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Growth performance, nutrient digestibility and nitrogen retention in Rabbits fed graded levels of Velvet bean (*Mucuna pruriens* L.) forage

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Target audience: Smallholder rabbit farmers, Forage agronomists, Animal scientists and Extension agents.

Abstract

A study was conducted to determine the effect of graded levels of velvet bean (Mucuna pruriens) forage on performance, nutrient digestibility and nitrogen retention in rabbits. A total of 24 growing rabbits of different breeds, with initial live weight range of 450-500g were fed rations with graded levels (0, 10, 20 and 30%) of velvet bean (Mucuna pruriens) forage supplement in the diet in a completely randomized design. The rabbits were grouped into 4 (6 rabbits per treatment) and the experiment was replicated 3 times. The experiment lasted for 63days. Results showed that the final live weight of rabbits fed 30% velvet bean (Mucuna pruriens) forage in the diet increased (P<0.05) by 57% than those fed the control diet (1350 vs.1550g). However, feed intake of rabbits fed 30% inclusion of mucuna forage was 47% lower (P<0.05) than those on the control diet (43.00 vs. 63.33g/d). Feed conversion ratio was 71% better (P<0.05) in rabbits fed 30% level of inclusion of mucuna forage than those fed the control diet (2.47 vs. 8.58). Also, feed cost/kg gain was 62% lower (P<0.05) in rabbits fed 30% inclusion level of mucuna forage (₦ 6.12) than those on the control diet (₦16.28). Digestibility of organic matter, crude protein and crude fibre and nitrogen retention were significantly higher (P<0.05) in rabbits fed 30% inclusion level of mucuna forage except in nitrogen absorbed by the rabbits (P>0.05). The study showed that velvet bean forage inclusion levels of 30% in the feed of growing rabbits will improve growth performance of rabbits in Northern Guinea savanna of Nigeria, without any detrimental effect.

Key words: Alternatives, feed, pasture, production, rabbit.

Description of Problem

Protein – energy malnutrition is among the most serious problems in Nigeria today, especially in camps of internally displaced people (IDPs) in the northeast (1). This can be attributed mainly to insurgency; security challenges and degraded structural facilities in these

areas (2). According to (3), the number of malnourished people in developing countries has been estimated to be 800 million. This has necessitated exploration of alternate sources of animal protein to bridge the gap for animal protein requirement of the Nigerian population. Rabbit is one of the farm animals with high potential to supply good quality meat for Nigerian populace, especially children and people living with diseases such as high blood pressure (4). Although rabbits are known for their rapid rate of reproduction with short gestation periods of 28-32 days (5), high feed cost has been identified to be the major hindrance to the production of rabbits in Nigeria (6). This problem has been attributed to escalating prices of conventional feed ingredients (7). Therefore, cheaper alternative feedstuffs are needed for successful rabbit production in Nigeria (8). Velvet bean (*Mucuna pruriens*) is one of the promising pasture legumes that supply alternative protein sources in rabbit production (9).

Mucuna pruriens is a tropical legume commonly known as velvet bean native to Africa and Asia. It is a prolific plant, producing high amounts of husk and forage (10). However, like many other grain legumes, velvet bean (seed) contains many anti-nutritional factors, including L-DOPA, which has a number of anti-physiological effects (11). Velvet bean is widely grown in the tropics mainly because of the medicinal properties that appear to be found in all fractions of the plant (12). In recent years, rabbit production based on low cost forages has increased considerably in order to meet the increasing demand for human food in Nigeria (13, 14). Therefore, including leguminous forages such as velvet bean (*Mucuna pruriens*) in the diet of rabbits will serve as one of the options to be explored by the smallholder farmers in Nigeria, in an attempt to increase the supply of animal protein to citizens through cheaper and available resources. Similarly, including *Mucuna pruriens* forage in the diet of rabbits will give us an insight about the inherent ability of Nigerian rabbits to utilize forage based diets efficiently, which is crucial in poverty alleviation and improved management practices in Nigeria. The main aims of this study were: i) to investigate the growth performance, nutrient utilization and nitrogen retention in rabbits fed varying inclusion levels of *Mucuna pruriens* forage and ii) to determine the cost effectiveness of including *Mucuna pruriens* forage in diets of rabbits in Northern Guinea savanna of Nigeria.

