vol13-issue3/Series-2/A1303020107.pdf

Abstract

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

24. **Effect of Dietary Replacement of Fishmeal by Insect Meal on Growth Performance, Blood Profiles and Economics of Growing Pigs in Keny**a. Chia S. Y., C. M. Tanga, **I. M. Osuga**, A. O. Alaru, D. M. Mwangi, M. Githinji, S. Subramanian, K. K. M. Fiaboe, S. Ekesi, J. J.A. van Loon and M. Dicke. **2019**. *Animals***,** *9*(10), 705. https://doi.org/10.3390/ani9100705.

Abstract

Pig production is one of the fastest growing livestock sectors. Development of this sector is hampered by rapidly increasing costs of fishmeal (FM), which is a common protein source in animal feeds. Here, we explored the potential of substituting FM with black soldier fly larval meal (BSFLM) on growth and blood parameters of pigs as well as economic aspects. At weaning, 40 hybrid pigs, i.e., crossbreeds of purebred Large White and Landrace were randomly assigned to five iso-nitrogenous and iso-energetic dietary treatments: Control (0% BSFLM and 100% FM (T0)), and FM replaced at 25% (T25), 50% (T50), 75% (T75) and 100% (T100) with BSFLM. Average daily feed intake (ADFI), average daily gain (ADG), body weight gain (BWG) and feed conversion ratio (FCR) were calculated for the whole trial. Hematological and serum biochemical parameters, the cost–benefit ratio (CBR) and return on investment (RoI) were evaluated. No

significant effect of diet type was observed on feed intake and daily weight gain. Red or white blood cell indices did not differ among diets. Pigs fed T25, T75 and T100, had lower platelet counts compared to T0 and T50. Dietary inclusion of BSFLM did not affect blood total cholesterol, triglycerides, low-density lipoprotein and high-density lipoprotein. CBR and RoI were similar for the various diets. In conclusion, BSFLM is a suitable and cost-effective alternative to fishmeal in feed for growing pigs.

25. **The nutritive value of black soldier fly larvae reared on common organic waste streams in Kenya**. Marwa S., **I. M. Osuga**, F. M. Khamis, C. M. Tanga, K. K. M. Fiaboe, S. Subramanian, S. Ekesi, A. Huis and C. Borgemeister. **2019**. *Scientific Reports*, 9(1). https://doi:10.1038/s41598-019-46603-z

Abstract

In Africa, livestock production currently accounts for about 30% of the gross value of agricultural production. However, production is struggling to keep up with the demands of expanding human populations, the rise in urbanization and the associated shifts in diet habits. High costs of feed prevent the livestock sector from thriving and to meet the rising demand. Insects have been identified as potential alternatives to the conventionally used protein sources in livestock feed due to their rich nutrients content and the fact that they can be reared on organic side streams. Substrates derived from organic by-products are suitable for industrial large-scale production of insect meal. Thus, a holistic comparison of the nutritive value of Black Soldier Fly larvae (BSFL) reared on three different organic substrates, i.e. chicken manure (CM), brewers' spent grain (SG) and kitchen waste (KW), was conducted. BSFL samples reared on every substrate were collected for chemical analysis after the feeding process. Five-hundred (500) neonatal BSFL were placed in 23 × 15 cm metallic trays on the respective substrates for a period of 3–4 weeks at 28 ± 2 °C and 65 ± 5% relative humidity. The larvae were harvested when the prepupal stage was reached using a 5 mm mesh size sieve. A sample of 200 grams prepupae was taken from each replicate and pooled for every substrate and then frozen at −20 °C for chemical analysis. Samples of BSFL and substrates were analyzed for dry matter (DM), crude protein (CP), ether extracts (EE), ash, acid detergent fibre (ADF), neutral detergent fibre (NDF), amino acids (AA), fatty acids (FA), vitamins, flavonoids, minerals and aflatoxins. The data were then subjected to analysis of variance (ANOVA) using general linear model procedure. BSFL differed in terms of nutrient composition depending on the organic substrates they were reared on. CP, EE, minerals, amino acids, ADF and NDF but not vitamins were affected by the different rearing substrates. BSFL fed on different

substrates exhibited different accumulation patterns of minerals, with CM resulting in the largest turnover of minerals. Low concentrations of heavy metals (cadmium and lead) were detected in the BSFL, but no traces of aflatoxins were found. In conclusion, it is possible to take advantage of the readily available organic waste streams in Kenya to produce nutrient-rich BSFL-derived feed.

26. **Experimental feeding studies with crickets and locusts on the use of feed mixtures composed of storable feed materials commonly used in livestock production.** Straub P., C. M. Tanga, **I. Osuga**, W. Windisch and S. Subramanian. **2019**. *Animal Feed Science and Technology*, 255, 114215. https://doi.org/10.1016/j.anifeedsci.2019.114215

Abstract

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