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Performance Characteristics of West African Dwarf Goats Fed Sweet Potato Peels and Cashew Nut Shell Supplemented with *Ocimum Gratissium Leaves*

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Abstract
The study assessed the impact of sweet potato peels and cashew nut shell with Ocimum gratissium leaves supplementation on performance characteristics of West African Dwarf Goats under intensive system. Goats weighing between 7.98 and 8.22 kg were randomized assigned to three dietary treatment groups with six goats per treatment group. The compared treatment diets that comprised sweet potato peels and cashew nut shell were in the following ratios, in the treatment diets; I (30:25), II (25:30) and III (20:35) respectively. Concentrate of 45% was also served to each of the experimental diet, while each goat also received 8 grams of Ocimum gratissium leaves powder as supplement in the diets. The results of the study showed that diet I, has pronounced effect (P<0.05) on average total feed intake (6.42kg), feed conversion ratio (2.15), digestibility of ash (60.77%), gross energy intake (12.78MJ/Kg) and faecal energy output (3.01MJ/Kg) than other treatments. Diet II was significantly highest (P<0.05) in final body weight (12.01kgkg), average total weight gain (3.89kg), dry matter digestibility(82.43%), crude protein digestibility(62.00), total digestible nutrient (70.43%), digestible energy intake(10.33MJKg) and metabolisable energy as percentage of gross energy (1.03MJ/Kg). Ether extract with crude fibre digestibility (62.18% and 77.89%) was significantly highest in diet III compared to other treatment diets). The experiment further showed that, there was no significant (P>0.05) difference in initial body weight of goats, average daily weight gain, metabolisable energy and metabolisable energy in $BW^{-.75.}$. It was therefore concluded that diet II improve and enhance performance characteristics of West African Dwarf Goats.
Keywords: Sweet potato peels, cashew nut shell, Ocimum gratissium, performance, goats.

Introduction

The availability of animal protein sustainable basis has been the major concern of the livestock industry in Nigeria. The animal protein intake in Nigeria had been reported to be abysmally low due to high cost of livestock product which result from rapid increase in the cost of most feedstuff (Sobayo *et al*., 2013). This inadequate animal protein origin intake in Nigeria needs to be seriously addressed. However, this can be achieved by improving livestock nutritional strategy to increase the level of animal production at reduced cost. This calls for aggressive approach towards small ruminant animal production to increase livestock meat productions that are now dwindling in supply in Nigeria.

One of such small ruminant animal species in this category is goat, which the level of participation in its farming has been so encouraged across the country's geographical region. Its excellent taste, high meat yield and protein quality account for its most preferred livestock meat. Considering this quality in addition to its high demand and potentials in alleviating the shortage of animal protein, encourages goat production. Goat is a multi-functional ruminant that has the capacity to efficiently utilize forages and agro industrial by-products as feeds (Aye and Adegun 2010). Although significant progress has been recorded on goat production over years under intensive rearing system because of their easy management (Okoruwa *et al*., 2012), goat is still faced with the problem of nutrition due to the scarcity of forages and escalating cost of conventional feed ingredients. Thus, intensive search for alternative feed sources to supplement conventional feeds calls for unconventional feed sources.

Sweet potato *(Ipomea batatas*) peels and Cashew (*Anacardium occidentiale)* nut shell are such unconventional feed sources that are ready available and cheap which can be used in ruminant feeding. Though sweet potato peels sugaring content is high, they are good energy sources in livestock feeds (Malik *et al*., 2011). The use of cashew nut shell that might otherwise be discarded as waste is limited, due to poor understanding of its nutritional value as well as their proper use in ruminant rations. The problem associated with the use of cashew nut shell in ruminants rations are its hardness, oily nature and high acidity which could be reduced with the level of inclusion in the diets and processing methods. Okolo et al.(2012) reported that lf cashew nut shell is to be used for more than 30% inclusion level in ruminant diet, the ration will require concentrate that is low in fat but rich in other nutrients to augment the ration. *Ocimum gratissimum* is a plant that belongs to lamiceae family. It is know as food spice and traditional herb, which has been recommended for treatment of various diseases such as upper respiratory tract infection and diarrhoea. The leaves contain nutrients, antioxidants and healthy proteins which can be used as supplement in ruminant feeds, to augment the nutrient content and reduce

the chances of micro organism infection in ruminants (Effiong, 2014). However there is paucity of information on the used of sweet potato peels and cashew nut shell with *Ocimum gratissimum* supplementation in goat rations. Thus the objective of this study is to determine the performance characteristics of West African Dwarf goats fed sweet potato peels and cashew nut shell supplemented with *Ocimum gratissium* leaves.