Materials and Methods

Site description

The experiment was carried out at the Teaching and Research Farm of the Department of Animal Science, Ahmadu Bello University Zaria, Kaduna State. Zaria is located within the Northern Guinea Savannah zone, between latitude 11°and 12° 33'N and longitude 7°and 8° 42'E; at an elevation of 610m above sea level, with a mean annual rainfall of 1150mm falling between May and October. It has an ambient temperature ranging between 22°C and 24°C (15).

Experimental design, animals and dietary treatments

A total of twenty four (24) weaner

rabbits of comparative body weight (450g-500g) and mixed breeds were used for the study. The rabbit house was cleaned and disinfected two weeks prior to the arrival of the rabbits. On arrival, the rabbits were given prophylactic treatment. Anti-bacterial (Oxyfuravit) and Ivomec (Ivomectin^{R}) were administered at the rates of 1g/litre of water and 0.02ml/kg body weight, respectively. The rabbits were individually housed in a long six tier wire cages, measuring 180 x 35 x 168cm^{3} consisting of 24 hutches (6 hutches in each column and 4 across the row) in a well ventilated room. Each hutch had feeding and water troughs. The floor of the house was made of a hard concrete for easier and proper cleaning. The rabbits were randomly allotted to four dietary treatment groups with six rabbits per group namely: T_1, T_2, T_3 and T_4. which contained velvet bean forage at 0, 10, 20 and 30%, respectively. The diets were formulated as total mixed rations (TMR) to meet the nutrient requirement for weaner rabbits (M.E= 2800-2880 kcal/kg and CP=16.0 to 16.43%). The composition of the diet is shown in Table 1.

Table 1: Percentage composition of experimental diets containing graded levels of *Mucuna pruriens* forage

	Inclusion level of *Mucuna pruriens* forage			
Feed Ingredients	0	10	20	30
Maize	53	44	38.5	35.5
Mucuna pruriens	0	10	20	30
GNC	17	16	14.5	14.5
S.B.M	6	6	6	6
Rice offal	10	10	8	5
Maize offal	10	10	9	5
Bone meal	3	3	3	3
Salt	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Vitamin Premix*	0.25	0.25	0.25	0.25
Total	**100**	**100**	**100**	**100**
Calculated Analyses				
M.E:Kcal/kg	2876.11	2820.58	2800.255	2800.385
% CP	16.43	16.29	16.01	16.21
E: Protein ratio	175.02	173.18	174.92	172.77
EE%	4.17	4.25	4.36	4.51
CF%	4.83	5.47	5.82	5.89
Ca%	0.07	0.16	0.24	0.32
Avail. P%	0.35	0.16	0.18	0.31
Ca:P ratio	0.21	0.99	1.30	1.04
Lysine	0.67	0.70	0.70	0.72
Met + Cyst (%)	0.51	0.49	0.46	0.45
Cost ₦/25kg	1681.88	1613.13	1543.75	1491.25

*A Vitamin mineral premix provides per kg diet: Vitamin A, 13.340 iu, vitamin D $_3$ 2680 iu, vitamin E $_{10}$iu, vitamin K, 2.68 iu, Calcium pentothenate, 10.68mg, Vitamin B $_{12}$ 0.022mg; Folic acid, 0.668mg; Choline chloride 400mg; Chlorotetracycline, 26 - 28mg; Manganese, 133.34mg; Iron, 66.68mg; Zinc, 53.34mg; Copper, 3.2mg; Iodine, 1.86mg; Colbal t, 0.268mg; Selenium, 0.108mg.

