

Red Sokoto goats performed well with high nutrient digestibility and nitrogen retention when fed with two varieties of cowpea haulm

*¹Bala, A. G., ²Hassan, M. R., ³Amodu, J. T., ³Tanko, R. J., ¹Hassan, A. H., ¹Bature, M. S.,
¹Mohammed, A and ¹Alhabib, I. K.

¹Division of Agricultural Colleges, College of Agriculture and Animal Science, Ahmadu Bello University, Mando, Kaduna State, Nigeria.

²National Animal Production Research Institute,
Ahmadu Bello University, Shika-Nigeria.



*Corresponding author: balaaminu@gmail.com; agbala@abu.edu.ng;

+2348068928548

Abstract

A study was carried out to investigate the effect of feeding two varieties of cowpea haulm on growth performance, nutrient digestibility and nitrogen balance in Red Sokoto bucks. The experiment consisted of 15 Red Sokoto bucks of average weight of 10kg, which were balanced for weight and randomly assigned to three dietary treatments with five bucks per treatment in a complete randomize design. The three treatment diets consisted of *Brachairia decumbens* hay as basal diet and concentrate diets which were supplemented with cowpea haulms at 0% (Control), 10% (SAMPEA 14) and 10% (SAMPEA 15). The study lasted for 90 days. Total dry matter intake (TDMI, g/day), total weight gain (TWG, kg), faecal (unit) and urine (unit) outputs were recorded. Results indicated that the TDMI were different ($P < 0.05$) with higher intake (237.64 g/day) in bucks fed control diet, followed by 223.00 g/day 10% SAMPEA 15 and 10% haulm of Sampea 14 (206.49g/day) in the concentrate. The TWG and average daily weight gain increased by 59.77% and 59.76%, respectively with respect to 10% SAMPEA 14 haulm inclusion compared to the control diet. The digestibilities of dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE) and nitrogen free extract (NFE) were higher ($P < 0.05$) in bucks fed diet constaining 10% SAMPEA 14 inclusion level compared to the treatment diets. The quantity of N retained by the bucks was higher ($P < 0.05$) with the inclusion of 10% of SAMPEA 14 (3.79 g/day) compared to those fed 10% SAMPEA 15 (1.18 g/day) and the control diet (0.68 g/day). It is concluded that farmers should include 10% SAMPEA 14 in concentrate diet of Red Sokoto bucks for optimum performance under smallholder production system.

Keywords: Cowpea, Digestibility, Performance, Varieties, Haulm

Les chèvres Rouges Sokoto ont obtenu de bons résultats avec une digestibilité élevée des nutriments et une rétention d'azote lorsqu'elles sont nourries avec deux variétés des haulms de niébé



Résumé

Une étude a été menée pour étudier l'effet de l'alimentation de deux variétés des haulms de niébé sur la performance de croissance, la digestibilité des nutriments et l'équilibre azoté chez les mâles Red Sokoto. L'expérience s'est composée de 15 bucks rouges de Sokoto de poids moyen de 10kg, qui ont été équilibrés pour le poids et aléatoirement assignés à trois traitements diététiques avec cinq dollars par traitement dans une conception randomize complète. Les trois régimes de traitement se sont composés de *Brachairiadecumbens* hay comme régime basal et régimes concentrés qui ont été complétés avec des haulms de niébé à 0% (contrôle), 10% (SAMPEA 14) et 10% (SAMPEA 15). L'étude a duré 90 jours. La

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consommation totale de matière sèche (TDMI, g/day), le gain de poids total (TWG, kg), les sorties fécales (unitaires) et urinaires (unitaires) ont été enregistrées. Les résultats ont indiqué que le TDMI était différent ($P < 0,05$) avec une consommation plus élevée (237,64 g/jour) dans le régime de contrôle alimenté par les mâles, suivi de 223,00 g/jour 10% SAMPEA 15 et 10% de transport de Sampea 14 (206,49 g/jour) dans le concentré. Le TWG et le gain quotidien moyen de poids ont augmenté de 59,77 % et de 59,76 %, respectivement en ce qui concerne l'inclusion de 10 % de SAMPEA 14 haulms par rapport au régime de contrôle. Les digestibilités de la matière sèche (le 'DM'), des protéines brutes (le 'CP'), des fibres brutes (le 'CF'), de l'extrait d'éther (le 'EE') et de l'extrait sans azote (le 'NFE') étaient plus élevées ($P < 0,05$) chez les mâles nourris à l'alimentation constaining 10% SAMPEA 14 niveau d'inclusion par rapport aux régimes de traitement. La quantité de N retenue par les mâles était plus élevée ($P < 0,05$) avec l'inclusion de 10% de SAMPEA 14 (3,79 g/jour) par rapport à celles nourries 10% SAMPEA 15 (1,18 g/jour) et le régime de contrôle (0,68 g/jour). Il est conclu que les agriculteurs devraient inclure 10% SAMPEA 14 dans le régime concentré de bucks Red Sokoto pour une performance optimale dans le cadre du système de production des petits exploitants.

