DIGESTIBILITY, PERFORMANCE AND BIO-ECONOMICS OF GROWING WEST AFRICAN DWARF GOATS FED DIETS CONTAINING GRADED LEVELS OF CASHEW NUT SHELL

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Abstract

Sixteen West African Dwarf goats were used to investigate the effect of cashew nut shell on performance and digestibility. They were randomly allotted to four dietary treatments of four goats each with T_1 receiving the control diet while T_2, T_3 and T_4 received diets containing 10 %, 20 % and 30 % levels of cashew nut shell inclusion, respectively. Each animal received 150 g of the supplement and 800 g of Pennisetum purpureum daily on cut and carry basis three hours later. The animals were weighed weekly throughout the 50 day period of the experiment. Feed intake, growth rate, bio-economics and digestibility were monitored. Daily dry matter intake decreased steadily from 407 g (T_1) to 337.74 g (T_4). The values decreased with increasing levels of cashew nut shell were significantly ($P<0.05$) different. Daily weight gain values increased steadily from 10.60 g/d (T_4) to 24.60 g/d (T_1). The values increased with increasing levels of cashew nut shell and were significantly ($P<0.05$) different. There was no significant ($P>0.05$) difference in daily forage intake. Feed conversion ratio improved significantly ($P<0.05$) from 31.36 (T_4) to 16.54 (T_1). The digestibility coefficients for DM, CP, CF, and EE all showed significant ($P<0.05$) differences in their values. However Nitrogen Free Extract digestibility decreased steadily from 66.00 (T_1) to 59.70 (T_4) but the values were not significantly ($P>0.05$) different. T_1 (0 % cashew nut shell) had the best digestibility values for the parameters considered. The cost of supplement decreased steadily with increasing level of cashew nut shell (from 194 ₦, T_1 to 60.16 ₦, T_4) and were significantly ($P<0.05$) different. Benefit/live weight gain decreased significantly ($P<0.05$) from 984 ₦, T_1 to 424 ₦, T_4. There were significant ($P<0.05$) differences in cost benefit ratio with 7.84 (T_3) having the highest. The results thus revealed that cashew nut shell can be included up to 20 % levels in rations of goats to improve the performance and digestibility as well as to lower feed cost.

Introduction

Studies have shown that there is a general dearth of protein supply especially of animal origin in the tropics (Okai *et al*., 2005). Animal protein is one of the most important components of human diet and its consumption varies from country to country (Okai *et al*., 2005). Rapid human population coupled with low protein intake constitutes a major problem facing developing countries. Perhaps as a result of the increasing population and dismal productivity of livestock in developing countries like Nigeria, the demand for protein of animal origin has far exceeded the supplies. Ani and Adiegwu (2005) suggested that a solution to the problem of inadequate consumption of animal products by an average Nigerian is to increase the level of animal production by intensifying the production of highly reproductive animals. Fanimo *et al*. (2004) reported that feed cost accounts for 65-70 % of the total cost of production in the intensive system of animal production. The situation is the result of competition between man and livestock for some feed and food ingredients. This competition is rigorous in developing countries, hence the urgent need to source for cheaply available feedstuff that meet requirements for growth and reproduction. Furthermore, in small ruminant production, energy and growth performance must be put into consideration as the primary purpose of goat production is to supply