Each treatment was replicated three times in a completely randomized design (CRD). The rabbits were fed daily with 200g of the experimental diets at 8:00am daily. Feed offered and refused were recorded daily. Rabbits were weighed at the beginning of the study and subsequently on a weekly basis to determine their weight change and adjust for their diets based on body weight. Clean and cool drinking water was provided *ad libitum*. The feeding trial lasted for eight (8) weeks. At the end of the feeding trial, nutrient digestibility study was conducted using 4 rabbits from each treatment. The rabbits were maintained on the same dietary treatments for one week. Total daily faecal droppings and urine output were collected. Urine samples were collected in small plastic bottles containing 10ml of 10% dilute H_2SO_4. The total faecal and urine samples collected were weighed, bulked and sub-sampled for analysis. Faecal samples were oven-dried to constant weight, while 10% of the urine was kept in deep freezer (-20°C) until needed for nitrogen determination.

Chemical analysis

Samples of the experimental diets were taken to the Biochemistry Laboratory, Department of Animal Science, Ahmadu Bello University, Zaria for proximate analysis. This was determined according to the procedure of (16). The following parameters were determined: % Dry matter (DM), % Crude protein (CP = N × 6.25), % Crude fibre (CF), % Ether extract (EE), % Ash and %Nitrogen-free extract (NFE). NFE was calculated as NFE= 100 - (%CP + % CF + %EE + %Ash). DM of the samples was determined in an oven at 105° for 48 hrs. Nitrogen determination in urine was done by the micro Kjedahl method (16).

Statistical analysis

All data obtained on feed intake, nutrient digestibility, growth performance and nitrogen retention were subjected to statistical analysis of variance (ANOVA) using SAS (17) procedure. For treatment means that were significant, Dunnet's Test was used to separate the treatment means. The model used for the analysis was:

$$\mathbf{Y_{ij} = \mu + T_i + e_{ij}}$$

Where Y_{ij} = The dependent variable, μ = General mean, T_i = Fixed effect of i_{th} dietary treatment,
(i= 1, 2, 3 and 4), and e_{ij} = random error of the model.

Results and Discussion

Table 2 shows the proximate composition of the experimental diets. The dry matter of the diets obtained in this study is comparable to the value of 95.81% reported in lablab forage cut at advanced stage of growth (13). The high dry matter content of diets containing mucuna forage can be attributed to rapid lignifications of carbohydrates with increase in age of the forage. The crude protein content of the experimental diets in this study was higher than the reported values of 17.20% (18) and 17.30% (19), but comparable to the report of (20). This might be related to lower rate of dilution of the crude protein contents of the mucuna forage due to rapid accumulation of cell wall carbohydrates

especially at later stage of growth. However, the values of crude fibre content observed in this study were comparably lower than the reported values of 22.10% and 31.53% in lablab forage (13). The crude fibre content in this study was higher than the value of 6.30 % reported by (21), but lower than 14.80% reported by (22). High crude fibre in diets of rabbits is known to enhance digestibility, decrease the blood cholesterol level and reduce the risk of large bowel cancers (23, 24). The digestive health (morbidity as well as mortality) of post - weaned rabbits is dependent of the level and quality of fibre content of the diet (25).

Table 2: Proximate composition of the experimental diets (%)

	Inclusion levels of *Mucuna pruriens* forage			
Parameter (%)	0	10	20	30
Dry matter	94.56	94.12	93.88	94.36
Crude protein	16.43	17.06	17.56	17.81
Crude fibre	11.38	19.10	28.03	31.34
Ether extract	7.84	7.69	8.33	8.69
Ash	8.10	8.69	9.00	8.40
Nitrogen free extract	56.25	54.47	53.23	53.78

Table 3 shows the growth performance of weaner rabbits fed diets containing graded levels of *Mucuna pruriens* forage. The result indicated that there were significant differences ($P < 0.05$) between the different treatments. The final weight and average daily weight gain of the rabbits increased with increase in the level of *Mucuna pruriens* forage in the diets. This result is in agreement with the findings of (13) and (9), which could be related to the quality of the mucuna forage in the diets due to increased level of nitrogen and crude fibre utilization by the rabbits (26). This assertion can be further confirmed by the low feed intake and feed conversion ratio of the rabbits fed 30% level of inclusion of mucuna forage in the diet.

