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Evaluation of the Feeding Potentials of *Vitellaria paradoxa, Nauclea latifolia* and *Terminalia macroptera* Foliage as Supplements to Concentrate Feed for Grower Rabbits

[1]A.M. Yusuf, [2]O.A. Olafadehan and [1]M.H.Garba

[1]Department of Animal Production Technology, Federal College of Wildlife Management, New Bussa, Niger State, Nigeria
[2]Department of Animal Science, Faculty of Agriculture, University of Abuja, Abuja, Nigeria

Abstract: The feeding potentials of *Vitallaria paradoxa, Nauclea latifolia* and *Terminalia macroptera* foliage as supplements to concentrate diets for grower rabbits were studied over a 13-week period. A total of 18 crossbred growing rabbits aged between 6-8 weeks were randomly allotted to the three dietary treatments consisting of three replicates of two rabbits each in a completely randomized design. *Nauclea latifolia* had the highest and least crude protein and crude fibre, respectively, which were intermediate in *Vitallaria paradoxa* but lowest and highest, respectively, in *Terminalia macroptera*. Organic matter was highest in *Vitallaria paradoxa* and lowest in *Nauclea latifolia*. Average daily feed intake (ADFI) and average daily gains were best in *Nauclea latifolia* followed by *Vitallaria paradoxa* and least in *Terminalia macroptera* (all ($P < 0.05$)). However, feed conversion ratio was similar ($P > 0.05$) among the treatments. Dry matter digestibility (DMD) was significantly ($P < 0.05$) higher in *Nauclea latifolia* than in *Vitallaria paradoxa* and *Terminalia macroptera*. Average daily gains were significantly ($P < 0.0001$, $R^2 = 0.9998$) influenced by ADFI and DMD. The fodder trees are promising non-conventional feedstuffs, with *Nauclea latifolia* forage having the best potential, followed by *Vitallaria paradoxa* and *Terminalia macroptera*, for grower rabbits when fed with sparing quantity of concentrate.

Key words: *Vitallaria paradoxum, Nauclea latifolia*, *Terminalia macroptera*, Feeding potential, Performance, Grower rabbit.

INTRODUCTION

The increasing cost of livestock feed with the concomitant increase in the cost of livestock products has necessitated research in the search for cheaper and readily available alternative feed ingredients for livestock feeding. Poor economic conditions in many tropical countries and associated increase in the shortage of animal protein have turned attention of many to rabbit production as a ready solution to the problem. In recent times, attention has shifted to rabbits as meat animals because of its low cost of production, high fecundity, prolificacy, fast growth and short generation interval.

Rabbits are herbivores with post-gastric digestion and can effectively utilise fodders and serve as alternative sources of meat for city dwellers. The problem for most producers, however, is the high cost of concentrates feed for the rabbits which has necessitated the need to seek for alternative feed sources in forages. This is especially so because of the greater availability of forages and ability of rabbits to convert forage into meat for human consumption. Being a monogastric herbivore, with digestive system that can cope with fibrous plant matter, such as grasses, legumes or their hays, rabbits can thrive on forage diets, although potential weight gains are not attained because of the poor nutritive value of tropical forages (Adegbola, *et al.,* 1985; Bamikole and Ezenwa, 1999). Even though locally grown feed materials have been identified (Bamikole *et al.,* 2000a. 2002b), formulation of a concentrate diet requires expensive feed ingredients, notably oil cakes, which are the major sources of protein and energy in the diets. Identification of forage that has high nutritive value that could replace or reduce the need for concentrate feeding will keep the cost of rabbit production low and sustain growing interest. However, Adegbola *et al.* (1985), utilising fresh materials, reported that all-forage diets were not suitable for rabbits as they result in weight losses. Studies have, therefore, shown that rabbits

Corresponding Author: O.A. Olafadehan, Department of Animal Science, Faculty of Agriculture, University of Abuja, Abuja, Nigeria.
E-mail: oaolafadehan@yahoo.com

can thrive on a number of tropical forages supplemented with concentrates (Odeyinka and Ijiyemi, 1997), but concentrate rations are expensive and can be a constraint to widespread exploitation of the potential of rabbits to meet the protein needs of rural and urban poor. Therefore, a feeding strategy that will engage sparing use of concentrate and dependence on forages will be of immense benefits to sustainable rabbit production. Such forages must, nevertheless, be abundant and available all year round.