Mots-clés: Cowpea, Digestibility, Performance, Variétés, Haulm

Introduction

Livestock is an important component in the agricultural production system, and plays a crucial role in the economy (Hasan *et al.*, 2010). The role of livestock in providing protein is essential in human nutrition and it is increasingly being recognized. This necessitates immediate concern in development programs for improvement of livestock productivity, through improved nutrition. However, feed constraint is the most important limiting factor in livestock production (Aregawi *et al.*, 2013). In Nigeria, the dietary energy (2.4 Mcal/kgDM) and protein (5.6%) obtained from rangelands, particularly in the dry season are generally too low to meet the nutrient requirements of ruminant livestock for maintenance (2.7 Mcal/kgDM and 11.6%CP) and production (2.9 Mcal/kgDM and 16.2%CP) (NRC, 1985). Animal productivity could be increased by the introduction of low cost technologies such as feeding systems that are simple, consistently practical and within the limits of the farmer's resources (Douthwaite, 2002). One of such feeding systems is the use of cowpea haulm that supplies protein

in fodder for livestock (FAO, 2000). Coker *et al.* (2014) emphasized the importance of cowpea forage as animal feed mainly during the dry season. Cowpea haulm addition improves nutrient supply and growth of livestock over the use of low quality forages alone (Antwi *et al.*, 2014). Previous studies by Anele *et al.* (2010) indicated that cowpea (*Vigna unguiculata* L. Walp) haulm can be utilized as a supplement for ruminants in the dry season. Similarly, Osafo *et al.* (2013) observed improved intake and digestibility of poor quality fodder with supplementation of cowpea haulm. The incorporation of promising legumes fodder such as cowpea haulms for livestock production will help to overcome the feed shortages. The Institute for Agricultural Research (IAR), Zaria with other collaborating institutes has bred and released new cowpea varieties overtime with focus mostly on higher grain yield while forage yield and quality is rarely a priority (Pande *et al.*, 2003). SAMPEA 14 and 15 varieties of cowpea are high yielding, striga resistant and tolerant to heat and drought with maturity period of 70-78 days (IAR, 2015). Considering the good qualities of this legume crop in the tropical

savanna, the knowledge of its nutritive value will be very important. This study was therefore, designed to investigate the effect of feeding two cowpea haulm varieties on growth performance, nutrient digestibility and nitrogen balance in Red Sokoto bucks.

Materials and methods

Experimental site

The feeding trial and nutrient digestibility study was conducted at the Sheep and Goat Unit of College of Agriculture and Animal Science, Division of Agricultural colleges, Ahmadu Bello University, Mando-Road, Kaduna State. The farm is located at an elevation of 676m and latitude of 10°35'N and longitude of 7°25'E (GPS, 2018).

Sources of experimental materials

Cowpea haulms (SAMPEA 14 and 15 varieties), *Brachiaria decumbens* hay (signal grass) and Red Sokoto bucks were obtained from Pasture Unit and Sheep and Goat Unit of College of Agriculture and Animal Science, Ahmadu Bello University, Mando-Kaduna State, Nigeria.

Experimental design and animal's management

Fifteen experimental Red Sokoto bucks of an average weight of 10kg were used for the experiment. The animals were balanced for initial weights before they were allocated to three treatment diets with five bucks per treatment in a Complete Randomize Design (CRD). The bucks were de-wormed with *Albendazole* by oral administration against internal parasites, *Rhodiacides* solution was sprayed on the animals using knapsack sprayer against external parasites. The animals were allowed 14 days to adjust to feed and confinement before the actual start of the experiment that lasted for 90 days.

Experimental feeds, treatments and feeding trial

The three treatment diets consisted of *Brachiaria decumbens* hay as basal diet. *Concentrate diets* (14% CP) was

supplemented with cowpea haulms at 0% (Control), 10% (SAMPEA 14) and 10% (SAMPEA 15). The supplemented concentrate consisted of other ingredients such as maize offal, cottonseed cake, bone meal and salt. The basal forage diet was fed *ad libitum* after feeding the supplements in order to ensure maximum supplement consumption at the rate of 1% of body weight per head per day in the morning (08:00 am). Water and mineral salt lick were provided *ad libitum* for the period of 90 days. All bucks were weighed at the beginning of the experiment and fortnightly thereafter, to determine the liveweight changes and to adjust the amount of feed offered in order to maintain the pre-determined level of 3% feeding of the animal's body weight for the periods in confinement.

