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GROWTH PERFORMANCE AND NUTRIENT DIGESTIBILITY OF YANKASA RAMS FED VARYING RATIO OF GROUNDNUT HAULMS AND *DIGITARIA SMUTSII HAY* (WOOLY FINGER GRASS)

[2]Salisu, S.S., [1]*Sani, R.T., [1]Ibrahim, U.M., [1]Achi, N.P., [1]Ahmed, S.A., [3]Idowu, W., & [1]Idris, I.D.
[1]National Animal Production Research Institute, Ahmadu Bello University, Shika - Zaria.
[2]Department of Animal Science, Ahmadu Bello University, Zaria
[3]Department of Animal Science, Federal University, Dutsin-Ma, Nigeria
[1]*Corresponding Author: geowife4life@gmail.com trsani@abu,edu,ng +2348038008759.

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ABSTRACT

This study evaluated the growth performance, nutrient digestibility, and nitrogen utilization of Yankasa rams fed diets containing varying ratios of groundnut haulms and *Digitaria smutsii* (woolly finger grass) hay. Six (6) Yankasa yearling rams of an average body weight of 17 kg were assigned to two dietary treatments: 75% groundnut haulm and 25% *Digitaria smutsii* hay (T1), and 50% groundnut haulms and 50% *Digitaria smutsii* hay (T2). Each diet was offered at 2% of body weight, with an additional concentrate supplement fed at 1% of body weight, in a completely randomized design (CRD). Key parameters measured included total live weight gain, daily weight gain, dry matter intake, nutrient digestibility, and nitrogen retention. The data collected were subjected to One-Way Analysis of Variance (ANOVA) using the General Linear Model Procedure (GLM) of Statistical Analysis System (SAS). Results indicated that animals on the T1 diet showed significantly higher ($P<0.05$) growth rates, nutrient digestibility, and nitrogen retention compared to those on the T2 diet, using a Duncan's Multiple Range Test. The increased proportion of groundnut haulm in T1 likely contributed to the enhanced crude protein and nitrogen-free extract intake, supporting improved performance outcomes. This study highlighted the potential of a higher groundnut haulm ratio in optimizing feed utilization and growth in small ruminants, offering a viable nutritional strategy for regions with seasonal feed shortages.

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INTRODUCTION:

Small ruminants form an important economic and ecological niche in Nigeria's livestock systems. They are an integral and vital component of animal production patterns in most rural communities. There are four prominent breeds of sheep namely; Balami, Uda, Yankasa and West African Dwarf breeds of sheep. Goats are also widely kept, with notable breeds including the Red Sokoto, West African Dwarf, and Sahelian goat, the latter being more common in Northern Nigeria despite not being indigenous (FMARD, 2020). The adaptability of these ruminants to varied climatic conditions and their relatively low management requirements make them suitable for smallholder farmers, especially in semi-arid regions (Leite *et al.,* 2021).

In Nigeria, most of the farming population consists of rural or peri-urban dwellers engaged in integrated crop and livestock farming. The country has the largest population of small ruminants in Africa, with 73.8 million goats and 42.1 million sheep, mostly owned by smallholder farmers. These animals serve as an important income source, supporting family needs (Henry et al., 2023; CSIRO, 2021). The economic importance of small ruminants extends beyond income generation; they are also crucial for cultural practices, food security, and nutrient cycling in farming systems (Sasu *et al.,* 2023).

Sheep are particularly vital as they reproduce quickly and can be converted to cash to meet financial needs such as agricultural inputs, school fees, and other expenses. They represent assets that require low initial investment and yield quick returns due to rapid reproduction rates (Amankwah *et al.,* 2012). In addition, small ruminants play a role in household resilience,

providing a financial buffer during times of crop failure or economic hardship (McPeak & Doss, 2006).

Groundnut haulms are more palatable and have higher protein than cereal Stover, which are typically low in nitrogen, high in fibre, and have poor digestibility. These characteristics made cereal stovers less valuable nutritionally, leading to their use as supplementary feeds (Singh *et al.,* 2011; Richard *et al.,* 2017). In male sheep, Prasad *et al.* (2010) reported an average daily voluntary feed intake of more than 4% of live body weight, which is considered high and is generally only observed in lactating animals (Forbes, 1986; Richard *et al.,* 2017). The use of groundnut haulms and *Digitaria smutsii* in Yankasa sheep production can improve feed resource availability, particularly in areas with limited grazing land or seasonal feed availability. These feed options are essential for sustainable livestock production, especially in the context of climate change, which increasingly affects grazing lands and feed availability in semi-arid regions (McCollum *et al.,* 2017). Proper management of these feed resources is crucial to ensure adequate nutrition without compromising animal health or productivity.

