

The Growth and Feed Conversion Efficiency of New Zealand White Rabbits Fed on Legume Supplementation

Sergon P. C., Kitilit J. K and Omega J. A

Department of Animal science & Production, University of Eldoret,
P.O Box1125, ELDORET
Email: philo200262@gmail.com

Abstract

Rabbit is a non ruminant animal with high reproductive potential and space requirement hence preferred by rural households for poverty alleviation and improved nutrition. There has not been much attention given to rabbit meat production in the smallholder areas despite its nutritional value for health, and potential for export markets. The objective of the study was to evaluate the effect of supplementing Rhodes grass hay (Chloris gayana) with Sweet potato vines (Ipomea batatas), Mulberry (Morus alba) and Sesbania (Sesbania sesban) leaves in terms of nutrient content, feed intake, growth rate and feed conversion efficiency. The study was carried out in Uasin Gishu County using a Completely Randomized Design. A number of 9 grower rabbits of equal ages were randomly allocated to 5 treatments. All the experimental rabbits were pre- treated with broad-spectrum anthelmintics and coccidiostats. The animal's body weight, daily feed intake were monitored and recorded for 11 weeks. Data collected was statistically analyzed using analysis of variance. Differences between means were separated using tukeys test. Treatment diets appeared similar in nutrient content except crude fat which was high of 2.24 in treatment B. Average daily gains and feed intake for treatments A, B, C, D and E were 40, 49, 30, 39 g and 19; 1.68, 1.62, 1.62, 1.62 and 1.4 respectively. Treatment B had significantly higher ADG, while treatment A had a higher Feed intake. In conclusion, rabbits in treatment B had higher final weights compared to all other treatments.

Key words: Legume forages, rabbit, Feed Intake, Feed Conversion Efficiency, growth rate.

INTRODUCTION

The rapid population growth in developing countries demands provision of sufficient supply of animal protein (Sese *et al.*, 2014). The availability of animal protein is considered to be about seven tenths of the recommended daily intake of 35g. Due to this deficiency, the stakeholders in the food and nutrition industry have increased their focus on the popular livestock species that include cattle, sheep, goat, swine and poultry with limited success (Sese *et al.*, 2014). Due to the limitations posed by dwindling farm size, soil degradation and climate change, the conventional protein sources are declining, while several African communities view rabbit husbandry as children's play activity that is of no impact. But food security is a top priority engagement in many developing countries, therefore a paradigm shift is needed in order to move from conventional to non conventional animal protein feed sources such as rabbit which emphasize on cost, time and space efficiency (Etim *et al.*, 2014). Rabbit rearing forms the alternative source of animal protein due to the virtues attributable to the rabbit that include; high rate of reproduction and early maturity, rapid growth rate, high genetic selection potential, efficient feed and land utilization, limited competition with humans for similar feeds and high quality nutritious white meat.

Many households in African countries widely practise backyard rabbit rearing systems where waste green herbage is the main feed source (Samkol & Lukefahr, 2008). There is however need to improve the nutrient supply through supplementation (Omoikhoje *et al.*, 2006). The rabbit feeding cost represents 60 -70% of the total cost of production, therefore a reduction in feed costs through combination of quality forages is important to farmers (Maertens, 2010).

Rabbits are monogastric herbivores with a digestive physiology that is well adapted to cellulose components (Sese *et al.*, 2014), therefore their feeds should contain high levels of fibre feeds (Gidenne & Bellier, 2000) that helps in the regulation of the intestinal transit, the gut flora and the intestinal mucosa integrity (Fortun-Lamothe & Boullier, 2007). The recommended dietary fibre content in the feed is between 10-14% (FAO, 2001) containing 320-360 g/kg and 50-90 g/kg of insoluble and soluble fibre, respectively, 2013) equivalent to 1.5 to 4% starch concentration (Gidenne, Lebas & Fortun-Lamothe, 1997) and 16% crude protein levels. The crude protein requirement of between 12 and 17% are recommended for different stages of life for rabbits (Wanjala, 2015)