Vitallaria paradoxa, Nauclea latifolia and *Terminalia macroptera* are some of the trees whose foliages are available even in dry season when most plants have senesced and can not be used as feeds for livestock. However, information on the use of these plants foliage as feed for rabbit is very rare making the examination of the potential feeding values of these unconventional forages a necessity. This study aimed at evaluating the feeding potentials of *Vitallaria paradoxa, Nauclea latifolia* and *Terminalia macroptera* foliage as supplements to concentrate diets for grower rabbits.

MATERIALS AND METHODS

Study Area:

This study was carried out at the rabbit unit of the Teaching and Research Farm of Federal College of Wildlife Management, New Bussa, Niger state. It is located between latitude 7^0 80′ and 10^0 00′N longitude 4^0 30′ and 4^0 33′E. The temperature and relative humidity averaged 34^0C and 60% during the period of the study.

Husbandry and Experimental Design:

Concentrate diet was formulated as shown in Table 1. Eighteen (9 males and 9 females) crossbred grower rabbits (6 rabbits per treatment with three replicates of two rabbits each) of equal sexes, aged between 6-8 weeks with an average initial weight of 515g were used for the study. The rabbits were balanced for their weights, paired and housed in wooden hutches and were randomly allotted to three experimental diets consisting of fresh forage of *Vitallaria paradoxa*, *Nauclea latifolia* and *Terminalia macroptera* for a period of 13 weeks comprising 12 weeks of feeding trial and a week of digestibility trial. Concentrate supplement was offered at 1.5% of the body weight; the forages and water were served *ad libitum*. The concentrate was served once daily in the morning while the forages were fed twice daily, morning and evening. The animals were provided with adequate healthcare before and throughout the experimental period. They were introduced to the formulated diet and forages over seven day's adjustment period. Daily feed intake was taken as difference between the quantity served and the ort while body weight changes were measured on weekly basis.

Table 1: Composition of the concentrate supplement diet (%)

Ingredient	Inclusion level
Maize	28.4
Groundnut cake	18.3
Maize offal	48.3
Blood meal	2.0
Bone meal	2.0
Salt	0.5
Vitamin –Mineral premix*	0.5
Total	100.0
Calculated composition	
Crude protein (%)	18
Metabolizable energy (Kcal/kg)	2400

*To provide the following per kg of feed: Vitamin A, 10,000 iu; Vitamin $D_{3,}$ 2000 iu; Vitamin E, 5 iu; Vitamin K, 2mg; Riboflavin, 4.2 mg; Vitamin $B_{12,}$ 0,01mg; Pantothenic acid, 5mg; Nicotic acid, 20mg; Folic acid, 0.5mg; Choline, 3mg; Mg, 56mg; Fe, 20mg; Cu, 1omg; Zn, 0.5mg; Co, 1.25mg; Iodine, 0.8mg.

Digestibility Trial:

After the feeding trial, seven day digestibility study was conducted at the 13th week by collecting and weighing the total daily feacal output. About 10% of the total faecal output for each animal was removed, wrapped in aluminium foil and dried in a forced draught oven at 60°C to a constant weight for dry matter determination.

Chemical Analysis:

The proximate compositions of the concentrate diet and the experimental forages were determined according to the procedures of AOAC (1990).

Statistical Analysis:

Data collected from the study were subjected to statistical analysis using statistical package for social science (SPSS, 1980). Significant means were separated using Duncan multiple range test of the same package. The following statistical model was used:

$$Y_{ij} = \mu + R_j + e_{ij}$$

where Y_{ij} = dependent variables; μ = general mean; R_j = the ration effect and e_{ij} = random error.