Feed insufficiency year-round remains a major issue in Nigerian ruminant production, worsened by high cost of conventional concentrates during the dry season. Animals on low- quality roughages exhibits decreased feed intake, weight loss, and increased susceptibility to health risk ultimately reducing productivity (GLSR, 2010). Small holder farmers often cannot afford pasture establishment, relying instead on natural pastures and agro-industrial by-products (Devendra and Leng, 2011). Exploring low-cost, high-quality forage alternatives is crucial to reduce feeding costs for smallholder farmers (Philip *et al.,* 2019).

Ensuring adequate nutrition all year-round can significantly enhance productivity, particularly in addressing the challenges of weight loss, low birth weights, and decreased milk production during the dry season. In the tropics, the primary limitation for livestock production is the lack of high-quality forage throughout the year (Ogunbosoye and Babayemi, 2010; Okafor *et al.,* 2021). Sources of cheaper alternative forages of high quality for ruminants have been a subject of research in recent years (Alan *et al.,* 2013), especially for farmers in the tropics. This seasonal variability often leads to undernutrition and stunted growth in small ruminants, making nutritional interventions essential for productivity improvement (Talukdar *et al.,* 2022).

Groundnut haulms, when used as a supplement to grass-based diets, can improve dry matter intake, nutrient digestibility, nitrogen utilization and growth rates in rams. Guinea grass is widely available along riversides in Northern Nigeria during the dry season, and combining it with forage legume such as groundnut haulms may help alleviate feed scarcity (Mbahi *et al.,* 2016). Such supplementation strategies are gaining attention as sustainable options for enhancing livestock production in resource-limited settings (Mamphogoro *et al.*, 2024).

The demand for easily accessible and nutritionally rich feeds for small ruminants is critical to promote livestock farming, particularly for smallholder farmers. This study aims to support both prospective and current small ruminant farmers by developing a diet that combines high-nutrient groundnut haulms with lower-nutrient grass, providing an affordable, year-round feed resource for both rural and urban areas.

MATERIALS AND METHODS

Site of the Study

This study was conducted at the Teaching and Research Livestock Farm of the Department of Animal Science, Faculty of Agriculture, Ahmadu Bello University, Zaria, Nigeria. Zaria is located in the Northern Guinea Savannah ecological zone of Nigeria and lies on Latitude 11^0 12^0N and Longitude 7^0 37^0E at an altitude of about 640 m above sea level. The area fall within the northern-guinea savannah zone of Nigeria, having an annual rainfall of 1100mm. the maximum temperature varies from 26^0C to 32^0C depending on the season (IAR, 2021). The climate of this region is ideal for small ruminant research as it closely simulates the environmental conditions experienced by pastoralists in Northern Nigeria, enhancing the study's applicability to local agricultural practices (CSIRO 2020).

Source of the experimental materials

Groundnut haulms (Arachis hypogaea L.) were purchased from local communities market in Giwa Local Government Area of Kaduna State and the *Digitaria smutsii* (woolly finger grass) hay were source from National Animal Production Research Institute (NAPRI). The quality and freshness of these feed components were verified prior to procurement to ensure consistency in nutritional composition throughout the experiment. Additional concentrate diet ingredients, including maize offal, brewers' dry grains (BDG), rice offal, bone meal, ruminant premix and common salt, were sourced from Labar's Feed Mill. A preliminary nutrient analysis was conducted on each feed ingredient to confirm alignment with prior studies on their nutritional values (Adewuyi, 2021).

Processing of the experimental diets

All forage samples were subjected to size reduction using hammer miller of the Department of Agricultural Engineering and Bio-Resources, Ahmadu Bello University Zaria. For size reduction to enhance mixing and also to avoid selective feed by the experimental animals while the concentrate diet formulated and mixed using floor mixing method in the animal science research farm Ahmadu Bello University, Zaria. This process improved feed homogeneity and prevented selective feeding among the experimental animals. The concentrate diet was formulated and mixed using a floor-mixing method to ensure even distribution of nutrients, as recommended for small ruminant feeding trials (Ezieshi and Olomu, 2007).