Use of legumes in feed supplementation has widespread gains both in the reduction of feeding cost and also in the utilization of nutritionally inferior food for human consumption. There are several studies which have designed and utilized agricultural and agro-industrial by-products such as velvet bean (*Mucuna utilis*) (Sese *et al.*, 2014), White lead tree (*Leucaena leucocephala*) or siratro (*Macroptilium purpureum*) leaves (Makinde, 2016), Sweet potato (*Ipomea batatas*) vines (Etim *et al.*, 2014), Rhodes grass hay (Wanjala, 2015), *Abelmoschus esculentus*, *Corchorus litorius*, *Vigna unguiculata*, *Amaranthus hybridus*, *Hibiscus sabdariffa*, *Manihot esculenta*, *Celosia argentea*, *Myrianthus arboreus*, *Basella alba*, *Talinum triangulare* and *Colocasia esculenta* (Franck *et al.*, 2016). Since rabbits are herbivores with post-gastric digestion, they can effectively utilize roughage and cope with fibrous contained in grasses and legumes. The objective of the current study was to evaluate the effect of supplementing Rhodes grass hay with sweet potato vines, Mulberry, and Sesbania on feed intake, Feed conversion efficiency (FCE) and growth rate in rabbits.

MATERIALS AND METHODS

Study site

The study was carried out in Uasin Gishu County situated within an altitude range of 1500 - 2100metres above sea level. The area receives rainfall of 960-1200mm/year. This rainfall is bimodal with the two peaks in March and September. Temperatures range from 8.8 to 25.6 °C. January is the hottest month, while July is the coolest (Jaetzold & Schmidt, 2010 and GoK, 2006).

Feed Materials

The current study materials included Rhodes grass (*Chloris gayana*), Sweet potatoes (*Ipomea batatas*), Sesbania (*Sesbania sesban*) and Mulberry (*Morus alba*) which were grown in the study area for both the study and harvest as seed by farmers. The forages were sundried on racks to a moisture content of 16-18%, milled to pass through a 1cm sieve then packaged in bags for storage. The feeds offered to the rabbits were weighed daily and the intake calculated as the difference between initial weight of the feed and weight of the leftovers.

Management of Experimental Animals

The rabbit house and cages were thoroughly cleaned and disinfected before introducing the rabbits in the cages measuring $0.760\text{m} \times 0.050\text{m} \times 0.045\text{m}$. Earthen bowls were used as feeders and water dispensing containers. The rabbits were weighed before the trial and pre-treated with a broad spectrum antihelminthic and an antibiotic before start of the study.

The live body weight of each replicate was recorded each week throughout the experimental period from 6 to 16 weeks of age. Body weight gain / rabbit / day recorded were used to compute feed conversion efficiency. At the end of the experiment two rabbits from each treatment were randomly selected, live weights were taken and sacrificed for the determination of hot carcass parameters.

Research Design

The study used completely randomized design with rabbits in similar cages and environmental conditions under the treatments provided below. The treatment period began with 7 days adaptation followed by 70 days of data collection. The treatment diets (kgs) were; treatment A = Hay0.6+ sweet potato vines0.40, treatment B=Hay0.6+ Mulberry leaves0.40, treatment C=Hay0.6 + Sesbania leaves0.40, treatment D=Hay0.6 + Sweet Potato Vines0.13 + Mulberry0.13 + Sesbania0.13 and treatment E=1.0 kg Hay only (Control)

Model equation

The model equation was a linear as;

$$Y_{ijk} = \mu + \alpha_i + \varepsilon_{ijk}$$

Where:

Y_{ijk} = the total observation on the j^{th} sampling unit of the i^{th} treatment.

μ = overall population mean

α_i = effects due to i^{th} treatment

ε_{ijk} = random error associated with Y_{ijk}

Nutrient contents

Sample collection area for Rhodes grass was 1 square meter whereby 1 kg was taken. Sample leaves for the fodder trees were randomly collected from the trees within a $20\text{ m} \times 10\text{ m}$ area. The 3 legumes and the Rhodes grass were compounded into rations that formed the 5 dietary treatments. From each sample 1Kg were collected and taken to Kenya Agricultural and Livestock Research Organization - Naivasha for nutrient content analysis.

Data collection

Each Rabbit was weighed weekly for 11 weeks and the growth rate within the various treatment diets determined. The daily feed intake was obtained by the difference between the feed offered and the residuals in each treatment. The difference gave the daily feed intake in grams which was recorded and the data set used to compute the feed conversion efficiency using the following formula:

$$\% \text{ F.C. E} = \frac{\text{Weight gained (g)}}{\text{Feed intake (g)}}$$

Data analysis

The feed samples in the laboratory were analyzed for nutrient contents using AOAC (1990) methods, while the data collected from the study was subjected to analysis of variance and significant means separated using tukey test.

RESULTS

Nutrient contents

The nutrient contents of the various ingredients of diets used in the treatments are as shown in table 1.