Materials and Methods

Study Location: The study was conducted at the Sheep and Goat Unit of Teaching and Research Farm, Ambrose Alli University, Ekpoma, Nigeria. The study area was located with Long. 6.09 ^{0}E and Lat. 6.42 ^{0}N in Esan central local Government Area, Edo State of Nigeria. Ekpoma is within the South-South geo-political Zone of Nigeria that has a prevailing tropical climate with a mean annual rainfall of about 1556mm. The mean ambient temperature range from 26^{0}C in November to 34^{0}C March, while relative humidity range from 61^{0}C in January to 92^{0}C in August with yearly average of about 82%. The vegetation represents an interface between the tropical rainfall and derived savanna.

Experimental Diets: Fresh sweet potato peels were collected from the processing points within Ekpoma, mixed, washed, sun dried and crushed. Cashew nuts were collected within the Teaching and Research Farm; the raw cashew nuts were washed manually with sand and water. Thereafter, they were soaked, steamed and dried in the sun for 4 to 5 days. The nuts were then roasted to facilitate the release of the kernels when shelling was done. The shelling was done manually with a locally fabricated Sheller. The cashew nuts shell, after shelling were dried in the sun and crushed. Concentrate ingredients of the following 50% brewer's dry gran, 35% wheat offal ,10% rice bran, 1.50% vitamin, 2.00% bone meal, 1.00% limestone and 0.50% salt with calculated 16.15% crude protein and 1930.50 Kcal/kg metabolizable energy was formulated. *Ocimum gratissimum* leaves that serve as supplement were obtained from the plant and sun dried. The dried leaves were milled in a hammer –mill to pass through a 20mm screen into powder form to reduce selection when mixed with diets.

However, the three compared experimental diets (I, II and III) which comprised the combination of sweet potato peels and cashew nut shell respectively were in different ratios which include diets I(30: 25), II(25: 30) and III(20: 35). Concentrate diet of 45% was also served to each experimental diet. The experimental diets were offered as ration at the rate of 5% (DM basis) of their body weight. While each goat received 8 grams of *Ocimum gratissimum* leaves powder in their respective diets.

Experimental Animals and Management: Eighteen growing male West African dwarf goats aged between 8 to 9 months old with an average body weight of 8.00$\pm$0.11kg were used for the study. The animals were purchased from an open livestock market within Ekpoma metropolis in Edo State, Nigeria. The goats were randomly allocated to the three dietary treatments in a completely randomized design. Each treatment was replicated with six animals. The goats were reared and maintained in individual pen with proper ventilation. The pen of each animal was clearly labelled for proper identification of each goat. The diets with 8 grams of *Ocimum gratissimum* leaves powder was fed to each goat once daily at 8.00am in the morning. Water and salt lick were also provided to the animal *ad- libitum*.

Strict hygiene condition was maintained in the confinement by regular cleaning of the pens and washing of the feeding and water troughs on daily basis. The goats were given prophylactic treatment against parasites and diseases before the commencement of the study that lasted for 12 weeks.

Experimental Studies

Growth Study: The daily feed intake of goats was determined by the difference in weight of quantity of feeds provided and the leftover of the previous day's feeds. Body weights of the goats were taken on weekly basis by using a hang scale in the morning before feeding the goats.

Data derived from daily feed intake and daily weight gain were computed and feed conversion ratio was calculated as the ratio of feed intake over the body weight gain.

Digestibility and Energy Utilization Studies: At the end of the 11th week, digestibility and energy studies were carried out on the goats. The animals were kept off for 12 hours but with water supplied constantly this was to evacuate their gut of the residual feed eaten. Fresh feeds of known weights were then given to the goats. The left-over (uneaten feeds) were collected the following day and weighed. Faecal samples were also collected daily and sun dried. The process of collection lasted for 7 days at the end of which each replicate samples were bucked together. The collected faecal samples were later oven-dried at 80^{0}C for 24 hours before they were stored separately in air-tight containers until required for analysis.

Thus, the nutrient digestibility and total digestible nutrient (TDN) were calculated using these formulas:

$$\text{Nutrient Digestibility}\,(\%) = \frac{\text{Nutrient in feeds - Nutrient in faeces}}{\text{Nutrient in feeds}} \times \frac{100}{1}$$

$$\text{Total digestible nutrient (TDN)} = \text{Digestibility crude protein} + \text{Digestible crude fibre} + 2.25 \times \text{Digestible ether extract} + \text{Digesible nitogen free extract.}$$

Gross energy of feeds and faeces were determined using an adiabatic bomb calorimeter. Dietary gross energy (GE) intake minus the gross energy (GE) of faeces gave digestible energy (DE). Metabolizable energy (ME) intake was calculated as 96% of DE (NRC, 1998; Amaefule *et al*., 2009).

