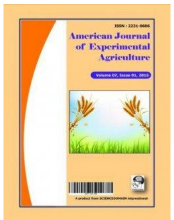

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Performance of Growing Grasscutters Fed a Concentrate Diet without Supplementation with Forage

G. S. I. Wogar[1*] and T. E. Ayara[1]

[1]Department of Animal Science, University of Calabar, Calabar, Nigeria.

Authors' contributions

This work was carried out in collaboration between the both authors. Author GSIW designed the study, wrote the protocol, supervised the conduct of the experiment and wrote the first draft of the manuscript. Author, undergraduate student, carried out the hands-on experimental work. Both authors managed the analyses and statistical analysis of the study. Both authors read and approved the final manuscript.

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ABSTRACT

Aim: To determine the effect of feeding growing grasscutters a concentrate diet without forage.
Study Design: The experiment involved three treatments with three replicates per treatment in a Completely Randomized Design.
Place and Duration of Study: The study was carried out in the Research Farm of the University of Calabar, Nigeria, between November, 2013 and March, 2014.
Methodology: Eighteen 10-weeks old male grasscutters of equal weight (850 g) were allocated randomly to three treatments (T_1, T_2, T_3), with six grasscutters per treatment and two grasscutters per replicate. The grasscutters were fed a concentrate diet containing 23.00% crude protein, 7.00% crude fibre, and 2300.00kcalME/kg with elephant grass (*Pennisetum purpureum*) as forage. This study involved three feeding regimes, in which all animals were fed a concentrate diet *ad libitum.* Varying levels of forage, including 24, 12 and nil hours access to forage, were allowed animals in treatment 1, 2, and 3 respectively. Water was supplied *ad libitum.* Weights of animals were taken at

**Corresponding author: E-mail: ikaniw@yahoo.com;*

the beginning of the study and every week thereafter. Records of feed intake were taken daily.
Results: Findings show that forage intake (239.90 g) was significantly (*P=0.05*) higher in grass cutters fed concentrate with *ad libitum* supply of forage, while concentrate intake (49.50 g) and total feed intake (69.40 g) were significantly (*P=0.05*) higher in grasscutters fed concentrate with *restricted* supply of forage. Average daily weight gain (11.20 g) was significantly (*P=0.05*) higher, while the best feed conversion ratio (4.22) and cost to gain ratio (0.40) were obtained, in grasscutters fed concentrate without forage.
Conclusion: It is concluded that the performance of growing grasscutters fed a concentrate diet without forage is superior to the performance of growing grasscutters fed a concentrate diet with forage. The indication is that commercial feeds containing the right amounts of nutrients, including fibre, and offering a low cost to gain ratio, can be packaged for the convenience of grasscutter farmers.

Keywords: Grasscutters; feeding; concentrate; without forage; weight gain.

1. INTRODUCTION

Wildlife animal species are an important source of animal protein in the diets of rural and urban populations in Sub-Sahara African countries [1]. In Nigeria, this widely accepted and highly priced meat from the wild is marketed as ''bushmeat''. With growing populations in these countries and a corresponding annual decline (estimated at 2% for Nigeria [2] in the production of conventional livestock, there is compelling need for increased supply of animal protein in human diets [3]. Given the high cost of protein from conventional livestock, wildlife animal species, including the grasscutter, provide a less expensive source of animal protein [4].

Most of the ''bushmeat'' is obtained from game species, which include rodents (grasscutters, porcupine), the apes (monkeys, baboons, chimpanzies), snakes, and big game (duickers, buffaloes, deers, etc). Of these, only the grasscutter has presently been successfully reared as a farmed animal [5]. To effectively source animal protein from the grasscutter as an alternative, the cost of production of grasscutter must be considerably lower than the cost of production of conventional livestock. A major factor in animal production is the cost of feeding, which constitutes 70-80% of the cost of production [6].

