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The effect of concentrated feed supplementation regimes on the nutrients digestibility of grasscutters (*Thryonomys swinderianus*) fed *Pennisetum purpureum* as basal feed.

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Abstract

The study was designed to determine the effect of concentrated feed regimes on nutrients digestibility of grasscutters (*Thryonomys swinderianus*) fed *Pennisetum purpureum* as basal feed. A total of fifty grower grasscutters were randomly assigned to 5 treatment groups of 10 grasscutters each with 5 replicates, two animals serving as a replicate. Treatment was 1, 2, 3, 4, and 5 for 1, 3, 5, 7, and 9%, respectively, of concentrated feed served at their weekly live weight. Parameters measured included apparent coefficient of digestibility and percentage digestible nutrients. The results obtained showed that the coefficient of digestibility showed a significant difference in all the nutrients evaluated. Percentage digestible nutrients and total digestible nutrients were also significantly affected. The high coefficient of digestibility of the various nutrients and total digestible nutrients are indications that adequate nutrients were available for growth and maintenance of the grasscutters. The findings of this study suggested that supplementation of forage with formulated concentrate can be an aid in the digestion of nutrients by grasscutters for their growth performance while in captivity. The digestibility of nutrients when concentrate supplement and elephant grass were combined, particularly 5% concentrate supplement was not affected. Based on the results, it was, therefore, recommended that it should be used in improving the growth performance of grasscutters.

Keywords: Concentrate, supplementation regimes, nutrient digestibility, Grasscutters, *Pennisetum purpureum*.

Introduction

Animal protein production in Nigeria from domestic livestock has been steadily falling by approximately 1.4% annually, while the human population has been increasing at an annual rate of 3.3% [1]. So, indeed, there is need to attempt to bridge the animal protein gap for Nigerians to attain the FAO recommended daily animal protein intake that is deficient in the diets of an average Nigerian and also try reducing the under-five death that is usually experienced as a result of malnutrition. This can be achieved by the provision of animal protein knowing its functions in the health status in the human body [2,3]. Unfortunately, conventional and regular sources of animal protein supply in the country Such as beef, pork, goat meat and poultry are getting out of the reach of the common populace due to economic down-turn. In an attempt to reduce this situation therefore, we must think of animals from the wild with acceptable potentials and one of such animals is grasscutter (*Thryonomys swinderianus*), a micro- livestock. Mbah [4] have suggested that an area where effort may be rewarded in terms of meeting the animal protein requirement of Nigerians is the contribution of wild animal.

He added that, the shortage of animal protein in the third world countries can be ameliorated by improving the existing conservation programme of wildlife particularly the conservation and domestication of rodents that are tractable, prolific and widely accepted to the public for consumption. Again, that, captive rearing of rodents and other species of manageable sizes in cages and enclosures might augment the bush meat supply from the wild which can lead to a reduction of hunting pressure on the wild game and rodent grasscutter could be the rodent of choice. It was observed a gradual shift from the production and consumption of conventional animal protein sources (cattle, sheep, swine, goat, poultry) to a class of livestock referred to as 'mini-livestock', 'micro-'unconventional livestock' [5].

With the shortage of animal protein, nutritionists are now interested in prolific, good converters of feed to flesh and short production cycle animals [6]. The grasscutter meat is favourite and it accounts for the greater proportion of bush meat sold in most part of the continent of Africa particularly West Africa [7]. The major problem in the production of monogastric animals, such as poultry and pigs, emanates from the high costs of ingredients such as cereal grains and soybeans, which form 50-80% of formulated feeds [8]. Their high cost emanates from the fact that, they feature prominently in human diets in the developing world but grasscutters do not belong solely in that group. Akinloye, [9] and Opara and Fagbemi [10] reported that, proper feeding is the major factor that determines the health of any animal that captive reared grasscutters are fed with both forages and concentrates but the proportion of concentrate must be in low quantity to avoid digestive problems hence the need to search for a concentrate-feeding regime that can improve the performance of grasscutters. Diseases are not very common problem in grasscutters [11]. They added that, the severity of these diseases is influenced by the nutritional status of the animals, especially in the dry season when feed is inadequate in quantity. Backyard rearing of grasscutter in rural or urban settlement has the capacity to provide adequate animal protein of an average family year round [12].