meat. It is also very essential to device means of evaluating wastes from agro-industries and crop by products or residues for limiting nutrients, energy and nitrogen to provide growth and other needs for goat production especially in the dry season. In Nigeria, there exists a largely untapped potential for utilizing these products for feeding ruminants. Among these is cashew nut shell, a by-product obtained from the processing of cashew kernel. Cashew nut shell has significant value as a feed while lowering the cost of feed input (Fanimo, *et al*., 2004). Since ruminants are essentially recyclers, the use of cashew nut shell is particularly suited to ruminants that would ultimately produce high quality products (Schroeder, 1999) from the feeding of cashew nut shell that might otherwise be discarded as waste. However, the usage of cashew nut shell is limited due to poor understanding of its nutritional and economic value as well as their proper use in ruminant rations. So environmentally as well as economically, crop by-products will continue to become more important as ingredients in ruminant rations (Fanimo *et al.,* 2004). Ocheja *et al*. (2011a) reported the proximate and mineral composition of cashew nut shell to be 92.21 % dry matter, 5.00 % crude protein, 20.75 % crude fibre, 40.25 % ether extract, 1.09 % ash and 32.91 % nitrogen-free extract, 0.0156 % phosphorus, 0.0875 % potassium, 0.0756 % calcium, 0.0057 % sodium, 0.0123 % copper, 0.0097 % iron, 0.0029 % zinc, 0.0028 % nickel and 0.0024 % magnesium. Ocheja *et al*. (2011b) reported that some phyto-chemicals exist in cashew nut shell, they are: cyanide 0.009 %, flavenoid 1.1035 %, saponin 0.0556 %, tannin 0.17 %, alkaloid 1.60 % phytate 0.0418 %, oxalate 0.157 % and phenolic compounds 16.832 %. They also reported the pH of cashew nut shell to be 4.0

The objective of this study was to evaluate the effect of including cashew nut shell in diets for growing West African Dwarf goats on digestibility, growth performance and cost implications.

Materials and methods

The experiment was carried out at the sheep and goat unit of Kogi State University Livestock Teaching and Research Farm Anyigba. Sixteen growing male West African Dwarf goats were sourced from Anyigba and its environs. The goats were treated with procaine penicillin, oxytetracycline hydrochloride and ivomec to control both endo and ecto parasites. The goats were weighed and randomly allotted to four dietary treatments, T_1 (control), T_2 (10% cashew nut shell), T_3 (20% cashew nut shell) and T_4 (30% cashew nut shell) with each having four goats. Forage *(Pennisetum purpureum)* at 800g/day was fed to the animals and the supplement was given at 150g/goat/day in the morning three (3) hours before feeding the forage. Water was given to the goats *ad-libitum.* The experiment lasted for 50 days after an adjustment period of seven (7) days. At the beginning of the experiment, the goats were weighed and subsequently on a weekly basis. Data on feed intake and body weight gain were determined. Both values were used to determine the feed conversion ratio. Seven days to the end of the experiment, two animals from each treatment were selected and put in metabolic crates for faecal collection. The collected faeces were bulked for each treatment, oven dried and later analysed for their proximate composition and thereafter used in calculating the dry matter and nutrient digestibility co-efficients using the formular.

$$\frac{\text{Weight of feed consumed - weight of nutrients in the faeces}}{\text{Weight of feed consumed}} \times \frac{100}{1}$$

The cost of the supplement diets were calculated using the prevailing market prices of feedstuff at the time the experimental diet was conducted. The following were calculated.

i. Cost of supplement consumed= cost of supplement/Kg x total supplement intake

ii. Benefit/live weight gain= total weight gain x cost of a Kg of goat meat at N800 (Ocheja *et al*., 2011c)

iii. Cost benefit ratio= $\frac{\text{benefit/live weight gain}}{\text{cost of supplement consumed}}$

The proximate analysis of cashew nut shell, forage, experimental diets and faeces were determined according to the standard method of AOAC (2000). Data collected were subjected to a one-way analysis of variance (ANOVA) and treatments means with significant differences were separated using Least Significant Different (LSD) with the aid of SAS (2000).