Management of experimental animals

The performance trial was conducted using six (6) Yankasa yearling rams of between 9-12 months of age and weighing between 13.5 - 20.5 kg. To minimize health risks, animals underwent a pre-experimental health check and received Ivomec® (0.5 ml/25 kg body weight, subcutaneously) for ectoparasite control, Oxytetracycline LA 20% (1.0 ml/10 kg body weight, intramuscularly) for bacterial infection prevention, and Albendazole® 10% solution in drinking water for deworming. This health regimen was based on standard protocols to ensure optimal health during the trial (Osuji *et al.,* 1993). After treatment, animals were given a one-week adaptation period to acclimate to their environment and the experimental diets, during which they were provided clean water *ad libitum.*

Experimental design and treatments

The study followed a Completely Randomized Design (CRD), with six Yankasa rams randomly assigned to two dietary treatments, each consisting of three animals (replicates). The dietary treatments were as follows:

Treatment 1 (T1): 25% *Digitaria smutsii* and 75% groundnut haulm.

Treatment 2 (T2): 50% *Digitaria smutsii* and 50% groundnut haulm.

The concentrate feed, formulated with the ingredients listed in Table 1, was provided at a rate of 1% of the animals' body weight. In comparison, the forage mixtures were offered at 2% of body weight throughout the 90days experimental period. The forage and concentrate intake rates were selected to meet maintenance and moderate growth requirements, as established by the National Research Council (NRC, 2007).

Table 1: Ingredient composition of the Concentrate diet

Ingredient	Quantity (Kg)
Maize offal	62.02
BDG	25.98
Rice offal	10.00
Bone meal	1.00
Salt	0.75
Ruminant pre-mixed	0.25
Total	100
Crude protein	10.30
Metabolizable energy (ME/kgDM)	11.623

Digestibility study

At the end of the feeding trial, all the animals were weighed and transferred to individual metabolism crates fitted with facilities for separate collection of voided faeces and urine. Experimental diets fed were the same as those used in the feeding trial. An adjustment period of 7 days was allowed for the animals to adjust to the condition of the metabolism crates before the collection of faecal and urine samples which lasted for 5 days. Faeces voided daily were collected separately from each animal and were dried, weighed, thoroughly mixed and sub-sampled for laboratory analysis as reported by Osuji *et al.* (1993). Nitrogen loss from urine was prevented by introducing the urine into a well-labelled collection bottle containing 5 ml of 0.1 Normal Sulphuric acid (H_2SO_4) to trap the ammonia and stored in a refrigerator at –4°C for laboratory analysis. Apparent nutrient digestibility of the diets was calculated using the formula described by Osuji et al. (1993).

$$\text{Apparent digestibility} = \frac{\text{nutrient in feed} - \text{nutrient in faeces}}{\text{Nutrient in feed}}$$

Growth performance

The experiment commenced with the weighing of animals to obtain their initial body weight. Subsequently, animals were weighed at two-week intervals to determine live weight gain. The total live weight gain (TLWG) was calculated as the difference between the final weight and initial weight.

Experimental rams were fed a concentrate diet at 1% of their body weight in the morning (7:00 am) and a basal diet consisting of Groundnut haulm and *Digitaria smutsii* was fed at 2 % of their body weight in the evening (4:00 pm). The leftovers (ort) were weighed the next morning. Daily feed intake was calculated as the difference between the feed offered and leftovers. Clean drinking water was provided to the animals ad libitum. A second water drinker was placed in the centre of the pen to measure water evaporation. Daily water intake for each animal was measured and recorded.