Table 1: Nutrient contents of feed Supplements (%)

Nutrient (%)	Sweet potato	Sesbania	Mulberry	Rhodes
Moisture	5.69	6.80	6.64	6.37
Ash	10.09	9.0488	10.90	8.85
Crude protein	24.62	22.61	24.69	13.21
Crude Fibre	14.79	9.32	12.78	20.46
Crude fat	2.34	2.56	3.04	1.70
Starch	3.41	0.00	5.88	2.75

The nutrient components of the treatment diets are shown in table 2.

Table 2: Nutrient Contents of the Experimental Feeds

Nutrient %	TreatmentA	TreatmentB	TreatmentC	TreatmentD	Treatment E
Moisture	6.098	6.478	6.542	6.373	6.370
Ash	9.346	9.670	8.926	9.315	8.850
Crude protein	17.774	17.802	16.970	17.516	13.210
Crude Fibre	18.192	17.388	16.004	17.195	20.460
Crude fat	1.956	2.236	2.044	2.079	1.700
Starch	3.014	4.002	1.650	2.891	2.750

Growth of the rabbits

At the start of the experiment, all the rabbits had an overall mean of 0.5288 ± 0.0108 Kgs with (Figure 1) indicating that there were no significant ($p > 0.05$) differences in weights at the beginning of the experiment. At the end of the experiment, treatment B had the highest weight with a mean of 1.017 ± 0.04 Kgs, followed by treatment A with mean of 0.97 ± 0.03 Kgs, while treatment E had the lowest net gain in weight with mean of 0.72 ± 0.03 Kgs. At the end of the experiment, there was statistical significant ($p \leq 0.05$) difference in weight, which was attributable to the different treatment regimes. As shown in figure 1, treatment B had the highest growth rates, followed by, treatment A and D, then Treatment C while treatment E had the lowest.

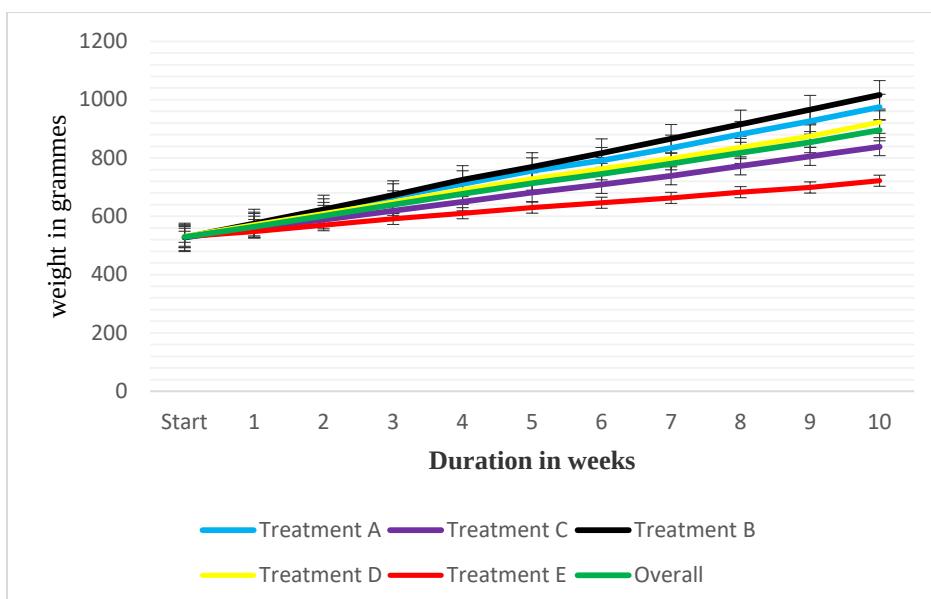


Figure 1: Weights trends of rabbits during the Experimental Period

Growth rates feed intake and feed conversion efficiency

Growth rate feed intake and feed conversion efficiency are shown in table 3. There were significant ($p \leq 0.05$) weekly weight gain by the rabbits indicating that Treatment B had a high rate of 0.049 kg, followed by treatment A at 0.045, treatment D at 0.04, treatment C at 0.03, and treatment E at 0.02 kg.

Regarding, feed intake, table 3 showed there were significant ($p \leq 0.05$) differences in average feed intake where treatments A, B, C and D were comparatively higher than Treatment E.

Lastly, the statistic on FCE indicated that there was significant ($p \leq 0.05$) differences in the FCE measures. Treatment B had the highest FCE, followed by Treatments A, D, C and E in that order. The mortality rate during the experiment was zero. The Feed Conversion Efficiency differed significantly ($p \leq 0.05$) between treatments.