Table 1: Composition of experimental diets (%)

INGREDIENTS	COMPOSITION/TREATMENTS			
	T_1	T_2	T_3	T_4
Cashew nut shell	0.00	10.00	20.00	30.00
Bambara nut waste	50.00	31.70	21.00	10.50
Burukutu waste	33.00	44.00	50.00	55.00
Rice offal	16.00	13.30	8.00	3.50
Table salt	0.50	0.50	0.50	0.50
Wood ash	0.50	0.50	0.50	0.50
Total	100	100	100	100

Results and discussion

The proximate chemical composition of experimental diets, cashew nut shell and elephant grass (*Pennisetum purpureum*) are presented in Table 2

Table 2: Proximate Chemical Composition of Experimental Diets, Cashew Nut Shell and *Pennisetum purpureum* (%DM)

NUTRIENTS (%)	TREATMENTS T_1	T_2	T_3	T_4	CASHEW NUT SHELL	*Pennisetum purpureum*
Crude protein	18.90	18.46	18.08	18.03	7.60	10.55
Crude fibre	18.27	18.95	19.45	19.60	25.70	34.34
Nitrogen free extract	50.50	46.46	44.55	42.20	28.00	42.83
Ether extract	6.04	10.88	14.00	17.66	37.50	1.12
Ash	6.29	5.25	3.92	2.51	1.20	11.16
Total	100	100	100	100	100	100
Dry matter	88.20	88.67	89.74	90.88	92.52	35.50
pH	7.20	6.70	6.40	6.28	4.10	-
Gross energy (Kcal/Kgdm)	2900	3226	3347	3434	3330.2	1981.4

The crude protein and crude fibre contents of 7.60 % and 25.70 % reported for cashew nut shell was higher than 5.00 % crude protein and 20.75 % crude fibre obtained by Ocheja *et al.* (2011a). The crude protein value was slightly lower than the critical level of 8.00 % crude protein level for ruminants as reported by NRC (1996). The nitrogen free extract and ether extract content values of 28.00 % and 37.50 % respectively were both lower than the 32.91 % and 40.25 % respectively reported by Ocheja *et al.* (2011a). However, the ash and dry matter contents of 1.20 % and 92.52 % respectively is comparable to the 1.09 % ash and 92.21 % dry matter reported by Ocheja *et al.* (2011a). In using cashew nut shell as a feed ingredient, a fairly high protein source is required to raise the protein content to recommended levels.

The crude protein content of 10.55 % obtained for *Pennisetum purpureum* was comparable to 9.70 % obtained by Osakwe and Udeogu (2007) and 10.90 % reported by Ocheja *et al.* (2008). The crude fibre content of 34.34 % was higher than 30.33 % obtained by Osakwe and Udeogu (2007) but lower than 36.33 % reported by Olorunsomo *et al.* (2011). The nitrogen free extract and ether extract contents of 42.83 % and 1.12 % respectively were lower than the 52.28 % nitrogen free extract content reported by Ocheja *et al.* (2008) and 3.72 % ether extract content reported by Amakiri *et al.* (2011). The value of 11.16 % obtained for ash was higher than 9.70 % reported by Osakwe and Udeogu (2007). The dry matter content of 35.50 % reported for *Pennisetum purpureum* in this study was higher than that obtained by Amakiri *et al.* (2011) who reported the dry matter content of elephant grass to be 23.20 %. This disparity could be due to the variety as well as stage of maturity of the grass. The differences observed in the proximate composition of these by-products can be attributed to source and variety and the method of preparation which may affect their composition.

Dry matter, crude protein, and crude fibre values of the experimental diets were similar while the ether extract content increased as the inclusion level of cashew nut shell increased. However, the nitrogen free extract and ash levels of the diets decreased as the inclusion level of cashew nut shell increased. They were also well above the critical protein requirement for goats as reported by NRC (1996).

Performance

Performance data are summarized in Table 3.