Statistical analysis

All data collected were subjected to One-Way Analysis of Variance (ANOVA) using the General Linear Model Procedure (GLM) of Statistical Analysis System (SAS, 2002). Significant means were compared using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSIONS:

Chemical composition of Feed ingredients:

Table 2 presents the chemical composition of the experimental diets, groundnut haulm, Digitaria smutsii (woolly finger grass) hay, and concentrate diet. The proximate composition of groundnut haulms used in this experiment indicated a dry matter content of 93.68%, closely aligning with values reported by Adewuyi (2021), who found a range of 93.08 - 93.44%. The variation in crude protein could be attributed to differences in soil fertility and environmental factors affecting groundnut growth, as suggested by Richardson *et al.* (2017). The crude fibre (CF) content of 25.21% was marginally higher than the range of 25.04-25.40% reported in Adewuyi's (2021) work. Additionally, the oil, ash, and nitrogen-free extract (NFE) values were recorded as 1.05%, 5.00%, and 59.39%, respectively. The chemical composition of Digitariasmutsii hay revealed DM 93.68%, which is consistent with previous findings by Yashim (2015), who reported 94.01%, Madziga *et al.* (2022), who found 94.63%. Lakpini et al (2015) also reported a similar DM content of 94.53%. The crude protein of 7.12% of Digitaria smutsii hay was larger than 5.36% reported by Yashim (2015), 5.76% reported by Madziga *et al.* (2022) and also 5.36% obtained by Lakpini *et al*. (2015). Such differences in protein content can be linked to variations in harvest timing and preservation methods, as highlighted by Katosh (2022), which affect the nutrient profile of forage. The crude fibre 29.83% observed in the experiment is slightly smaller than 30.87% reported by Yashim (2015) but largely smaller than 68.89% reported by Madziga *et al.* (2022). The oil, ash and nitrogen free extract of Digitariasmutsii hay were observed to be 1.53, 5.56 and 55.96 respectively.

The proximate composition of concentrate diet was 92.48% DM, 10.30% CP, 4.21%CF, 3.11% oil, 9.65% ash, and 72. 73% NFE. This concentrate composition supports the nutrient requirements for moderate growth in ruminants, providing a balanced source of energy and protein as indicated in previous studies on concentrate diets (NRC, 2007).

Table 2: Proximate compositions of feed ingredients of the experimental diet fed to Growing Yankasa rams.

Parameter	Digitaria smutsii	Groundnut haulms	Concentrates
Dry matter	93.68	94.65	92.56
Crude protein	7.12	9.75	10.30
Crude fibre	29.83	25.21	4.21
Oil	1.53	1.05	3.11
Ash	5.56	5	9.65
Nitrogen free extract	55.96	59.39	72.73

Proximate composition of the experimental diet containing varying ratio of Groundnut haulms and Wooly finger grass (*Digitaria smutsii*) hay.

Table 3 shows the proximate chemical composition of the feed mixtures and concentrate fed to experimental rams. The diet with 50% groundnut haulm and 50% *Digitaria smutsii* hay (T2) exhibited the highest DM content at 95.67%, followed by the diet with 75% groundnut haulm and 25% *Digitaria smutsii* hay (T1). The CP content was marginally higher in T1 (9.75%) than in T2, which could indicate better protein availability in the T1 mixture. The CF content in the experimental diets was higher in T1 (25.29%) compared to T2, aligning with findings that suggest groundnut haulm as a significant source of fibre (Mbahi *et al.,* 2016). The ash content was slightly higher in T2, whereas the oil and NFE contents were recorded as 0.9% and 58.35% in T1, both higher than in T2.

The dry matter intake (DMI) of the experimental rams ranged from 480.60 to 499 g/day, with the highest ($P<0.05$) intake observed in animals fed a diet of 75% groundnut haulm and 25% *Digitaria*

smutsii hay. This higher intake suggests that the 75% groundnut haulm mixture was more palatable and acceptable to the rams, potentially due to its favourable taste and texture, as indicated by palatability studies in similar forages (Buxton *et al.,* 1995).

Table 3: Proximate composition of the experimental diet containing varying ratio of Groundnut haulms and Wooly finger grass (*Digitaria smutsii*) hay.

	Groundnut haulms	*Digitaria smutsii* hay	
Parameters	75:25 (T_1)	50:50 (T_2)	Concentrate diet
Dry matter	94.56	95.67	92.48
Crude protein	9.75	9.23	10.30
Crude fibre	25.29	26.01	4.21
Oil	0.96	0.79	3.11
Ash	5.65	6.13	9.65
Nitrogen free extract	58.35	57.84	72.73

Growth performance of Yankasa rams fed varying rations of Groundnut haulms and *Digitaria smutsii* (wooly finger grass) hay

The growth performance data for Yankasa yearling rams fed varying ratios of groundnut haulm and D*igitaria smutsii* hay, supplemented with concentrate, are shown in Table 4.