The nutrient content of feed used in the rearing of grasscutter determines the cost of feed and level of performance in terms of growth [7] and reproduction [8,9]. Grasscutter should be raised on feeds, which are rich and balanced in nutrients [10]. The farming of grasscutters, therefore, requires that rations include forage and concentrate diets, which should be formulated to satisfy the requirements for health and productive activity [11]. Though forage is the dominant constituent of its diet in the wild, the grasscutter cannot live on a forage-only diet. In the wild it relies on wild and cultivated roots, berries, nuts, and various fruits and seeds as sources of energy and protein to supplement its high fibre diet. Studies [12,13] have shown that concentrates can be used along with various fibre sources in the rearing of grasscutter in captivity.

The specialized digestive system, which incorporates the caecum, enables the grasscutter to survive on a low calorie and high fibre diet [14]. Forages are sources of fibre, and are less expensive feedstuffs than concentrates. Fibre undergoes microbial digestion in the caecum of the grasscutter, with the release of volatile fatty acids, which are substrates for the synthesis of protein and energy stores of the body [15].

The use of forage in grasscutter farms is associated with tedium, bulk, and increased cost, during harvesting and feeding. These difficulties could be avoided if formulated concentrate diets supply the required level of fibre in grasscutter rations. Further, the prospects of formulating commercial diets containing the required level of fibre for the desired level of productivity in grasscutters would obviate the need for the use of forage, while expanding interest in grasscutter farming. The objective of this study, therefore, is to evaluate the performance of growing grasscutters fed a concentrate diet without forage.

2. MATERIALS AND METHODS

This study was carried out at the Grasscutter Research Farm, University of Calabar, Nigeria, between November, 2013 and March, 2014.

2.1 Experimental Diets

The experimental diet was formulated to supply 23.00% crude protein, 7.00% crude fibre, and 2300kcal ME/kg. Soybean was the main source of protein, while cassava flour was the main source of energy in the diet. The starch of cassava also served as the binding agent in the pelleted diet, which was produced from a thick paste of the compounded ingredients. The gross composition of the experimental diet is shown in Table 1 while the proximate composition, which was determined using the AOAC [16] method is shown in Table 2.

The grasscutters were fed elephant grass (*Pennisetum purpureum*) as forage and a concentrate diet formulated to contain 23% crude protein, 7% crude fibre, and 2300kcalME/kg. Three feeding regimes (Treatments (T)) used were as follows: 24 hours *ad libitum* supply of both concentrate diet and forage (T1); 24 hours *ad libitum* supply of concentrate diet and12 hours (*restricted)* supply of forage (T2); 24 hours *ad libitum* supply of concentrate diet, but without forage (T3). The 12 daylight hours supply of forage from 6.00 am to 6.00 pm is predicated on the knowledge that the period of 12.00 noon to 6.00pm, is part of that 18-hour period of the day, during which time feed intake is highest among grasscutters [17].

Table 1. Gross composition of experimental diet for feeding growing grasscutters with and without supplementation with forage

Ingredients	Composition (kg)
Soybean	16.40
Wheat offal	30.00
Palm kernel cake	20.00
Cassava flour	30.70
Salt	0.40
Bone meal	2.00
Vitamin premix	0.50
Total	**100**

2.2 Digestibility Trial

A digestibility trial was carried out at the end of the 12th week of the feeding trial and lasted for 10 days. No faeces were collected during the first 3 days of digestibility study. Records of feed intake and faecal samples collected were taken during the last 7 days of the study. Samples of faeces collected daily for 7 days from each of the grasscutters were oven-dried at 65°C, packed in plastic bags and stored in a refrigerator. At the end of 7 days, faeces collected from each replicate were pooled, and samples were taken for proximate analysis using the AOAC [16] methods. The apparent digestibility coefficients (%) of the nutrients of the experimental diet are shown on Table 3.

Table 2. Proximate composition of experimental diet for feeding growing grasscutters with and without supplementation with forage

Nutrient	Composition (%)
Dry matter	86.646
Crude protein	23.108
Crude fibre	7.700
Ash	5.304
Ether extract	5.020
Nitrogen free extract	45.514

2.3 Research Animals

Eighteen 10-weeks old malegrass cutters of equal weight (850g) were allocated randomly to the three treatments ($T_{1,}$ $T_{2,}$ T_3), with six grasscutters per treatment and two grasscutters per replicate. The eighteen grasscutters were randomly selected from six does, which had kindled on the same day and had been weaned of pups on the same day.