Table 3: Performance characteristics of experimental animals

PARAMETERS	TREATMENTS				SEM
	T_1	T_2	T_3	T_4	
Number of goats	4	4	4	4	-
Duration (days)	50	50	50	50	-
Initial weight (Kg)	10.23	10.60	10.50	11.00	0.13
Final weight (Kg)	11.47	11.72	11.48	11.53	0.08
Total weight gain (Kg)	1.24^{a}	1.12^{a}	0.98^{b}	0.53^{b}	0.11
Daily weight gain (g)	24.60^{a}	22.40^{a}	19.60^{b}	10.60^{c}	2.31
Daily supplement intake (g)	135^{a}	108.96^{b} 101.46^{b}	74.74^{c}	8.21	
Daily forage intake (g)	272	266	271	263	5.78
Daily dry matter intake (gDM)	407^{a}	374.96^{ab}	372.46^{ab}	337.74^{b}	12.39
Feed conversion ratio	16.54^{a}	16.73^{a}	22.43^{b}	31.36^{c}	2.46

a,b,c,d= Treatment means on the same row with different superscript differ significantly ($P<0.05$)

SEM= Standard error of mean

The values obtained for total weight gain was significantly ($P<0.05$) affected by treatments. T_1 and T_2 were similar while T_3 and T_4 were not statistically different. The daily weight gain was significantly ($P<0.05$) affected by treatments and treatment means of T_1 and T_4 were statistically different while T_2 and T_3 were similar. The total and daily weight gain obtained in this study were lower than 4.5-5.2 Kg and 84.9-94 g respectively reported by Olomola *et al.* (2008) and daily weight

gain of 31.27-42.26 g reported by Eniolorunda *et al.* (2008). These differences may be due to the experimental diet used, experimental location and season in which the experiment was conducted. Animals in T_1 had a higher growth rate which might be attributed to highest feed (supplement) intake and feed utilization while animals in T_4 had the lowest weight gain which may be attributed to unfavourable energy to protein ratio from the treatment diet (Tolera *et al.,*2000). The values obtained for daily supplement intake were significant ($P<0.05$) with T_2 and T_3 being similar and T_1 and T_4 being statistically different. Treatment means had no effect ($P>0.05$) on forage intake. The feed intake in T_1 was higher than in other treatments which possibly led to a higher weight gain. This effect of feed intake on weight gain was in line with the findings of Tolera *et al.* (2000) who stated that supplementation of forages with concentrate feedstuff is a necessity in improving goat productivity. Low supplement and forage intake may be due to the contribution of levels of inclusion of dietary components which might have affected the taste of the diet. T_1 had the highest feed intake (135 g) which might be attributed to the palatability of the feed as well as a high protein to energy ratio. Treatment effects on daily dry matter intake was significant ($P<0.05$). T_2 and T_3 were similar and T_1 and T_4 being statistically different. The values obtained for daily dry matter intake was higher than 235.91 - 388.32 gDm obtained by Ifut, *et al.* (2011). The lowest dry matter intake recorded in T_4 could be due to the low level of supplement consumed. Feed conversion ratio showed significant ($P<0.05$) differences with T_1 having the best feed conversion ratio value which might be attributed to highest feed utilization exhibited by animals in this treatment.

Bio-economics

Bio-economics data are summarized in Table 4

Table 4: Bio-economics of Experimental Animals

PARAMETERS	TREATMENTS				SEM
	T_1	T_2	T_3	T_4	
Cost of supplement/Kg (₦)	28.75^a	23.38^b	19.75^c	16.10^d	1.21
Cost of supplement consumed (₦)	194^a	126^b	100.19^c	60.16^d	18.44
*Benefit/live weight gain(₦)	984^a	896^b	784^c	424^d	82.87
**Cost benefit ratio (₦)	5.07^c	7.11^b	7.84^a	7.06^b	0.41

a,b,c,d= Treatment means on the same row with different superscript differ significantly ($P<0.05$)

SEM= Standard error of mean

*Total weight gain x cost of a Kg of goat meat at N800 (Ocheja *et al.,* 2011c)

**Benefit/live weight gain divided by cost of supplement consumed

Increasing levels of cashew nut shell lowered feed cost/Kg significantly ($P<0.05$). Cost benefit ratio showed significant differences with T_1 having the best. This was in line with the results of earlier studies by Bawa *et al.* (2003), Abeke (2005) and Ogundipe *et al.* (2003) who reported that the need to lower feed cost in order to produce affordable meat and other animal products for the populace cannot be over-emphasized in the face of dwindling standard of living. T_1 had a higher benefit/live weight gain than other treatments but had a lower cost benefit ratio than other treatments

Dry matter and nutrient digestibility coefficients

The dry matter and nutrient digestibility coefficients are presented in Table 5.