In addition, its management requirements are low-cost. It feeds on a wide range of feedstuffs, such as grasses, legumes, to tuber crops Such as sweet potatoes and cassava and other industrial by-products [12]. Asibey [13] earlier reported that grasscutter meat has a protein content of 24.7%, and a low fat content of 1.2% makes it better than beef with a protein content of 19.6% and fat content of 6.6% and pork with a protein content of 19.4% and fat content of 13.4%. The grasscutter's gastro-intestinal tract is adapted to handle high fibre materials because of the presence of a large caecum which houses some microbes that help in the digestion of cellulose. The presence of cellulolytic bacteria in the caecum of the grasscutter has been shown by [14]. Animals with this system are referred to as hind-gut fermenters, meaning that feed is broken down by bacteria at the end of the digestive system. The microbial activity of the

caecum is of great importance for the processes of digestion and nutrient utilization from fibrous material [15].

Grasscutter exhibit some features of the ruminant by consuming large quantities of forages (leaves and stems) and fermenting it in the gut chamber that harbours microbes and B-vitamins are useful by-product of the process. The difference is that whereas, for the ruminants the rumen is at the beginning of the gut and the products of fermentation are absorbed from the rumen and lower gut, the caecum is towards the end of the gut, and the grasscutter has to re-ingest fermentation products through the mouth, that is, they also practice caecotrophy Such as the rabbit. The fermentation of fibre in the guts of herbivorous results in the production of volatile fatty acids (VFAs) [16] which is absorbed across the epithelial membrane. VFAs account for much of the metabolizable energy supply to the animals [17]. KariKari and Nyemeasem [18] reported that increase in the dietary components of crude fibre (CF) acid detergent fibre (ADF) and neutral detergent fibre (NDF) decreased digestibility and daily weight gain in grasscutters. In another study with grasscutters, Van zyl *et al* [19] found that high dietary fibre reduced the digestibility of dry matter, protein and fat while the digestibility of fibre component (NDF, ADF and hemicellulose and cellulose) was comparable to that of grasscutters on the low fibre diet. Elephant grass is rather low in energy and protein, due to its high cell wall content [20]. Elephant grass is very sensitive to climatic conditions, maturity and regrowth days, with a decrease in crude protein content, an increase in fibre, a decrease in dry matter and cell wall, as measured by *in situ* degradability and *in vivo* digestibility [21, 22, 23].

Since at the moment, no baseline nutrient requirements and no particular feeding regime for concentrate have been established that can aid for nutrients digestion for optimal performance. Therefore, the objective of this research was to evaluate the concentrate-feeding regime on the nutrients digestibility of grasscutters using Elephant grass as basal feed.

Materials and Methods

Experimental Location

The study was carried out in Obubra, Cross River State, Nigeria. This is located between longitude 80-90 E and Latitude 60-70 N of the equator. The mean annual rainfall of the area ranges from 500 to 1070 mm with warm weather and ambient temperature of about 200c-300c [24]. Obubra is located along the banks of the Cross River in the Southern Guinea Agro-Ecological Zone of Nigeria. Obubra is about 159 km from Calabar, the State Capital of Cross River State of Nigeria.

Experimental Animals and Design

A total of fifty weaned grasscutters between the ages of 3-4 months obtained from a local farmer in Ibadan were used for the digestibility trial. The grasscutters were put into groups of similar body weights and were randomly assigned to five treatments feeding regimes in a completely randomized design. The grasscutters were randomly assigned to 5 treatment groups of 10 grasscutters each with 5 replicates with two animals serving as a replicate. The animals were given elephant grass as basal feed *ad libitum* and formulated concentrate supplemented at a feeding regime of 1, 3, 5, 7, and 9% for T₁, T₂, T₃, T₄ and T₅ respectively of their weekly live body weight throughout the period of the experiment.

Housing and Experimental procedure

The grasscutters were individually housed in clearly and properly-labelled concrete cells measuring 90 x 75 x 40 cm (length x width x height). There was an opening only at the top in order to eliminate cross-ventilation and prevent the adverse effect of cold because grasscutters are highly susceptible to pneumonia. The top was partly covered to create a dark area meant for hiding which is their habit. Each cell was provided with a feeder and a drinker. The cemented cells were constructed in a well-ventilated cement block walled house roofed with asbestos sheets to protect the animals from bad environmental conditions such as rainfall and cold conditions.