Table 3: Growth performance of weaner rabbits fed diets containing graded levels of *Mucuna Pruriens* forage

	Inclusion levels of *Mucuna pruriens* forage					
Parameter	0	10	20	30	SEM	LOS
Initial weight (g)	577.10	569.17	569.60	575.70	5.67	NS
Final weight (g)	990.30^{d}	1190.00^{c}	1350.00^{b}	1550.00^{a}	7.13	*
Weight gain (g)	413.20^{d}	620.83^{c}	780.40^{b}	974.30^{a}	4.26	*
ADWG (g)	7.38^{d}	11.09^{c}	13.94^{b}	17.40^{a}	1.11	*
Feed intake (g/d)	63.33^{a}	60.00^{b}	50.00^{c}	43.00^{d}	1.30	*
FCR	8.58^{d}	5.41^{c}	3.58^{b}	2.47^{a}	0.25	*
Feed cost/kg (₦)	67.28^{a}	64.53^{b}	61.75^{c}	59.65^{d}	1.00	*
Feed cost/kg gain (₦)	16.28^{a}	10.39^{b}	7.91^{c}	6.12^{d}	0.45	*

^{abc} Means with different superscripts in the same row differed significantly ($P<0.05$), SEM = Standard error of means, LOS = Level of significance, ADWG = Average daily weight gain, FCR = Feed conversion ratio.

A lower feed intake and conversion ratio in rabbits fed the highest inclusion level of mucuna forage in the diet implies that more feed was retained in the rabbits with less waste into the system (27). The poor utilization of feed by rabbits fed the control diet could be an indication of the low quality nature of the diet which might have led to poor feed conversion ratio in those rabbits. The highest feed intake in rabbits fed the control diet was contrary to the report of (28) and (29) that increase in crude fibre content of the diet is associated with decrease in feed intake. The economic efficiency of feed utilization was better in rabbits fed the highest inclusion level of mucuna forage. Previous studies reported a similar trend when rabbits were fed groundnut haulms (30). Table 4 shows the nutrient digestibility of weaner rabbits fed diets containing graded levels of *Mucuna pruriens* forage. The result indicates significant differences ($P < 0.05$) between the treatments.

Table 4: Nutrient digestibility of weaner rabbits fed diets containing graded levels o f *Mucuna pruriens* forage

	Inclusion levels of *Mucuna pruriens* forage					
Nutrient digestibility (%)	0	10	20	30	SEM	LOS
Dry matter	89.17[a]	88.63[b]	87.63[c]	85.11[d]	1.03	*
Organic matter	3.42[d]	9.78[c]	20.90[b]	31.62[a]	0.02	*
Crude protein	92.26[c]	89.48[d]	95.61[b]	96.13[a]	0.89	*
Crude fibre	91.45[b]	88.47[d]	90.35[c]	91.86[a]	0.91	*
Ether extract	97.01[a]	90.65[d]	93.30[c]	96.63[b]	0.74	*
Ash	85.75[a]	78.85[b]	66.73[c]	53.49[d]	1.10	*
Nitrogen free extract	84.29[b]	86.33[a]	84.50[b]	83.84[b]	0.66	*

[abc] Means with different superscripts in the same row differed significantly ($P<0.05$), SEM = Standard error of means, LOS = Level of significance.