Measurement of growth performance

Weekly feed intake (g/day), weight gain (kg) and feed conversion ratio were determined. Feed intake was obtained by the difference between supplied feed and feed left in each pen. Weight gain was determined as the difference between the weight of the animal at the beginning of the experiment and subsequently at two weeks intervals. Feed conversion ratio was obtained as the ratio of feed intake and weight gain within each week for each pen.

Digestibility and nitrogen retention study

At the end of the feeding trial, three animals were randomly selected from each of the three treatment groups and housed in metabolic crates for total faecal and urine collection as described by *Osuji et al. (1993)*. The bucks were maintained on the same treatment diets used in the feeding trial and were allowed 14 days adjustment period before the start of the digestibility studies. Each morning (8.000am), feed left over, faecal output and urine output were collected and weighed for seven days. The daily total faecal output collected from each

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buck was weighed, bulked and sub-sample was taken for analysis. The daily urine output from each buck was collected into a plastic container containing 10mL of 0.1M H₂SO₄ placed under the metabolic crates to prevent nitrogen loss by volatilization. Urine collected was bulked and about 10% of the total urine output was subsampled for each buck and stored in the refrigerator pending nitrogen determination.

Laboratory analysis

Feed samples offered, feed left over and faecal output were analysed for chemical compositions, urine samples were analyzed for nitrogen using the method described by AOAC (2005) at the central laboratory of

National Animal Production Research Institute, Shika-Kaduna. Metabolizable Energy (ME) of the diet was estimated using the equation of Alderman (1985):

$$ME \text{ (MJ/kg DM)} = 11.78 + 0.00654CP + (0.000665EE)^2 - CF (0.00414EE) - 0.0118A$$

Statistical analysis

Data collected were analysed using Analysis of Variance (ANOVA) by General Linear Model procedures (SAS, 2003). Data on rumen metabolites and weight changes were analyzed using repeated measures ANOVA and trend analysis. Treatment means were separated using Dunnet's Test.

Results

Table 1: Ingredient composition of concentrates containing cowpea haulms supplements

Parameter	CONTROL (0%)	cowpea haulm variety	
		SAMPEA 14 (10%)	SAMPEA 15 (10%)
Cowpea haulm	0.00	10.00	10.00
Maize offal	35.46	27.33	31.08
Rice offal	30.00	30.00	30.00
Cottonseed cake	32.54	30.67	26.92
Bone meal	1.50	1.50	1.50
Common salt	0.50	0.50	0.50
Total	100.00	100.00	100.00
Cost/ kg feed (₦)	72.29	61.76	58.22
Calculated analysis:			
Crude protein (%)	14.46	14.19	14.41
M.E (Kcal/kg)	3090	3059	3051

ME = Metabolizable energy, ° = Naira

Table 2: Chemical composition of two varieties of cowpea haulm and *Brachiaria decumbens*

Parameters (%)	cowpea haulm variety		<i>Brachiaria decumbens</i> hay
	SAMPEA 14	SAMPEA 15	
Dry matter	89.66	88.52	87.39
Crude protein	16.11	15.55	7.31
Crude fibre	27.88	28.50	28.8
Ether extract	1.83	1.55	0.93
Nitrogen Free Extract	47.34	51.48	42.18
Ash	5.28	5.88	5.14
Neutral detergent fibre	59.97	61.4	62.06
Acid detergent fibre	34.03	35.3	30.76
Lignin	17.18	18.4	7.21

The result presented in Table 3 showed the effect of feeding two varieties of cowpea haulm on growth performance of Red Sokoto bucks fed *Brachiaria decumbens* hay as basal diet. Treatments diet with 10% SAMPEA 14 haulm inclusion resulted in significantly higher ($P<0.05$) final weight gain (12.31kg) compared to the control (10.65kg) and 10% SAMPEA 15 (10.94kg) in the concentrate. Treatments diet with 10% SAMPEA 14 resulted in significantly higher ($P<0.05$) total weight gain (2.61kg) compared to the control (1.05kg) and 10% SAMPEA 15(1.09kg) in the concentrate which were similar. However, treatments diet with 10% SAMPEA 14 resulted in higher ($P<0.05$) average daily weight gain (29.00g) compared to the control (11.67g) and 10% SAMPEA 15 (12.11g) treatment. Total weight gain and average daily weight gain increased by 59.77% and 59.76%, respectively with respect to 10% SAMPEA 14 haulm inclusion compared to the control diet. Bucks fed 10% SAMPEA 14 in the concentrate gained statistically higher ($P<0.05$) feed conversion ratio (7.12) compared with the control diet (20.36) and 10% SAMPEA 15 (18.41) treatment diet. Similarly, bucks fed the control diet had the highest supplement and *Brachiaria decumbens* hay intake of 207.97 and 29.67g/day, respectively compared to diets