Table 3 Performance Indices of rabbits under the Treatment Regimes

Parameters	T ^A	T ^B	T ^C	T ^D	T ^E	p
Initial wgt (Kg/rabbit)	0.53	0.53	0.528	0.530	0.531	0.92
Final wgt (Kg/rabbit)	0.97 ^{cd}	1.017 ^d	0.839 ^b	0.923 ^c	0.722 ^a	0.01
ADGin (Kg/)	0.04 ^d	0.048 ^e	0.03 ^b	0.039 ^c	0.019 ^a	0.01
Feed intake(g)	1.68 ^b	1.615 ^b	1.618 ^b	1.624 ^b	1.376 ^a	0.01
FCE	0.027 ^{cd}	0.03 ^d	0.02 ^{ab}	0.025 ^{bc}	0.014 ^a	0.01

Rows with different superscript in a are not significantly different ($p \leq 0.05$).

Key: T-Treatment

DISCUSSION

The nutrient contents of the various ingredients of diets as shown in table 1 indicated that mulberry had 24.69% CP content which was considerably higher than the recommended level for growing rabbits (Cheeke *et al.*, 2003). The Sweet Potato crude fat was 2.34% which was a bit lower than the recommended amount of 3.50% (Cheeke 2003), while a 14.79% CF content was not far from recommended 15-16% for rabbit diets (Fekete and Gippert, 1985). The crude fat levels for all the three treatments were in agreement with Halls (2010) and Lebas *et al.*, (1997). Fibre is critical for normal functioning of digestion and therefore FAO (2001), recommends a 10-14% CF range. The analysis showed that all the experimental feeds had ash levels $\leq 11\%$ which is lower than 13-14% recommended by Halls (2010) and Lebas *et al.*, (1997).

The findings showed that treatment B which was composed of mulberry leaves and hay had the highest growth rate, average weekly weight gain, average weekly feed intake and FCE. This was in agreement with Villamide and Maertens (2010) who reported that FCE levels for growing rabbits should range between 3.00 and 3.50. The best feed conversion ratio (3.08 DMI /g/w gain) was obtained for rabbits fed Mulberry forage (treatment B) with the highest fibre intake.

All the treatments met the threshold level for starch concentration of around 1.50 to 4.00% (Gidene *et al.*, 2010), however, the crude fat content for all the treatments were well below the recommended range of 3.50% (Gillespe and Cheeke 2003), But the ether extract levels for all the three treatments were in agreement with Halls (2010) and Lebas *et al.*, (1997). The findings showed that all the treatment diets had ash levels $\leq 10.00\%$ which is lower than 13-14.00% recommended by Halls (2010) and the intake levels of the forages were similar to the findings reported by (Lebas *et al.*, 1997).

The current findings agree with those of Kandylis *et al.* (2009) who reported that Mulberry leaves had high digestibility and palatability, while Benavides (2000) affirmed that the protein content ranges between 18 and 25% in DM and 75 to 85% range in-vivo DM digestibility. Further, Sánchez, (2002) reported that mulberry leaves had 70 - 90% digestibility. Bamikole, *et al.*, (2005) also reported that mulberry leaves can support good feed intake, digestibility and thus promote a satisfactory weight gain in rabbits.

Evidently, sweet potato vines also have a comparatively moderate to high effect as indicated by the study. The growth of rabbits in treatment A, with sweet potato vines, were second to those of the mulberry leaves in all instances and some cases there were little differences between the two feed supplements as in the case of average feed intake. The current findings agreed with those of Abonyi *et al.*, (2012) and Iyeghe-Erkapotobor & Uchegbu, (2006) who mixed sweet potato vines with concentrates and though with some moderate differences in average weekly weight gains, a fact attributable to nutritive contents of the concentrates. Luyen, & Preston, (2012) also reported high growth rates and better feed conversion rates with sweet potato vines supplements.

Considering that there were no concentrates in the study, the growth rate of the rabbits were within the satisfactory levels 48.9 g week⁻¹ for mulberry, 45.8 g week⁻¹ for sweet potato vines, 39.3 g week⁻¹ for the assorted feed supplement and 31.2 g week⁻¹ for sesbania and 19.2 g week⁻¹ for hay. Other studies reported higher levels than this study include Abonyi *et al.*, (2012) who reported 102 g week⁻¹ on a sweet potato vines – concentrate mix ratio of 50:50,

Franck *et al.*, (2016) reported an average feed intake of 1.099 Kgweek⁻¹ but a higher weight on a sweet potato – concentrate mix when compared to 1.683 kg week⁻¹ with much lower weight gain.