Total live weight gain and daily weight gain were significantly higher (P<0.05) in animals fed the 75% groundnut haulm and 25% *Digitaria smutsii* hay diet, with values of 5.83 kg and 64.77 g, respectively. This was in contrast to the 4.0 kg total live weight gain and 44.44 g daily weight gain observed in animals receiving the 50% groundnut haulms and 50% *Digitaria smutsii* hay mixture. The improved weight gain in rams fed the 75% groundnut haulm diet may be attributed to the increased crude protein and nitrogen-free extract (NFE) intake from this treatment, as higher protein levels are known to enhance growth in small ruminants (El-Nomeary *et al.,* 2021).

The feed conversion ratio (FCR) varied significantly (P<0.05) across treatments, ranging from 7.71 in animals on the 75% groundnut haulm and 25% *Digitaria smutsii* hay diet to 10.81 in animals on the 50% groundnut haulm and 50% *Digitaria smutsii* hay diet. A lower FCR in the 75% groundnut haulms diet indicates more efficient feed-to-weight conversion, highlighting the superior utilization of this diet by the rams. This efficient conversion could be attributed to the higher palatability and protein content of the 75% groundnut haulm mixture, which likely enhanced digestibility and nutrient absorption (Adebisi *et al.,* 2015).

The findings suggest that increasing the proportion of groundnut haulm in the diet mixtures enhances growth performance, with the 75% groundnut haulm and 25% *Digitaria smutsii* hay mixture providing the best outcomes in terms of DMI, weight gain, and FCR. These results underscore the potential of groundnut haulm as a valuable feed component in optimizing small ruminant growth, particularly in regions where forage quality and availability vary seasonally (Mbahi *et al.,* 2016).

Table 4: Growth performance of Yankasa rams fed varying rations of Groundnut haulms and *Digitaria smutsii* (wooly finger grass) hay

Parameters	T1	T2	SEM
Initial weight (Kg)	16.00	15.17	0.95
Final weight (Kg)	21.83	19.17	1.51
Total weight gain (Kg)	5.83[a]	4.00[b]	0.72
Average Daily Weight Gain (g/day)	64.77[a]	44.44[b]	8.00
Total feed intake (kg)	44.96	43.25	3.69
Daily feed intake (g/d)	499.50	480.60	40.97
FCR (kgTFI/kg gain)	7.71[a]	10.81[b]	1.19

ab=means with different superscript along the rows shows significant difference (P<0.05), SEM= Standard Error of Mean, FCR=feed conversion

Apparent Nutrient Digestibility of Yankasa ram fed the Experimental Diets.

The apparent nutrient digestibility results for Yankasa rams fed the experimental diets are presented in Table 5 below. A significant difference (P<0.05) was observed in dry matter (DM) digestibility across treatments, with the highest DM digestibility recorded in T1 (86.45%), followed by T2 (81.66%). This higher DM digestibility in T1 may be attributed to the

increased proportion of groundnut haulm, which is known for its favourable nutrient profile (Adeyemi *et al.,* 2021).

Crude protein digestibility (CPD) did not show a significant difference (P>0.05) across treatments, although there was an increase observed with T1 showing the highest CPD (87.05%) and T2 the lowest (84.40%). The similarity in CPD values across treatments suggests that both diet mixtures provided sufficient protein quality for effective digestion (Ogunbiyi & Alade, 2019).

Crude fibre digestibility (CFD) also did not differ significantly (P>0.05) between treatments; however, T1 had a slightly higher CFD at 78.98% compared to T2 at 73.71%. This trend aligns with findings by Bala *et al.* (2018), who noted that higher proportions of groundnut haulm enhance fibre digestibility. Ether extract digestibility (EED) was also not significantly different (P>0.05) between treatments, with T1 exhibiting a slightly higher EED (75.37%) compared to T2 (73.91%). The use of groundnut haulm in the diets likely contributed to the high digestibility of ether extract observed in both treatments.

A significant difference (P<0.05) was observed in nitrogen-free extract (NFE) digestibility, with T1 achieving the highest NFE digestibility (75.39%) and T2 the lowest (72.42%). Neutral detergent fibre digestibility (NDFD) did not differ significantly (P>0.05) between treatments, although there was a slight increase in T1 (71.69%) compared to T2 (71.33%). These values indicate that the diets provided adequate fibre that supported efficient nutrient absorption (Ibrahim *et al.,* 2020).