with cowpea haulm varieties. The total dry matter intake was statistically different ($P<0.05$) with highest intake (237.64g/day) in bucks fed the control followed by 223.00g/day 10% Sampea 15 while 10% SAMPEA 14 in the supplement recorded the least (206.49g/day). The dry matter intake increased by 13.10% with respect to the control diet compared to 10% inclusion level of SAMPEA 14 cowpea haulm.

Table 4 shows the effect of feeding two cowpea haulm varieties on nutrient digestibility (%) in Red Sokoto bucks fed *Brachiaria decumbens* hay as basal diet result of nutrient digestibility study. There were significant ($P<0.05$) differences across the treatments in the entire digestibility coefficient. The result showed that the digestibilities of dry matter (DM), crude protein (CP), crude fibre (CF), ether extract (EE) and nitrogen free extract (NFE) were significantly higher ($P<0.05$) in bucks fed diet constantly with 10% SAMPEA 14 inclusion level compared to other treatment diet. Though, the DM, CP, EE and NFE digestibility of bucks fed 10% SAMPEA 15 diet were at par ($P>0.05$) with those fed on the control diet. However, bucks fed the control diet had higher ($P<0.05$) Ash digestibility (41.72%) compared to bucks fed 10% SAMPEA 14 (32.83%) and 10% SAMPEA 15 (24.94%) diets.

Table 3: The effect of feeding two cowpea haulm varieties on growth performance of Red Sokoto bucks fed *Brachiaria decumbens* hay as basal diet

Parameter	cowpea haulm variety			SEM	LOS
	CONTROL 0	SAMPEA 14 10	SAMPEA 15 (%) 10		
Body weight change (kg)					
Initial	9.60	9.70	9.85	1.12	NS
Final	10.65 ^b	12.31 ^a	10.94 ^{ab}	0.57	*
TWG	1.05 ^b	2.61 ^a	1.09 ^b	0.68	*
ADWG (g/d)	11.67 ^b	29.00 ^a	12.11 ^b	2.15	*
FCR	20.36 ^b	7.12 ^a	18.41 ^b	2.10	*
DM Intake (g/day)					
Concentrate	207.97 ^a	186.46 ^c	197.33 ^b	3.23	*
<i>B. ducumbens</i> hay	29.67 ^a	20.03 ^b	25.67 ^{ab}	1.26	*
TDMI	237.64 ^a	206.49 ^c	223.00 ^b	3.11	*

^{abc} Means with different superscripts along the row differed significantly ($P<0.05$). LOS = Level of significance
NS = Not significant ADWG = Average daily weight gain TWG = Total weight gain TDMI = Total dry matter intake,

FCR= feed conversion ratio SEM = Standard error of means

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Table 4: The effect of feeding two cowpea haulm varieties on nutrient digestibility in Red Sokoto bucks fed *Brachiaria decumbens* hay as basal diet

Nutrient Digestibility (%)	cowpea haulm variety			SEM	LOS
	CONTROL	SAMPEA 14	SAMPEA 15 (%)		
	0	10	10		
Dry matter	51.10 ^b	75.81 ^a	54.11 ^b	1.87	*
Crude protein	61.19 ^b	77.41 ^a	61.71 ^b	2.30	*
Crude fibre	63.22 ^c	86.08 ^a	72.87 ^b	1.31	*
Ether extract	26.62 ^b	39.17 ^a	27.57 ^b	2.49	*
Ash	41.72 ^a	32.83 ^b	24.94 ^c	3.03	*
Nitrogen free extract	60.06 ^b	84.41 ^a	67.34 ^b	1.98	*

^{abc} Means with different superscripts along the row differed significantly (P<0.05) SEM = Standard error of means LOS = Level of Significance

The effect of feeding two cowpea haulm varieties on nitrogen (N) balance in Red Sokoto bucks fed *Brachiaria decumbens* hay as basal diet is shown in Table 5. There were no significant (P<0.05) differences in all parameters measured, except for total N loss and N retained. Bucks on 10% SAMPEA 15 and the control diets,

had the highest (P<0.05) total N loss compared to 10% SAMPEA 14 diet. The quantity of N retained by the bucks was higher (P<0.05) with the inclusion of 10% of SAMPEA 14 (3.79 g/day) compared to those fed 10% SAMPEA 15 (1.18 g/day) and the control diet (0.68 g/day).