2.4 Management of Research Animals

The grasscutters were housed individually in concrete cells, each of which was fitted with one door. The provision of just one door had the effect of reducing the loss of heat from the cell, thus enhancing a warm environment for the grasscutter, which is easily susceptible to pneumonia. Temperatures in the cells fluctuated between 26–29°C during the experimental period. Grasscutters were housed in sanitary conditions.

The grass cutters were given dewormers (Piperin WS, produced by Interchemie Werchen of Holland) and anti stress drug (Anagess (WSM), also called Vet Glucose, produced by Agritech of India) in drinking water at the beginning of the experiment. The experimental diet was fed with or without elephant grass (*Pennisetum purpureum*) depending on the requirement of the treatment. The elephant grass was allowed to wilt for two days before it was fed daily as a supplementary diet. Water was supplied *ad libitum* to all the animals. The experimental diet and forage were served for seven days before commencement of record taking in order to allow for adjustment to the experimental diet. The animals were weighed at the beginning of the study and every week thereafter. Records of feed intake were taken daily.

2.5 Statistical Analysis

Data collection involved observations of daily forage intake, forage dry matter intake (which was estimated as 12% of elephant grass consumed), daily diet intake, and daily weight gain. The Completely Randomized Design was used for the study. Data was analysed using the Genstat [18] software method of the analysis of variance. The Least Significant Difference Method of the same software [18] was used to separate significant means.

3. RESULTS AND DISCUSSION

3.1 Proximate Composition

The results of the chemical analysis (Table 2) show the composition of nutrients (crude protein, crude fibre, ether extract, ash and nitrogen free extract) of the experimental diet, which was fed to the grass cutters. The chemical contents of crude protein (23.108%) and crude fibre (7.7%) were close to the target (23%) crude protein and crude fibre (7%) envisaged in the gross composition. This study assumes that nutrients of the experimental diet were equally available to all the experimental animals.

3.2 Apparent Digestibility Coefficients

There were significant (*P=.05*) differences between treatments in the apparent digestibility coefficients (ADC) of all nutrients (Table 3) of the experimental diet.

Apparent digestibility coefficients for dry matter was significantly (*P=.05*) higher in grasscutters allowed unrestricted access to forage (93.80%) than in grasscutters with restricted access (93.60%), or without access (93.50%), to forage. Apparent digestibility coefficients for crude protein was significantly (*P=.05*) higher in grasscutters allowed only restricted access to forage (90.80%) than in grasscutters with unrestricted access (89.50%), or without access (85.50%), to forage. This finding indicates that increased digestion and utilization of crude protein among grasscutters was enhanced by restricted access to forage. It has been found that increase in the dietary component of fibre decreased digestibility [19].

Apparent digestibility coefficients for crude fibre (85.60%), ash (86.20%), and nitrogen free extract (98.50%) were significantly (*P=.05*) higher in grasscutters fed concentrate without forage than in grasscutters fed concentrate with forage. The ADC for ether extract in grasscutters fed concentrate without forage (96.40%) was significantly (*P=.05*) higher than in grasscutters allowed restricted access (94.60%) to forage. It has been reported [20] that the digestibility of protein, fat, and crude fibre were reduced by high dietary fibre.

Table 3. Apparent digestibility coefficients (%) of nutrients of the experimental diet for feeding growing grasscutters with and without supplementation with forage

Nutrients	Treatments (%)			SEM
	T1	T2	T3	
Dry matter	93.80^{a}	93.60^{b}	93.50^{c}	0.09
Crude protein	89.50^{b}	90.80^{a}	85.50^{c}	1.06
Crude fibre	84.50^{b}	82.80^{c}	85.60^{a}	0.82
Ash	85.10^{b}	83.50^{c}	86.20^{a}	0.80
Ether extract	96.70^{a}	94.60^{b}	96.40^{a}	0.65
Nitrogen free extract	98.20^{b}	98.10^{b}	98.50^{a}	0.12

1. $^{a, b, c}$means on the same row with different superscripts are significantly (P=.05) different.; 2. SEM = Standard error of mean (Ref. Genstat, 2013 (18))

3.3 Growth Performance

The performance of growing grass cutters fed a concentrate diet with and without forage is shown in Table 4.