Chemical and Statistical Analyses

Proximate composition of the feeds used in the feeding trail and faeces were determined according to AOAC (2002).

Data obtained on growth, digestibility and energy utilization were subjected to one-way analysis of variance (ANOVA). Significant differences between means were separated by Duncan Multiple Range Test (SAS, 2003).

Results and Discussion

The proximate composition (%DM) of sweet potato peels, cashew nut shell, *Ocimum gratissimum leaves and concentrate* are shown in Table I. Dry matter values ranged from 81.50% in *Ocimum gratissimum leaves* to 92.20% in cashew nut shell. The difference observed in their dry matter could be due to the ingredient of the feeds that were characteristically different in dry matter content. Sweet potato peels (6.40%), cashew nut shell (5.50%) and *Ocimum gratissimum leaves (4.43%)* were relatively low in crude protein than the critical level of 8% for ruminants, as reported by NRC (1996) necessary to provide minimum ammonia levels required by rumen micro-organism to support optimum activity (Ocheja *et al.,* 2011). Hence, 16.15% for concentrate was used in the ration which was fairly high protein source to raise the overall protein content of the ration to facilitate maximum dietary crude fibre digestion in the rumen. Crude fibre values that ranged between 4.00 and 22.75% were highest in cashew nut shell and lowest in sweet potato peels. This indicated that cashew nut shell had higher fibre content than other feed ingredients used in the study. The ether extract of 39.25% for cashew nut shell was rather high, this high content might reduced methane emission because Ocheja *et al.*(2011) reported a 33% reduction in methane emission when 4% canola oil was added to a diet containing 85% concentrate in feedlot. It could also be translated to corresponding high carotene content (Anbarasu *et al.,*2004). On the other hand, this high level of fat content could depressed fibre digestion, since Ocheja *et al.*(2011) reported a depression in fibre digestion when fat level exceeded 5-6% in ruminant rations. Thus, sweet potato peels (6.00%), *Ocimum gratissimum leaves (2.70%) and concentrate (1.14%) ether extract were low, so as to reduce the fat content of the ration to recommended levels. The ash content of cashew nut shell (1.09%) and Ocimum gratissimum leaves(1.15%) were low which could probably balanced up by sweet potato peels (7.50%) and concentrate (7.89%). The nitrogen free extract for cashew nut shell (23.62%) and concentrate (44.53%) were rather too low, hence sweet potato peels (65.20%) and Ocimum gratissimum leaves (69.02%) would augment the overall energy content of the experimental diets***.*** However, the proximate composition (%DM) of sweet potato peels, cashew nut shell and *Ocimum gratissimum leaves* observed in this study were similar to values reported by Malik *et al.* (2011) ; Okolo *et al*.(2012) ; Efiong (2014) respectively.

Table 1. Proximate composition (%DM) of sweet potato peels, cashew nut shell, *Ocimum gratissium* leaves and concentrate.

Parameters	Feeds			
	Sweet potato peels	Cashew nut shell	*Ocimum gratissium* leaves	Concentrate
Dry matter	89.10	92.20	81.50	83.96
Crude protein	6.40	5.50	4.43	16.15
Crude fibre	4.00	22.75	4.20	14.25
Ether extract	6.00	39.20	2.70	1.14
Ash	7.50	1.09	1.15	7.89
Nitrogen free extract	65.20	23.62	69.02	44.53

Table 2: Growth indices of goats fed experimental diets

Parameters	Diets			SEM±
	I	II	III	
Initial body weight (kg)	7.98	8.12	8.22	0.05
Final body weight (kg)	10.96[b]	12.01[a]	11.01[b]	0.02
Av. total weight gain(kg)	2.98[b]	3.89[a]	2.79[b]	0.06
AV. daily weight gain(kg)	0.48	0.65	0.47	0.01
Av. total feed intake (kg)	6.42[a]	4.53[b]	4..92[b]	0.08
Feed conversion ratio	2.15[a]	1.17[b]	1.96[a]	0.03

[a, b, c] means along the same row with different superscripts are significantly (P<0.05) different from each other.