The digestibility of organic matter, crude protein and crude fibre were significantly ($P<0.05$) higher in rabbits fed diet containing 30% level of inclusion in the diet than other treatments, respectively. This observation agrees with the findings of (13). However, the decline in apparent digestibility of dry matter (DM), ether extract (EE) and ash observed in this study with increasing level of mucuna forage in the diet could be related to the harvesting and processing method of mucuna forage before incorporating into the diets. (29) reported that forage crops decrease in the amount of digestible nutrients during the curing process due to plant respiration. This is in agreement with the report of (31), who reported that digestibility and palatability of forage legumes decrease with advancing maturity of the forage and increasing level of fibre. Coefficient of apparent digestibility values obtained in this study were higher than those reported by (32) using increasing levels of Falseflax seeds on performance of male and female rabbits, respectively. Values obtained in this study were higher than those obtained by (33) with New Zealand white rabbits fed *Nigella* seed meal as source of protein in the diet, but comparable with the digestibility coefficients reported by

(34) for growing rabbits fed soybean cheese waste meal diet and lablab hay.

Table 5 shows the nitrogen retention of weaner rabbits fed diets containing graded levels of *Mucuna pruriens* forage. The result showed significant differences (P < 0.05) between the treatments, except in the amount of nitrogen absorbed by the rabbits (P>0.05). The nitrogen intake was higher (P < 0.05) in rabbits fed the control diet. Similar trend was observed in nitrogen contents of the urine, faeces and total nitrogen voided, respectively

Table 5: Nitrogen retention of weaner rabbits fed diets containing graded levels of *Mucuna pruriens* forage

	Inclusion levels of *Mucuna pruriens* forage					
Parameter	0	10	20	30	SEM	LOS
N intake (g)	3.40^{a}	3.22^{b}	2.68^{d}	3.11^{c}	0.03	*
N urine (g)	0.51^{a}	0.42^{b}	0.34^{c}	0.30^{d}	0.01	*
N faeces (g)	0.95^{a}	0.80^{b}	0.64^{c}	0.63^{d}	0.02	*
Total N voided (g)	1.46^{d}	1.22^{c}	0.98^{b}	0.93^{a}	0.10	*
N retained (g)	1.94^{c}	2.00^{b}	1.70^{d}	2.18^{a}	0.12	*
N absorbed (g)	2.45	2.42	2.04	2.48	0.23	NS
N as % of intake (%)	57.06^{d}	62.11^{c}	63.43^{b}	70.10^{a}	1.31	*

[abc] Means with different superscripts in the same row differed significantly (P<0.05), N = Nitrogen, SEM = Standard error of means, LOS = Level of significance.

However, values of nitrogen retained and nitrogen as percent of intake were significantly higher (P<0.05) in rabbits fed diet containing 30% level of inclusion of mucuna forage. It was observed that the differences in nitrogen intake resulted in the same pattern of differences in nitrogen retained; suggesting that nitrogen retention in rabbits may be related to nitrogen intake. The significant higher nitrogen retained in rabbits fed the highest level of mucuna forage in the diet (30%), might be related to inherent ability of rabbits to recycle nutrients through caecotrophy. (5) reported that caecal microbiota in rabbits help to utilize non-protein compounds in the diet and caecotrophy contributes to improved digestion of nitrogen and retention in rabbits. According to (35), endogenous nitrogen (e.g. digestive enzymes, mucoproteins and urea) could be a source of protein for microorganisms in the gut of rabbits, which represents 64% of the total ileal protein flow. However, this contribution could be variable and may be influenced by dry matter (DM) intake, diet composition, fibre type and levels of anti-nutritional substances in the diet (5).

Conclusion and Application

This study has shown that:

1. Feeding growing rabbits with diets containing up to 30% velvet bean (*Mucuna pruriens*) forage enhanced growth performance, nutrient utilization and nitrogen retention in rabbits without any negative effect. However, the 30% level of inclusion of the forage may not be the optimum for growth of weaner rabbits in Northern Guinea savanna of Nigeria.

2. Including *Mucuna pruriens* forage at 30% reduced feed cost/kg diet by 62%. Hence, smallholder farmers in Nigeria can increase their financial base through backyard rabbit production using legume forages.

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