On the introduction into the cells, the animals were provided with antistress agents in drinking water. They were also dewormed and given a dosage of 5 gm each of coccidiostat. Elephant grass (*Pennisetum purpureum*), were cut and allowed to wilt for about 12 hours, weighed and fed daily as a basal diet. Water and elephant grass were supplied *ad libitum*. The animals were weighed weekly throughout the period of 20 weeks of the study. All cells were cleaned daily in order to ensure an adequate level of sanitation.

Experimental diet

A concentrate supplement diet was formulated to contain approximately 18% crude protein and a metabolizable energy of 2961.47 kcal/kg (**Table 1**) which was used at different feeding regimes of 1, 3, 5, 7 and 9% of their weekly body live weight and fed with wilted Elephant grass as basal feed.

Chemical Assay

The grasses were harvested around the study area wilted for about 18 hours chopped to pieces, milled and analysed for Proximate chemical composition (to include gross energy) according to the procedure outlined by [25] while the fibre obtained was characterized to its component fractions according to the procedures outlined by [26].

Digestibility trial

At the end of the feeding trial, one grasscutter per replicate with the live weight approximately their treatment average live weight, were selected and used for the digestibility trial. Faecal collection lasted for seven (7) days, during this period the grasscutters were fed about 75% of weight of their feed intake per day since the level of feed intake increases the rate of passage of the digest from the GIT and thus reduces the digestibility of nutrients [27]. Faecal collections were obtained after sorting out other contaminants. Before the commencement of faecal collection the grasscutters were deprived of feed for 18 hours to ensure that the faecal collection corresponded to the feed offered. The fresh faeces from each replicate were weighed and oven-dried at 80°C for 24 hours, the oven-dried faeces per replicate were bulked, thoroughly mixed together and milled. Samples of the ground faeces were stored in airtight sample bottles properly labelled and taken for chemical analysis.

Table 1. Composition of concentrate feed and calculated values of experimental diets

Ingredients	%
Maize	58.41
Soybean meal	27.59
Rice offal	10
Bone meal	3
Vitamin-min-premix*	0.5
Common salt	0.5
Total	100
Calculated nutrients composition.	
Crude Protein	18
Metabolizable Energy (/kcal/kg)	2961.47
Crude fibre (%)	6.97
Calcium (%)	1.16
Phosphorus (%)	0.89

* Each 1 kg of vitamin/mineral premix manufactured by BEAUTS Co. Inc. Man, U.S.A., contains Vitamin A 220,000, Vitamin D 66,000, Vitamin E 44,014; Vitamin K 88 mg; Vitamin B 12; 0.76 mg; Niacin 1122 mg, Calcium 27%, Phosphorus 10%, Iron 0.6%, Zinc 0.35%, manganese 0.25%, Copper 0.06%; Iodine 0.002%, Cobalt 26 ppm, Selenium 4 pp. ME = Metabolizable Energy.

Statistical analysis

Data collected were subjected to analysis of variance (ANOVA) using MINI-TAB version 16.0 [28], where means were significant, there were separated at 5% significant level of probability using the least significant difference according to the procedures contained in the software.

Results and Discussion

Proximate composition of the concentrate feed supplement and Elephant grass

The result of the proximate composition of the formulated diet and elephant grass used for the study are presented in **Table 2**. The crude protein content of the experimental diet analysed (17.8%) was similar to the

calculated value (18%) and met the crude protein requirements of growing grasscutters (18%) [29]. Elephant grass has low protein content of 8.18%, high fibre content of 27.19% and ether extract content of 1.18%, thus necessitating the use of formulated concentrate which may be suitable to satisfy the nutrient requirements of a growing grasscutter especially when supplemented with concentrate [9, 10]. The results of proximate analysis is similar to that of Onyeanusi *et al.* [30] and Wogar *et al* [31] with some variations may be due to soil nutrients or period of harvest since these factors among others are known to affect the nutrients availability of forages.