Relationship between ADG and ADFI and DMD was determined using multiple regressions as applicable to parametrical analyses. The statistical model used was:

$$Y = \beta o + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$$

where Y = average daily gain; X_1 = average daily feed intake; X_2 = dry matter digestibility; β_o = the intercept; β_1 and β_2 are the slopes and ε the error. The R^2 and P values were used to indicate the importance of the significances.

RESULTS AND DISCUSSION

The proximate compositions of the concentrate supplement and the experimental diets are shown in Table 2. Due to the low crude protein (CP) contents of the experimental forages which were lower than 16% recommended for growing rabbits (NRC, 1981) and the possibility of the animals rejecting these novel forages which have not been used before, to the best of our knowledge in any previous studies, all the rabbits were placed on concentrate supplement diet. This was done in order to sustain the animals through the period of the growth study and to keep them alive in case of refusal of the forages. Whereas CP was highest in *N. latifolia*, followed by *V. paradoxa* and least in *T. macroptera*, the reverse was the case for crude fibre (CF) which was higher than the recommended level of 12 – 15% for growing rabbits (Aduku and Olukosi, 1990). Since the potential nutritive value of a feed depends most often on the protein and fibre contents, it appears logical to say that *N. latifolia* has the best feeding value followed by *V. paradoxa* and then *T. macroptera*. Ether extract was highest in *V. paradoxa* intermediate in *N. latifolia* and least in *T. macroptera*. The highest ether extract content of *V. paradoxa* foliage could be attributed to the fact that the plant is an oil producing tree. The sheabutter fat, consumed in the northern part of Nigeria, is obtained from the fruits of this plant which are abundantly available with a lot of them being left to waste yearly. Like the ether extract, organic matter was also highest in *V. paradoxa* but least in *N. latifolia* and intermediate in *T. macroptera*. Ash was, however, highest in *N. latifolia* followed by *T. macroptera* and then *V. paradoxa*. Nitrogen free extract showed this rank order: *T. macroptera* > *N. latifolia* > *V. paradoxa*.

Table 2: Composition of the concentrate and experimental forages (% DM)

Composition	Concentrate	*V. paradoxa*	*N. latifolia*	*T. macroptera*
Crude protein	17.58	10.43	10.86	8.67
Crude fibre	10.87	17.57	16.04	18.56
Ether extract	3.25	7.81	5.23	3.48
Ash	8.65	4.26	5.66	5.23
Organic matter	91.35	95.74	94.34	94.77
NFE	59.64	59.93	62.21	64.06

The performance characteristics of the experimental rabbits are presented in Table 3. Average daily feed intake (ADFI) and average daily gains (ADG) were significantly ($P < 0.05$) varied among the treatments in this rank order: *N. latifolia* > *V. paradoxa* > *T. macroptera*. The significantly ($P < 0.05$) higher feed intake of rabbits fed *N. latifolia* suggests that it was probably more palatable than the two other forages, whereas the better weight gain of the rabbits seems to suggest that the nutrients were better utilized compared to rabbits on *V. paradoxa* which also demonstrated superiority over *T. macroptera.* Also, it could be that the lowest CF and highest CP compared to the other two forages might have induced more intakes. High CP in the diets has been considered an important factor that enables high feed intake. Oldham and Alderman (1980) established that sometimes *ad libitum* intake by animals is increased by an increase in the CP. The depression in the feed intake and ADG of rabbits fed *T. macroptera* forage possibly suggest that the forage from this plant may likely contain some anti-nutritional factors which must have affected its intake and utilization. Anti-nutritional factors such as tannins, cyanogens, saponnins, etc have been implicated for depressed feed intake and consequently weight gain response in livestock (D'Mello, 1992; Ensiminger, 1990; Obun, 2008). In particular, tannins have been reported to induce astringents taste that affect palatability, reduce feed intake and consequently body weight (Marker and Becker, 1998). It thus becomes imperative to carry out the phytochemical study of the forage of this plant. Besides, the lowest CP and the highest CF contents of the forage may also have possibly affected its consumption and utilization. High dietary fibre has been shown to depress feed intake (Kass *et al.*, 1980). The dietary fibre may have exerted its depressive effect on feed intake by causing early gut fill. According to McDonald *et al.* (1995), fibrous feeds tend to spend a long time in the digestive tract thereby resulting in reduced feed intake. Corollary to this, the reduced feed intake could have resulted in the inability of the rabbits to meet their optimum production and metabolic requirements compared to those fed other experimental forages. The ADG reported in this study are, similar to those reported by Odeyinka and Ijiyemi (1997).and Iyeghe-Erakpotobor *et al.* (2004) who fed concentrate and forage combinations to grower rabbits.