Table 5: The effect of feeding two cowpea haulm varieties on nitrogen balance in Red Sokoto bucks fed *Brachiaria decumbens* hay as basal diet

Nitrogen balance (g/day)	cowpea haulm variety			SEM	LOS
	CONTROL	SAMPEA 14	SAMPEA 15 (%)		
	0	10	10		
Nitrogen intake	5.07	6.43	5.46	0.68	NS
Faecal Nitrogen	3.45	2.13	3.46	0.72	NS
Urinary Nitrogen	0.94	0.51	0.81	0.45	NS
Total Nitrogen Loss	4.39 ^a	2.64 ^b	4.28 ^a	0.77	*
Nitrogen retained	0.67 ^b	3.79 ^a	1.18 ^b	0.62	*
Nitrogen absorbed	1.61	2.80	1.68	1.11	NS

^{abc} Means with different superscripts along the row differed significantly (P<0.05) LOS = Level of Significance

SEM = Standard Error of Mean

Discussion

Bucks fed SAMPEA 14 haulm variety in the supplement gained more weight on daily basis compared to the control treatment and SAMPEA 15 haulm variety in the supplement. The higher average daily weight gain of bucks fed diet containing 10% level of SAMPEA 14 cowpea haulm variety was most likely due to adequate energy and protein provided, which are critical for the growth of livestock. This can

be explained by the fact that the cowpea haulm varieties might have helped to increase the efficiency of utilization of roughages by the rumen microbes which resulted to improved weight gain in mature animals (Karikari and Blasus, 2009). Previous studies by Anele *et al.* (2010) indicated that cowpea haulm can be utilized as a supplement for ruminants in the dry season. The result of this study is in agreement with previous findings which

indicated that cowpea haulm in the diets of goats can improve live weight gain and nutrient utilization (Yashim *et al.* 2016; Tekle *et al.* 2018). Similarly, dry matter intake was highest in bucks fed the control diet compared to 10% SAMPEA haulm variety in the supplement. The low intake could be attributed to the nutrient supply of the cowpea haulms in the supplement, thereby satisfying the bucks' nutritional needs at lower intake. This is evidenced in the low feed conversion ratio observed in the two treatments containing Sampea haulm varieties compared to the control. Improve leguminous forages in diets of ruminant livestock help to improve nutrient supply and energy of the diet (Singh *et al.* 2010; Antwi *et al.*, 2014). This is in contrast to the works of Osafo *et al.* (2013); Nuwam (2015); Yashim *et al.* (2016) and Tekle *et al.* (2018) who reported that cowpea haulm supplementation in concentrate diet of goats improved dry matter intake. The difference could be attributed to the cowpea haulm varieties and level of inclusion in the diets.

The digestibility of dry matter, crude protein, crude fibre, ether extract and nitrogen free extract were found to increase with inclusion of cowpea forage. The most probable explanation for this phenomenon is that diet at 10% inclusion level of SAMPEA 14 might have resulted in high palatability, increased activity of rumen microorganisms for rapid fibre digestion in the rumen and better utilization of the nutrients by the bucks. The improvement in digestibilities of nutrients might be attributed to the quality of SAMPEA 14 cowpea forage which might have improved the digestibility of other poor quality roughages. The improvement in CP digestibility due to cowpea hay supplementation could be attributed to the high CP content of the legumes as argued by Umunna *et al.* (1995) and Murphy and Colucci (1999).

Nitrogen retention (N) is the major indicator for accessing the protein nutritional status of ruminant livestock (Abdu *et al.*, 2012). The N retained recorded in bucks fed 10% SAMPEA 14 inclusion levels is in agreement with the report of Yashim, (2016) that N depends on efficient digestibility of nutrients and or utilization. The low N retention for bucks in the control diet could be due to the inadequacy of the diet to maintain N equilibrium and, consequently, live-weight gain (Abule *et al.*, 1995). In the study, the significantly higher N retained and lower N loss in bucks fed 10% SAMPEA 14 inclusion levels cowpea forage indicated that, it might contain enough digestible nutrients to provide nutrient retention for better performance in Red Sokoto bucks. However, the better N retention in the diet supplemented with SAMPEA 14 cowpea haulm, could be due to a higher rumen degradable protein available which reduced the total N losses. Elseed *et al.* (2005) also, observed that supplementation of protein sources improved microbial N yield and N retention.

Conclusion

From this study, it can be concluded that 10% SAMPEA 14 in concentrate diet of Red Sokoto bucks improved growth, digestibility and nitrogen retention.

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