Characterization of the crude fibre content of Elephant grass

The characterization of the crude fibre content of elephant grass presented in **Table 3** showed that, it contained 39.91% cellulose, 20.82% Hemicellulose, 66.95% neutral detergent fibre (NDF), 41.91% acid detergent fibre (ADF) and 35.10% acid detergent lignin (ADL). Characterization of the crude fibre of the elephant grass showed that, cellulose content of 39.9% recorded in this study was slightly different from 45.60% reported by [32] but this fell within the range of 35-48% reported by [33, 34]. The hemicellulose content of 20.82% was similar to 20.78% reported by Ogunjobi, *et al.* [35]. The neutral detergent fibre (NDF) of 66.95% fell within the minimum and maximum range of 54.1-79.9% reported by Egbunogie and Bamikole [33], Mohammed *et al* [34] but slightly higher than 63.65% reported by Ogunjobi *et al* [35]. The acid detergent fibre (ADF) of 41.91% was similar to 40.5% reported by (Tangendjaja *et al.* [32] and also fell within the range 29.5-52.9% reported by Egbunogie and Bamikole [33], Islam *et al* [34]. The acid detergent lignin (ADL) of 35.10% corresponds to 35% reported by Ogunjobi *et al.* [35] but differed from the value range of 27-59% reported by Egbunogie and Bamikole [33, Mohammed *et al.* [34]. These variations in the fibre characterization in this study and these authors may be due to the season or age of harvest of the elephant grass. It is known that lignification of forages depends on the seasons and particularly the age because the cell wall gets more lignified as the plant matures [36].

Table 2: Proximate composition of elephant grass and concentrate supplement.

Constituents	Dry matter	Crude protein	Crude fibre	Ether extract	Ash	NFE	ME/kcal/kg
Elephant grass % composition	34.3	9.25	31	1.17	9.28	49.3	2187.17
Concentrate % composition	86.98	17.85	5.07	3.2	10.12	50.74	2720.92

The high and comparable coefficient of digestibility of crude fibre in all the feeding regime treatments (67.46 to 85.95%) may indicate that the elephant grass dietary fibre contains more digestible carbohydrates than indigestible. The acid detergent lignin present in elephant grass fibre is 35.10% and may be low enough to be handled by grasscutters. The digestibility of crude fibre has earlier been shown to be

Apparent coefficient of digestibility of grasscutter fed Elephant grass with different levels of concentrate supplement regimes

The nutrient digestibility of grasscutter fed elephant grass with different levels of concentrate supplement regimes is shown in **Table 3**. The high coefficient of digestibility of crude protein of the diets in this study (68.53 to 82.94%) is an indication that dietary fibre levels of 5% and 31% concentrate and elephant grass, respectively, did not adversely affect the digestibility of crude protein. The crude fibre levels present in this study did not impair the utilization of other nutrients, especially crude protein. This animal being a pseudo-ruminant was able to handle the fibre content of the elephant grass. It is known that, fibre in the diet of monogastric impair the utilization of other nutrients, especially crude protein utilization [37].

Table 3. Characterization of the crude fibre fractions of Elephant grass (*Pennisetum purpureum*).

Constituents	Proportion (%)
Neutral Detergent Fibre (NDF)	66.95
Cellulose	39.91
Hemicellulose	20.82
Acid Detergent Fibre (ADF)	41.91
Acid Detergent Lignin (ADL)	35.1

Elephant grass have acid detergent fibre ADF content of (35.10%) and thus, elephant grass dietary crude fibre may not reduce digestibility of CF and other nutrients in grasscutter since this species of animal digestive system has been adapted to this type of grass with this CF level in the wild. This explains why the crude protein digestibility was very high in T₁ in attempt to meet their nutrient requirements since the nutrients were low in grasses. Adegbola and Okonkwo [38] reported that there is a negative correlation coefficient between crude fibre and nutrients digestibility, an indication that high crude fibre in the diet depresses nutrient digestibility. The levels of fibre inclusion in this study may be within the acceptable range for grasscutter, thus the digestibility of crude protein was high.

modified by the degree of lignification of the dietary fibre rather than the fibre level, and this shows differences in feed consumption [39]. The high coefficient of digestibility of non-lignified materials has been previously reported Adegbola and Okonkwo [38]. Fibres from different sources could vary in digestibility depending on the proportions of cellulose, hemicelluloses and lignin. Karikari and

Nyameasem [18] reported that concentrate of high neutral detergent fibre (NDF) (55%) content may not be able to support rapid growth of captive reared grasscutters. They added that increase in the dietary component of crude fibre, acid detergent fibre (ADF) and NDF decreases digestibility and daily gain in grasscutters. In another study with grasscutters, Van zyl *et al.* [19] reported that high dietary fibre reduced the digestibility of dry matter, protein and fat while digestibility of fibre component, NDF, ADF, hemicelluloses and cellulose was comparable to that of grasscutters on a low fibre diet.