Table 5: Dry Matter and Nutrient Digestibility Coefficients (%)

PARAMETERS	TREATMENTS				SEM
	T_1	T_2	T_3	T_4	
Crude protein	61.33[a]	54.20[ab]	43.60[ab]	40.00[b]	3.70
Crude fibre	43.84[a]	38.00[b]	36.00[b]	32.00[c]	2.01
Nitrogen free extract	66.00	64.00	63.00	59.70	1.34
Ether extract	67.00[a]	63.50[b]	62.00[b]	60.00[b]	1.38
Dry matter	56.86[a]	48.00[ab]	43.88[b]	41.07[c]	3.02

a,b,c,d= Treatment means on the same row with different superscript differ significantly (P<0.05)

SEM= Standard error of mean

Nutrient digestibility values for crude protein, crude fibre, ether extract, and dry matter were significantly (P<0.05) different among treatments. The high digestibility values obtained for most nutrients suggest that the diets were highly degraded in the rumen. This is in line with results obtained by Eniolorunda *et al.,* (2008) who suggested that high digestibilities of cell wall fractions demonstrate the ability of ruminants to process structural carbohydrates and obtain nutritional benefit from them. Crude protein digestibility was significantly (P<0.05) different among treatment means and was highest in T_1. This suggests that protein digestibility decreased with decreasing levels of dietary protein. The result is in accordance with that obtained by Ifut, (1992). Crude fibre digestibility values varied from 32-44%. Treatment effects on crude fibre digestibility were significant (P<0.05). Values obtained for goats in T_2 and T_3 were similar and T_1 was different (P<0.05) from T_4. T_1 had the highest crude fibre digestibility value of 43.84%. The values obtained for nitrogen free extract digestibility were not significant (P>0.05) among treatment means. Treatment effects on ether extract digestibility were significant (P<0.05) with T_2, T_3 and T_4 being similar while T_1 had the highest ether extract digestibility. There were significant differences observed (P<0.05) in the dry matter digestibility of the dietary treatments. T_2 was not significantly (P>0.05) different from T_1 and T_3. T_4 had the lowest dry matter digestibility value and T_1 the highest. This might be due to better nutrient synchronization (Isah and Babayemi, 2010). T_1had the best digestibility values for all the parameters considered.

Lower digestibility values of T_2, T_3 and T_4 may be due to increasing levels of cashew nut shell leading to higher fibre and ether extract content of the treatment diets and this could have inhibited digestibility (Baiden *et al.,* 2007). This is because the rate of microbial colonization of a feed with high fibre content is lower compared to another with lower fibre content. The high level of ether extract resulting from higher level of cashew nut shell may have impaired crude fibre and hence dry matter digestibility. This is in line with the report of Maithison *et al.* (1997) that ether extract levels above 5-6 % impair crude fibre and hence dry matter digestibility.

The dry matter digestibility values of 56.86 % (T_1), 48.00 % (T_2), 43.88 % (T_3) and 41.07 % (T_4) showed that all the diets could be considered as ruminant diets in line with the report of Preston (1986) that for any feedstuff or ration to be considered as ruminant feed, it should have a dry matter digestibility coefficient of 40-50 %.

Conclusion and Recommendation

Animals fed the control diet performed better with respect to feed intake, daily weight gain and feed conversion ratio and dry matter as well as nutrient digestibility coefficients than those fed diets containing varying levels of cashew nut shell. However, the inclusion of cashew nut shell led to significant (P<0.05) decrease in feed cost/Kg and

better cost benefit ratio than the control. Further research using different classes, breeds and species of ruminant is suggested.

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