3.3.1 Feed intake

There were significant (*P=.05*) differences between treatments in respect of forage, concentrate and total feed intake by grasscutters. Forage intake (239.90 g/day) was higher in grasscutters allowed 24 hours access to forage, while concentrate intake (49.50 g/day) was highest in grasscutters allowed restricted (12 hours) access to forage. This observation suggests that grasscutters with unrestricted access preferred forage, which is a bulkier feed, to concentrate, which offers higher nutrient utilization by the animal [21]. Grasscutters allowed restricted access struck a more beneficial balance between forage and concentrate intake. While concentrate intake in grasscutters allowed restricted access (49.50 g/day) to forage was significantly (*P=.05*) higher than in those with unrestricted access (39.10 g/day), it was not different from concentrate intake (47.30 g/day) in grasscutters deprived of forage. Results indicate that restricting forage intake increases concentrate intake in grasscutters. This finding has a behaviourial and physiological basis, which permits the grasscutter to satisfy its requirement for forage, after a period of restriction, while enhancing a higher rate of digestion and utilization of both forage and concentrate. The significantly (*P=.05*) higher total feed intake (69.40 g/day) in grasscutters allowed only restricted forage intake, than in other treatments, is consistent with the suggested higher level of feed digestion and utilization due to the probable balance in the consumption of concentrate and forage on this treatment. Average daily feed consumption has been reported to be higher in grasscutter fed a concentrate diet only than when green forage was supplemented with concentrate [22].

It is known that the grasscutter benefits from enzymatic digestion in the foregut, while hindgut microbial fermentation produces volatile fatty acids, which are important in the synthesis of protein and energy food stores in the animal [20,23]. Therefore, it is suggested that the proportion of forage to concentrate intake affects this digestive strategy of the grasscutter. This finding indicates that grasscutters adjust their feed intake according to the energy and other nutrient contents of the feed in order to satisfy their needs [23]. This findings suggest that grasscutters eat to satisfy their energy and nutrient requirements, and that high intake of forage undermines the intake of the nutrient-rich concentrates. It has been reported that digestibility in grasscutters decreases with increase in dietary fibre [19].

3.3.2 Daily weight gain of growing grasscutters

Daily weight gain (DWG) of growing grasscutters was significantly (*P=.05*) different between treatments. Grasscutters, which were not fed forage, had significantly (*P=.05*) higher ADG (11.20 g/day) than those allowed unrestricted (9.03 g/day) and restricted (11.10 g/day) supply of forage. Elephant grass is high in fibre and, therefore, bulky. The high intake of forage in grasscutters with unrestricted access resulted in lower intake of concentrate, which has higher nutrient value and is more easily utilizable by the animals. Nutrient content and utilization is lower in bulkier forage feeds than in concentrate diets, which offers higher nutrient utilization [21] for the enhancement of growth. This finding is consistent with the report that animals fed high fibre diet had reduced digestibility of dry matter, protein and fat, with lower growth rate than animals fed low fibre diet [20]. Further, though the grasscutter is able to break down some of the cellulose in its diet by microbial fermentation, its ability to absorb volatile fatty acids and thereby extract energy from cellulose digestion is less than in ruminants [24]. This characteristic of the grasscutter explains the lower ADG in grass cutters allowed unrestricted access to grass, which resulted in lower intake of concentrate diet in that group. The consumption of high fibre has also been associated with low fat deposition [25], which reduces the rate of weight gain.

It is known that the utilization of protein is directly related to energy expenditure. The implication is that higher metabolic rates in small animals like the grasscutter involve higher requirement for protein per unit of body mass. This means that

Table 4. Effect of feeding growing grasscutters a concentrate diet with and without forage

Parameter	Treatments			SEM
	T1	T2	T3	
Initial weight (g)	850	850	850	0
Final weight (g)	1267.90	1340.50	1346.40	25.70
Average daily weight gain (g/day)	9.03^b	11.10^a	11.20^a	0.72
Average daily forage intake (g/day)	239.90^a	165.70^b	NA	37.48
Average daily forage dry matter intake (g/day)	28.80^a	19.90^b	NA	4.50
Average daily concentrate intake (g)	39.10^b	49.50^a	47.30^a	3.25
Average daily total feed intake (g/day)	67.80^a	69.40^a	47.30^b	7.25
Feed conversion ratio	7.51^a	6.30^b	4.22^c	0.28
Average daily cost of concentrate intake (N.K/day)	3.80^b	4.70^a	4.50^a	0.28
Cost to gain ratio (N.K/g)	0.42	0.42	0.40	0.01