The coefficient of digestibility of crude fat, (27.65 to 72.69%) observed in this study is similar to the value 64.40% reported by Ogunjobi *et al.* [35]. The high coefficient of digestibility of fat in T₁ by the grasscutters in this study can be attributed to the acceptable range of crude fibre in that treatment which did not contain high amount of lignin even though they ate more forage, thus nutrients utilization and availability at the tissue level were not depressed, it was just the quantity of nutrients in the diet that may not be sufficient. The coefficient of digestibility of ash in this study ranged from 65.01 to 84.47% which was highest at T₁ but similar at T₅, T₇ and T₉. The concentrate supplement was formulated to supply balanced nutrients to the growing grasscutters.

The coefficient of digestibility of ash can be attributed to increase in retention time of the food in the caecum since it was given alongside with elephant grass increased the availability of nutrients by increasing the period of exposure of food to the digestive enzymes and absorptive surfaces, thus, increasing digestibility and absorption of nutrients. Underwood [40] had earlier on reported that, diets with adequate mineral supplementation seldom vary in their ash digestibility. The nitrogen-free extract (NFE) in the experimental feeding regime diets which represents the readily available carbohydrates recorded a relatively low

coefficient of digestibility of 25.10 to 56.41%. However, this implies that, this concentrate feeding regime and elephant grass as basal feed can be reported not to have relatively adverse effect on the readily available carbohydrate, since the coefficient of digestibility of NFE of the treatments were within the range of at least (50.02%). The dry matter coefficient of digestibility, which varied from 75.65 to 82.05% was high and more that 66 to 68% Obi *et al.* [41] when they carried out a study to evaluate the nutritive potentials of four conventional forages fed to growing grasscutters. The high coefficient of digestibility of dry matter of the grasscutters in this study probably means that crude fibre level in the experimental diet did not induce excessive production of mucin. Excessive mucin increases the viscosity of the digesta within the gastro intestinal tract which adversely affects the digestibility of dry matter (DM) [42]. In the absence of this adverse effect of high fibrous diets, the digestibility of dry matter increases.

The negative correlation coefficient between crude fibre and dry matter digestibility values reported by Adegbola and Okonkwo [38] did not apply, which implies that the crude fibre levels in the diet may be within the acceptable and tolerable range for the grasscutters. It was observed that, digestible energy which represents the proportion of gross energy which does not appear in the faeces was found to be very high across the treatments (91.82 to 95.38 kcal/kg). The proximate analysis of concentrate supplement and elephant grass presented in **Table 4** reveals that the concentrate supplement and elephant grass have fibre ratio of (5.07:31.00%) respectively that can be handled by grasscutters being pseudo-ruminant with large caecum that occupies about 40% of the abdominal cavity [43]. Crude fibre is feed diluents and reduces the caloric content (Digestible energy) of feed, but that was not the case in this study as seen by this very high digestibility of energy.

Table 4. Mean apparent coefficient of digestibility of grasscutter fed elephant grass with different concentrate feeding regimes.

Nutrients	T1	T3	T5	T7	T9	SEM
Dry matter (%)	82.05 ^a	75.65 ^b	68.92 ^c	69.77 ^c	67.46 ^c	1.68
Crude protein (%)	82.94 ^a	77.52 ^a	68.09 ^b	70.66 ^b	66.53 ^b	1.92
Crude fibre (%)	85.95 ^a	74.84 ^b	70.51 ^b	75.05 ^b	67.46 ^c	1.62
Ether extract (%)	72.69 ^a	53.59 ^b	35.16 ^{cd}	41.94 ^c	27.65 ^d	3.13
Ash (%)	84.47 ^a	77.23 ^b	65.01 ^d	71.66 ^c	67.05 ^{cd}	1.54
Nitrogen-free extractive (%)	56.41 ^a	43.01 ^b	29.80 ^c	28.37 ^c	25.10 ^c	3.95
Energy	95.38 ^a	94.09 ^b	91.82 ^c	91.82 ^c	93.10 ^b	0.41

a, b, c, and d means within rows with similar superscripts are not significantly different ($p > 0.05$), SEM= Standard error of mean, NFE = Nitrogen-free extractives.