Presented in Table 2 are the growth indices of goats fed experimental diets. Growth parameters observed in this study were all significantly (P<0.05) affected by treatment diets except initial body weight and average daily weight gain. Final body weight values of 10.96, 12.01 and 11.01 kg were obtained for diets I, II and III respectively, with goats on diet II significantly (P<0.05) highest than those on diets I and II. Average total weight gain followed the same pattern of variation as observed in final body weight gain. Goats on diet II (3.89kg) were the heaviest, followed by those on diets I (2.98kg) and III (2.79Kg). The significant (P<0.05) highest final body weight and weight gain observed in diet II could be as a result of the diet supplying reasonable levels of available energy and nitrogen when fed to goats and the ability of the animals to properly utilize the nutrient as well. Okoruwa *et al*. (2013) reported that an efficient utilization of nutrients that supply adequate energy and protein is required for optimum growth performance in livestock.

Average total feed intake that was significant (P<0.05) highest in diet I (6.42kg) and lowest in diet II (4.53kg) were influenced by the dietary treatments. This observation could probably be due to factors such as nature of ingredients, sub-limiting or excessive levels of some nutrients and environmental condition of the animals. This is supported by earlier report of Fatufe *et al*. (2007) that physical and chemical composition of a diet and environmental condition of an animal influenced their average feed intake. Feed conversion ratio of goats were significantly (P<0.05) varied across the treatment diets with goats on diet II (1.17) lower than those on diets I (2.15) and III (1.96). The result revealed the ability of goats on diet II to convert their feeds consumed to weight gain well than either of the two other diets.

Table 3: Apparent nutrient digestibility and total digestible nutrient (%) of goats fed experimental diets.

Nutrients	Diets			SEM±
	I	II	III	
Dry matter	77.93[b]	82.43[a]	71.86[b]	1.64
Crude protein	59.98[a]	62.00[a]	48.67[b]	0.93
Crude fibre	52.81[c]	60.78[b]	77.89[a]	0.44
Ether extract	52.04[b]	57.96[b]	62.18[a]	0.12
Ash	60.77[a]	56.98[b]	41.78[c]	0.52
Total digestible nutrient	66.89[b]	70.43[a]	53.95[c]	0.25

[a, b, c] means along the same row with different superscripts are significantly (P<0.05) different from each other.

Table 4: Energy utilization of goats as influenced by experimental diets (MJ/Kg)

Parameters	Diets			SEM±
	I	II	III	
Gross energy (GE) intake	12.78[a]	12.30[a]	11.98[b]	0.10
Faecal energy (FE) output	3.01[a]	1.97[b]	2.68[a]	0.61
Digestible energy (DE) intake	9.77[b]	10.33[a]	9.30[b]	0.34
Metabolizable energy (ME) intake	9.38	9.92	8.93	0.21
Metabolizable energy in $BW^{0.75}$	5.36	5.59	5.17	0.13
ME as % GE	0.92[b]	1.03[a]	0.83[b]	0.02

[a, b, c] means along the same row with different superscripts are significantly (P<0.05) different from each other.

The apparent nutrient digestibility and total digestible nutrient of goats fed experimental diets are shown in Table 3. Dry matter digestibility values were not significantly affected (P>0.05) between diets I (77.93%) and III (71.86%) but diet II (82.43%) was significantly (P<0.05) higher than diets I and III. The relatively high dry matter digestibility observed in this study could be attributed to the ingredient of the diets which were characteristically high in dry matter content. Crude protein digestibility was significantly affected (P<0.05) across dietary treatments with goats on diet II (62.00%) recorded the highest, followed by diet I (59.98%) before diet III (48.67%). This observed difference could be associated with protein content of the diets and degree of nutrient utilization. Aye and Adegun (2010) reported that digestibility of nutrients varies with nutrient composition of diets and their degree of nutrient utilization. The crude fibre digestibility that ranged