1.$^{a, b, c}$means on the same row with different superscripts are significantly (P=.05) different.; 2. SEM = Standard error of mean (Ref. Genstat, 2013 (18)).; 3. NA = Not Applicable (i.e. grass cutters not fed forage).; 4. N.K. = Naira. Kobo (Nigerian currency); US$1.00 = N205.00 (as at March, 2015) the optimization of the use of protein depends on a high energy to protein ratio [26]. Therefore, the higher ADG in grasscutters in treatments 2 (restricted access to grass) and 3 (no access to grass) than in treatment 1 (unrestricted access to grass) is explained by the higher intake of the concentrate diet, which is richer in energy and protein.

The finding that grasscutters, which were not supplied forage, had the highest ADG indicates that the fibre content (7.70%) of the experimental diet was consistent with higher weight gain in grasscutters on this treatment. While ADG in grasscutters allowed only restricted supply of forage was higher than in grasscutters allowed unrestricted access to forage, it was lower than ADG in grasscutters not fed forage. This finding indicates that, in the context of total fibre content of forage and concentrate consumed by grasscutters, weight gain decreased with increase in fibre intake. This observation corroborates the finding [20] that a high fibre diet is associated with reduced growth rate. Growth rate and carcass characteristics have been shown to be superior in grasscutters fed a concentrate diet with 0% or 7.5% elephant grass than in grasscutters fed concentrate diet with 15% elephant grass [19]. The finding of this study is consistent with the digestive strategy of the grasscutter, which involves foregut enzymatic digestion and hindgut microbial fermentation [27], resulting in greater benefits for growth in grasscutters with a balanced intake of concentrate diet and forage.

The findings of this study show lowest ADG in treatment 1, where grasscutters were allowed unrestricted access to grass, resulting in the highest intake of forage and lowest intake of concentrate. The explanation for decreased ADG in treatment 1 is insufficient feed intake to supply the energy needs for metabolic processes as well as inadequate protein to build and maintain organs and muscles [28].

Further, findings suggest that dietary content of the various nutrients of the experimental diet, including crude fibre content of 7.70%, were adequate to balance nutrient availability to requirements resulting in enhanced weight gain in growing grasscutters fed the diet without forage. It has been reported that proteins which are directly available to the herbivorous animal increase the efficiency of anabolism of absorbed nutrients in growth, pregnancy, lactation, and work [29].

3.3.3 Feed conversion ratio

The feed conversion ratio indicates that ADG varied inversely with the duration of exposure of grasscutters to forage. This is due to increased forage/fibre intake with increased duration of exposure to forage. Studies have shown that grasscutters have better feed conversion efficiency on protein-rich concentrates than on grass diets [30].

3.3.4 Cost to gain ratio

The superiority of performance of grasscutters fed a concentrate diet (containing an adequate 7.7% crude fibre) without forage, over the performance of grasscutters fed the concentrate diet with forage, is further indicated in the lowest (0.40) cost to gain ratio observed in grasscutters fed concentrate without forage.

4. CONCLUSION

Findings show that forage intake was significantly (P=.05) higher among grasscutters fed rations with *ad libitum* supply of grass, while concentrate intake and total feed intake were significantly (P=.05) higher among grasscutters fed rations with *restricted* supply of grass. However, the average daily weight gain was significantly (P=.05) higher, while the best feed conversion ratio and cost to gain ratio were obtained in grasscutters fed rations without grass.

From the above findings, it is concluded that the performance of growing grasscutters fed a concentrate diet without forage is superior to the performance of growing grasscutters fed a concentrate diet with forage. Findings further indicate that commercial feeds containing the right amounts of nutrients, including fibre, and offering a low cost to gain ratio, can be packaged for the convenience of grasscutter farmers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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