Table 3: Performance characteristics of the experimental rabbits

Diets	ADFI (g/day)	ADG (g/day)	FCR	DMD (%)
Vitallaria paradoxa	42.65^b	10.08^b	4.22	63.37^b
Nauclea latifolia	48.21^a	11.76^a	4.10	65.02^a
Terminalia macroptera	39.29^c	9.17^c	4.28	63.21^b
SEM	0.68	0.53	0.42	0.48

a, b, c = means within the same column with different superscripts differ significantly ($P < 0.05$).
ADFI = Average daily feed intake
ADG = Average daily gain
FCR = Feed conversion ratio
DMD = Dry matter digestibility.
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Analysis of relationship between ADG and ADFI and DMD shows that ADG was significantly ($P < 0.0001$) and positively correlated ($r = 0.9999$) with ADFI (X1) and DMD (X2), with about 100% ($R^2=0.9998$) of variation in ADG being due to these independent variables. The regression equation is $Y= -9.183 + 0.2648X1 + 0.1257X2$. However, ADFI had a marginal more contribution ($R^2 = 0.992$) to ADG than DMD ($R^2 = 0.927$). Similarly, relationship between the two independent variables shows that ADFI was positively and significantly ($r = 0.9114$, $P < 0.001$) related to DMD, with about 83% ($R^2 = 0.8306$) of the DMD being attributable to the ADFI. The results confirms previous reports that ADG is a function of ADFI and the higher the feed intake, the higher the weight gain and vice versa ceteris paribus (Obun *et al.,* 2008; Olafadehan *et al.,* 2008).

The efficiency of conversion of feed to meat was not significantly influenced ($P > 0.05$) by the forage types, though it was best for rabbits fed *N. latifolia*. The reason for the insignificant difference in feed conversion ratio is not clear but it could be that the concentration of the anti-nutritional factors in the forage of *T. macroptera* is below the level that could impair the conversion of the forage to meat. The values obtained in this study were similar to many reported values (Oluokun, 2005; Orunmuyi *et al.,* 2006).

Dry matter digestibility (DMD) of all the treatments was fairly high and impressive. However, it was significantly ($P < 0.05$) better in *N. latifolia* than *V. paradoxa* and *T. macroptera*, which were similar. As earlier suggested, the lower DMD of *V. paradoxa* and *T. macroptera* forages compared to *N. latifolia* could be to their higher fibre content relative to *N. latifolia*. This observation is in line with report of Adegbola and Osuji (1985) who reported reduced digestibilities due to high levels of dietary fibre. The DMD values are similar to the range of 59 – 72% reported by Iyeghe-Erakpotobor *et al.* (2004) for growing rabbits fed concentrate, grass and legume combinations but higher than the range of 45 – 56% reported by Bamikole and Ezenwa (1999) for rabbits fed combinations of concentrate and grass (guinea grass) or concentrate and legume (Verano stylo).

Conclusion:

The acceptance and consumption of the foliage, impressive weight gain and digestibility of the forages indicate the nutritive value of these forages when fed with small quantity of concentrate supplement. It is thus concluded that *V. paradoxum, N. latifolia* and *T. macroptera* foliage have potentials to support growth when fed with small quantity of concentrate diet to grower rabbits. However, *N. latifolia* showed greatest potential followed by *V. paradoxum* and then *T. macroptera.* It is therefore recommended that the foliage of these fodder trees be used in mixed feeding regime for grower rabbits, especially during dry season when conventional forages are scarce.

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