Finally, there was a significant difference (P<0.05) in acid detergent fibre digestibility (ADFD) between treatments. T1 showed the highest ADFD (70.74%), while T2 recorded a lower value (67.26%). This difference in ADFD could be linked to the fibre composition of groundnut haulms, which has been associated with improved digestibility in small ruminants (Lawal *et al.,* 2022).

Table 5: Apparent Nutrient Digestibility of varying rations of Groundnut haulms and *Digitaria smutsii* (wooly finger grass) hay fed to Yankasa Rams

Parameters	T1	T2	SEM
Dry Matter	86.45[a]	81.66[b]	0.72
Crude Protein	87.05	84.40	2.09
Crude Fibre	78.98	73.71	4.95
Ether Extract	75.37	73.91	1.37
Nitrogen Free Extract	75.39[a]	72.42[b]	1.06
Neutral Detergent Fibre	71.69	71.33	0.63
Acid Detergent Fibre	70.74[a]	67.26[b]	1.27

ab=means with different superscript along the rows shows significant difference (P<0.05), SEM= Standard Error of Mean

Nitrogen utilization in red Sokoto goats fed diets containing varying ratio of Groundnut haulms and *Digitaria smutsii* hay.

Table 6 presented the nitrogen utilization results for growing Yankasa rams fed diets with different ratios of groundnut haulms and *Digitaria smutsii* (woolly finger grass) hay. The analysis revealed no significant difference (P>0.05) among the treatments in terms of total nitrogen output. Rams fed the diet containing 75% groundnut haulm and 25% Digitariasmutsii hay (T1) showed the highest nitrogen losses in both urine and faeces, with values of 4.45 and 0.56 g/day, respectively, compared to the lower nitrogen losses in urine and faeces recorded in T2 (4.42 and 0.54 g/day).

A significant difference (P<0.05) was observed between T1 and T2 in terms of nitrogen absorbed, with T1 showing a higher absorption rate of 10.91 g/day compared to 7.88 g/day for T2. This higher nitrogen absorption in T1 can be attributed to the greater crude protein intake provided by the 75% groundnut haulm ratio, enhancing protein availability for absorption (Adewuyi et al., 2020). Nitrogen retention, which is a key indicator of protein nutrition status in ruminant livestock (Abdu et al., 2012), also varied significantly between treatments. Rams on T1 demonstrated the highest nitrogen retention (10.35 g/day), while T2 showed a significantly lower retention of 7.88 g/day.

The superior nitrogen retention observed in T1 is likely due to the high groundnut haulm content, which increased the dietary crude protein intake for animals on this treatment. This finding aligns with previous studies that reported improved nitrogen retention and protein digestibility with higher dietary crude protein levels (Sahlu *et al.,* 1993; Aye & Adegun, 2010).

The higher nitrogen absorption and retention in T1 underscore the effectiveness of a higher groundnut haulm ratio in improving protein utilization, making it a valuable dietary

component for ruminants in regions where protein availability fluctuates seasonally.

Table 6: Nitrogen balance of Yankasa rams fed varying rations of Groundnut haulms and *Digitaria smutsii* (wooly finger grass) hay.

Parameters	T1	T2	SEM
Nitrogen intake	15.34[a]	12.87[b]	0.57
Faecal Nitrogen	4.45	4.42	0.33
Urinary Nitrogen	0.56	0.54	0.02
Total Nitrogen Loss	4.99	4.98	0.35
Nitrogen absorbed	10.91[a]	8.42[b]	0.48
Nitrogen retained	10.35[a]	7.88[b]	0.47

ab=means with different superscript along the rows shows significant difference (P<0.05), SEM= Standard Error of Mean

CONCLUSION

The study found that Yankasa rams fed a diet with 75% groundnut haulms and 25% *Digitaria smutsii* hay, along with a concentrate supplement, showed better growth performance, nutrient digestibility, and nitrogen retention compared to those fed a 50:50 ratio of the two hays.

RECOMMENDATION

It is here by recommended that Treatment 1 diet supplemented with concentrate diet fed to Yankasa ram is adequate to promote feed utilization efficiency, optimum weight gain, digestibility and nitrogen balance.

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