The main differentiating issue in the study seems to be the digestibility and the nutritive content of the feed supplements and thus highly nutritious and palatable feed supplements have a significant effect on the growth performance of the rabbits under the treatment. This information agreed with those of other authors, including Samkol & Lukefahr, (2008); Kandyliis, *et al.*, 2009; and many others who considered mulberry leaves and sweet potato vines as being palatable and rich in protein and thus can be used as replacements or in combination with the conventional feed source such as concentrates, soybean and fish meals. The results showed that despite the differences between the chemical compositions of the forages fed, animals were able to consume dry matter to meet the nutrient requirements of the growing rabbit and hence the animal's weight gain was not compromised (Iyeghe-Erakpotor *et al.*, 2006).

The feed conversion efficiency experienced in this study may be explained by the crude protein and fibre intake levels for rabbits. The results indicated that the treatment with the highest CP and CF intake recorded better FCE (Maertens, 2010). Mmereole *et al.*, (2011) stated that rabbits can obtain high FCE and weight gain on diets high in crude fibre due to that ability to ferment forage and release the nutrients from it, but diets low in CF levels tends to have a depressant effect on the animals' ability to utilize feed. Leng (2008) also stated low CF reduces the retention time of the digesta in the caeco-colic segment and reduces the fermentation activity of the animal resulting to reduced absorption.

In conclusion the rabbits that gave highest growth rate were those fed Rhodes Grass Hay .60kg and supplemented with Mulberry 0.40kg.

On evaluation for alternative cheap feed source for growing rabbits (*Oryctolagus cuniculus*) in this study, Mulberry leaves supplementation was found to give the best results.

The growth rate and feed conversion efficiency of growing rabbits were better when supplemented with Mulberry leaves. This indicated that Mulberry leaves had a high potential as a protein-rich forage supplement for animal production. On this basis, the study concluded that Mulberry legume was the best supplement for rabbit feeding as per the parameters of interest.

RECOMMENDATIONS

The study recommends rabbit feed formulation to include Mulberry leaves as a protein source in Kapseret sub county of Uasin Gishu. Further study is needed to investigate the response to the increasing percentages of Mulberry leaves in diets of adult rabbits.

More studies on the length of period after which supplementation of Mulberry should be continued to reproductive stage of the rabbits so as to establish additional effects especially on prolonged period of feeding regime.