from 52.81% to 77.89% was significantly highest in diet III, followed by diet II before diet I which was the lowest. The gradual increase in trend of crude fibre digestibility as the level of cashew nut shell increased with decrease in the level of sweet potato peels inclusion in diets could be associated with high crude fibre content in cashew nut shell and high degree of the utilization. Fibre utilization by animals have been reported to be influenced by the physical and chemical composition of the diet, level of feeding, age and weight of animal, adaptation to the fibre diet and individual variation among the animals (Hansen *et al*., 2007). The digestibility coefficient of crude fibre observed in this study could therefore be attributed to ingredient matrix of the diets, level of fibre and individual variation among the animals fed the treatment diets. Ahamefule *and Udo* (2009) reported that fibre provides substrate for microbial fermentation in the rumen of ruminants. This could have also improved the apparent digestibility coefficient of dietary crude fibre of up to 77.89% for diet III. Ether extract digestibility values of 52.04, 56.48 and 62.18% were obtained for diets I, II and III respectively. This implies that the diets were more effective in improving the utilization of ether extract in diet III than diets I and II. This finding confirms the experience of Okoruwa *et al*. (2012) who affirmed that ether extract content of a diet is essential for the assessment of its digestibility. Ash digestibility varied significantly ($P<0.05$) among diets with goats on diet III (41.78%) being the lowest, followed by diet II (56.98%) before diet I (60.77%) which was the highest. The reduction in the digestibility coefficient of ash by goats on diet III could be due to interaction among ingredient components of the diet which did not improve microbial activity in the rumen. This suggestion was in consistent with the report of Hansen *et al*. (2007) who reported that information on the ash contents of a diet is essential for the assessment on their digestibility. The total digestible nutrient that ranged from 53.96% to 70.43% were significant ($P<0.05$) influenced by treatment diets. The highest total digestible nutrient values observed in diet II could be an indication of better proportion of energy and protein sources in the diet that were appropriate for the enhancement of growth performance in goats obtained on the treatment diet. Previous researchers have indicated that studies on total digestible nutrient are important as they allow the estimation of nutrient really available for animal performance (Aye and Adegun, 2010; Okoruwa *et al*., 2012). However, the highest nutrient digestibility and total digestible nutrient observed in animals on diet II which associated with 25% sweet potato peels and 30% cashew nut shell could probably attributed to the gradual solubility of the diet, thereby making nutrient available over a long period of time which enhances rumen microbial activity.

Table 4, shows the result for energy utilization of goats fed experimental diets. Significant difference ($P<0.05$) was observed in gross energy (GE) intake with goats on diet I (12.78MJ/kg) and II (12.30MJ/Kg) being the highest and diet III (11.98MJ/Kg) was the lowest. The difference could be as a result of inclusion level of the test ingredients (sweet potato peels and cashew nut shell). This observation was contrary to the report of Noblet and Van Milgen (2004) who reported that daily energy intake of livestock remains relatively constant across diets irrespective of the intake with different energy densities. Faecal energy (FE) output values were significantly highest ($P<0.05$) in diets I (3.01MJ/Kg) and III (2.68 MJ/Kg) than diet II (1.97MJ/Kg). Highest FE values observed in goats on diets I and III, could probably be explained by imbalance levels of nutrient utilization caused by inhibitory effects of residual toxic substance of sweet potato peels and cashew nut shell used in the treatment diets. This is in conformity with the earlier reports of Malik *et al*. (2011) who reported that although sweet potato peel has a very low anti-nutritional factors, its total presence could influence high faecal output in rabbits. Okolo *et al.* (2012); Ocheja *et al.* (2011) also reported that, if cashew nut shell is to be used at more than 30% of inclusion level in ruminant diets, then the ration may require more nutrient especially high concentrate diets. Thus, the 35% inclusion level of cashew nut in diet III could have been responsible for the higher FE obtained.

The estimated digestible energy (DE) intake values of 9.77, 10.33 and 9.30MJ/Kg, that were obtained for diets I, II and III respectively, were significantly ($P<0.05$) influenced by dietary treatments. The DE low values observed in diets I and III could probably be explained by high energy loss through faecal energy output. This could attributed to improper energy utilization by the animals and environmental factors as reported by Okoruwa *et al*. (2013). Metabolizable energy (ME) and Metabolizable energy (ME) in $BW^{0.75}$ among treatments effects were not significant ($P>0.05$) between treatment diets. The *Ocimum gratissimum leaves supplementation* in diets could have been the reason for this non significant effect among the treatment diets. Johnson *et al*. (2003) reported that digestible and metabolizable energy requirement of animals play important role in determining the growth performance of animal. ME as % of GE followed similar pattern of variation as DE intakes assessed. This finding is in agreement with the report of Ahamefule *and Udo* (2010) who reported that the level of DE in ruminants have a direct effect on the ME as % of GE.

Moreover, the energy utilization results for goats were highest on diet II that has the best apparent nutrient digestibility and total digestible nutrient. This also corresponded and confirmed the best average total weight gain obtained on diet II compared to other diets.

Conclusion

The results obtained from this study indicated that sweet potato peels and cashew nut shell with *Ocimum*

gratissimum leaves supplementation *can serve as cheap alternative in ruminant feeds,* since they have low human preference and less industrially important. It was therefore concluded that impact of sweet potato peels and cashew nut shell with *Ocimum gratissimum leaves* supplementation improved and enhanced growth indices, nutrient digestibility, total digestible nutrient and energy utilization of goats.

These improvements were however more pronounced without any adverse effect in goats on diet II compared to diets I and III.

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