Effects of concentrate supplement regimes on percentage digestible nutrients and total digestible nutrients (TDN) of grasscutter

The effect of concentrate supplement regimes on percentage digestible nutrients and total digestible nutrients (TDN) of grasscutters is presented in **Table 5**. The feeding regimes affected significantly ($P < 0.05$) all digestible

nutrients evaluated in this study. It was observed that digestible crude protein (DCP) of T₅, T₇ and T₉ were similar ($P > 0.05$) while T₃, T₅ and T₇ did not also differ ($p > 0.05$) but differed with that of T₁. However, these significant differences cannot be linked to the different feeding regimes since a particular sequence was not followed. The digestible crude fibre (DCF) also followed the same sequence of

significant. Such as the (DCP) which may suggest that the crude fibre was at the tolerable level that nutrients could be digestible by grasscutters as seen in the digestible crude protein level. The digestible ether extract (DEE) was also observed to be significant but no particular sequence was followed. The digestible nitrogen-free extract (DNFE) was significant ($P < 0.05$). It was also observed that T₅, T₇ and T₉ did not differ significantly ($p > 0.05$).

The total digestible nutrient (TDN) is a figure used to indicate the relative energy value of a feed to an animal. It is influenced by the percentage dry matter since water does not contribute to the energy value of feeds. The dry matter of feed has to be digestible for feed to have a TDN value [42]. The dry matter digestibility value obtained in this study 75.65 to 82.05% is higher than values by Obi et al. [41]. An indication that, the crude fibre content of the diet did not interfere with nutrients availability at the tissue level and adequate nutrients were available for growth and maintenance. The different feeding regimes (1 to 9%) of concentrate supplement using elephant grass as basal feed did not adversely affect the digestible nutrients.

The percentage digestible energy (PDE) was observed to be significantly affected ($P < 0.05$) and the highest value observed was in T₉ though did not differ ($P > 0.05$) significantly with T₅ and T₇. The lowest was observed in T₁ which suggests that T₁ with 1% level of concentrate supplement was not enough for energy supply for the experimental group of the grasscutters which reflected in them having the lowest total weight gains of 667.50g as was observed in the growth performance.

Conclusion

The findings of this study suggest that supplementation of forage with formulated concentrate can be an aid in the digestion of nutrients by grasscutters for their growth performance while in captivity. The digestibility of nutrients when concentrate supplement and elephant grass are combined particularly 5% concentrate supplement were not affected. It was therefore recommended that, it should be used in improving the growth performance of grasscutters.

Table 5. Effects of concentrate supplement-feeding regimes on percentage digestible nutrients and total digestible nutrient (TDN) of grasscutter.

Nutrients	T1	T3	T5	T7	T9	SEM
Digestible crude protein	5.14 ^c	5.84 ^b	6.27 ^{ab}	6.46 ^{ab}	6.73 ^a	0.22
Digestible crude fibre	7.11 ^b	7.50 ^b	8.88 ^a	9.13 ^a	9.04 ^a	0.29
Digestible ether extract	0.73 ^a	0.64 ^b	0.50 ^c	0.62 ^b	0.44 ^d	0.02
Digestible Nitrogen-free extractive	14.55 ^a	13.19 ^{ab}	11.64 ^{bc}	10.76 ^c	10.23 ^c	0.65
Total digestible nutrient	28.44 ^a	27.98 ^{ab}	27.92 ^b	27.73 ^b	26.99 ^c	0.17
Energy.	1075.60 ^c	1290.70 ^{bc}	1575.80 ^a	1520.70 ^{ab}	1716.60 ^a	79.15

a, b, c, and d means within rows with similar superscripts are not significantly different ($p > 0.05$), SEM= Standard error of mean.

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