REFERENCES

- Abonyi, F. O., Iyi, E. O., & Machebe, N. S. (2012). Effects of feeding sweet potato (*Ipomoea batatas*) leaves on growth performance and nutrient digestibility of rabbits. *African Journal of Biotechnology*, 11(15), 3709-3712.
- Bamikole, M. A., Ikhatua, M. I., Ikhatua, U. J., & Ezenwa, I. V. (2005). Nutritive Value of Mulberry (*Morus* Spp.) Leaves in the Growing Rabbits in Nigeria. *Pakistan Journal of Nutrition*, 4(4), 231-236.
- Benavides, J., 2000. Utilisation of Mulberry in Animal Production Systems. In: Sanchez (ed), "Mulberry for Animal Production". <http://www.fao.org/ag/AGA/AGAP/FRG/Mulberry/Papers/PDF/Benavid.pdf>
- Binh, D., Nguyen, T., K.S. N., & Hoang, M. (2008). Results of research and the development of rabbit production in Vietnam. *MEKARN Workshop 2008: Organic rabbit production from forages*, (pp. 6-17). Niah-Mard, Vietnam.
- Cheeke, P. (2003). *Feeding systems for tropical rabbit production emphasizing root, tubers and bananas*. Food and Agriculture Organisation.
- Etim, N. N., Ekpo, J. S., & Enyenihi, G. E. (2014). Dietary Influences of *Aspilaafricana* on Litter Traits of Breeding Female Rabbits. *American Journal of Experimental Agriculture*, 4(2), 153.
- Fekete, S., & Gippert, T. (1985). Effect of crude fiber on protein utilization by rabbits. *The Journal of applied rabbit research*.
- Food and Agriculture Organization of the United Nations (FAO), 2001. FAOSTAT: FAO Statistical Databases. Online at <http://apps.fao.org>, November 2001
- Food and Agriculture Organization of the United Nations (FAO), 2001. FAOSTAT: FAO Statistical Databases. Online at <http://apps.fao.org>, November 2001
- Fortun-Lamothe, L., & Boullier, S. (2007). A review on the interaction between gut microflora and digestive mucosal immunity: possible ways to improve the health of rabbits. *Livestock Production Science*, 107 (1), 1-18.
- Franck, Y. K., Athanase, O. K., Marie, W. L. R., Anselme, K. K., & Sebastien, N. (2016). Growth Parameters, Protein Digestibility And Health Status Of Rabbit (*Oryctolagus cuniculus*) Fed With Palatable Leafy Vegetables. *European Scientific Journal*, 12(27).
- Gidenne, T., & Bellier, R. (2000). Use of digestible fibre in replacement to available carbohydrates: Effect on digestion, rate of passage and caecal fermentation pattern during the growth of the rabbit. *Livestock Production Science*, 63(2), 141-152.
- Halls, A. E. (2010). Nutritional requirements for rabbits. Retrieved September, 21, 2014.
- Iyeghe-Erakpotobor, G. T., Aliyu, R., & Uguru, J. (2006). Evaluation of concentrate, grass and legume combinations on performance and nutrient digestibility of grower rabbits under tropical conditions. *African journal of biotechnology*, 5(20).
- Jaetzold, R., & Schmidt, H. (2010). *Farm Management Handbook of Kenya: Natural conditions and Farm Management Information* (Vol. 2 Part B). Nairobi.
- Kandylis, K., Hadjigeorgiou, I., & Harizanis, P. (2009). The nutritive value of mulberry leaves (*Morus alba*) as a feed supplement for sheep. *Tropical animal health and production*, 41(1), 17-24.
- Lebas, F., Coudert, P., Rouvier, R., & De Rochambeau, H. (1997). *The Rabbit: husbandry, health, and production*. Rome: Food and Agriculture organization of the United Nations.
- Leng, R. A. (2008). Decline in available world resources; implications for livestock production systems in Asia. *Livestock Research for Rural Development*, 20(1), 2008.
- Luyen, L. T., & Preston, T. R. (2012). Growth performance of New Zealand White rabbits fed sweet potato (*Ipomoea batatas*) vines supplemented with paddy rice or Guinea grass supplemented with commercial concentrate. *Livestock research for rural Development*, Kandylis, K., Hadjigeorgiou, I., & Harizanis, P. (2009). The nutritive value of mulberry leaves (*Morus alba*) as a feed supplement for sheep. *Tropical animal health and production*, 41(1), 17-24.
- Maertens, L. (2010) Feeding Systems for Intensive Production, *Nutrition of the Rabbit*, 2nd ed 254 – 266
- Maertens, L. (2010) Feeding Systems for Intensive Production, *Nutrition of the Rabbit*, 2nd ed 254 – 266
- Makinde, O. (2016). Growth performance, carcass yield and blood profiles of growing rabbits fed concentrate diet supplemented with white lead tree (*Leucaena leucocephala*) or siratro (*Macroptilium atropurpureum*) leaves in north central Nigeria. *Trakia Journal of Sciences*, 1, 80-86
- Mmereole, F. U. C., Egho, J. O., & Obinne, J. I. (2011). Growth performances and cost analysis of weaner rabbits fed varying dietary levels of crude protein supplemented with *tridaxprocumbens*. *Pakistan journal of Nutrition*, 10(2), 120-123.
- Omoikhoje S.O., Bamgbose, A.M., Aruna, M.B. and Animashahun, R.A. (2006) Response of weaner rabbits to concentrate supplemented with varying levels of *Syndrella nodiflora* forage. *Pakistan Journal of Nutrition* 6: 577-579.
- Samkol, P., & Lukefahr, S. D. (2008). A challenging role of organic rabbit production towards poverty alleviation in South East Asia. In *Proc., 9th World Rabbit Congress, Verona, Italy* (pp. 10-13).

- Sese, B. T., Okpeku, M., & Igirigi, A. (2014). Impact of Tropical Velvet Bean (*Mucuna Utilis*) Leaf Meal on Performance, Organ Weight and Haematological Indices of Young Rabbits. *J. Anim. Sci. Adv*, 4(4), 777-786.
- Villamide, M. J., Maertens, L., De Blas, C., & Perez, J. M. (2010). Feed evaluation. *Nutrition of the Rabbit*, 151.
- Wanjala, F. N. (2015). *Performance And Cost Of Production Of New Zealand White, California White Rabbit (Oryctolagus Cuniculus) Breeds And Their Cross Under Two Feeding Regimes* (Doctoral dissertation, University of Nairobi).