Growth Performance and Apparent Nutrient Digestibility of West African Dwarf Goats Fed B-Carotene Cassava Peel-Centrosema Leaf Meal Based Diets

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Abstract

A study was carried out to evaluate the growth performance and apparent nutrient digestibility of West African Dwarf (WAD) goats fed β-carotene cassava peel-centrosema leaf meal based diets. Four diets designated A, B, C and D were formulated to contain 0, 10, 20, and 30% levels of Centrosema pubescens leaf meal respectively. Thirty six WAD bucks of about 8 – 10 months of age and averaging 7.19kg in weight were used to conduct the growth performance and four bucks used in the digestibility study in completely randomized design and 4 x 4 Latin square design experiments respectively. Results showed that β-carotene cassava peel-centrosema leaf meal supplementation significantly increased (P<0.05) the average daily feed intake, average daily body weight gain and feed conversion ratio of WAD goats. Diet D containing 30% Centrosema pubescens leaf meal produced the best performance for optimum intake and growth of the goats. Apparent-Nutrient digestibility was also significantly (P<0.05) higher in the treatment groups fed Centrosema pubescens leaf meal than in the control group. The results of this study indicated that the inclusion of β-carotene cassava peel-centrosema leaf meal at 30% level enhanced growth performance and apparent nutrient digestibility of West African Dwarf goats and therefore recommended for better goat production.

Keywords: *provitamin A cassava peel, alternative feed resources, growth performance, digestibility, WAD goats and Centrosema pubescens leaf meal.*

Introduction

Livestock plays a significant role in the economy of the developing and developed countries; supporting agriculture in the form of critical inputs, contributing to the health and nutrition of the household, supplementing incomes, offering employment opportunities and finally being a dependable source of high quality meat. Goat production is an integrated economic activity which contributes 55% of the total number of ruminant livestock in Nigeria (Ahamefule, 2005). By number, Lawal-Adebowale (2012) ranked goat as the nation's greatest supplier of animal protein (34.5 million goats, 22.1 million sheep and 13.9 million cattle). However, goat production has been hampered primarily by the high cost and non availability of good quality and quantity of feed (Onwuka, 1999). During the dry season, the little forage and natural pastures available are low in quantity and quality, hence lacks the essential nutrients required for increased rumen microbial fermentation and will result to weight losses, low birth weight, lowered resistance to diseases, poor digestibility and overall poor performance of the animal (Jiwuba *et al*., 2016). Consequently, recent research attentions are geared towards the use of cheaper and readily available unconventional feed resources that can possibly provide all season supplement for ruminants.

Cassava is highly cultivated in Africa and Latin America for its starchy roots and ranks first as a staple food in Nigeria. Its drought tolerance and ability to thrive well in marginal soil makes it vital from both social and economic perspective. According to Bradbury and Hollowary (1988) cassava tuber generally possess a cream or white flesh colour and contain legible amount of carotenoids. Carotenoids have extensive applications as anti-oxidants in dietary supplements, and as colours in foods and beverages as well as pigments in poultry and fish. The carotenoids used as food ingredients include astaxanthin, beta-apo-carotenal, canthaxanthin, beta-carotene, lutein, zeaxanthin and lycopene. The essential role of beta-carotene and others as the main dietary source of vitamin A has been studied for years (Carlier, 1993). The recently introduced provitamin A root cassava, yellow root or β-carotene cassava varieties through the interventions of National Root Crops Research Institute (NRCRI), Umudike in collaboration with International Institute of Tropical Research Institute (IITA), Ibadan, Nigeria are very rich in Vitamin A and other carotenoids. Vitamin A remains very important component of human nutrition, as it involved in vision, cell differentiation, synthesis of glycoprotein, reproduction and overall

growth and development (Woolfe, 1992). Vitamin A, is a fat-soluble vitamin and considered as an essential nutrient for normal growth and development of an organism (Guimarãesa *et al*., 2014). These numerous advantages has led to high demand for the provitamin A cassava for different human or industrial uses thereby enhancing the availability of the peels which are grossly underutilized and were hitherto discarded as waste. The β-carotene cassava peels are made up of mainly polysaccharides and carotenoids; hence holds inestimable potentials as energy and vitamin A sources for goats.

Cassava roots have been implicated with low protein content; thus the need to fortify it with higher protein resources. However, one of the possible sources of cheap protein for ruminants is the leaf meals of some tropical legumes (Esonu *et al*., 2003). *Centrosema pubescens* has relatively high crude protein content of 23.24% (Nworgu and Egbunike, 2013), moderate to high dry matter digestibility (45-65%) and highly palatable. Information on the use of β-carotene cassava peel and *C. pubescens* leaf meal as dry season supplement in goat production is virtually none existing. Hence, the objective of the study was to evaluate the growth performance and apparent nutrient digestibility of West African Dwarf goats fed β-carotene cassava peel-centrosema leaf meal based diets.

MATERIALS AND METHODS

The experiment was carried out at the sheep and goat unit, Federal College of Agriculture, Ishiagu, Ivo L.G.A., Ebonyi state, Nigeria. The College is located at about three kilometers (3km) away from Ishiagu main town. The College is situated at latitude 5.56^0N and longitude 7.31^0E, with an average rainfall of 1653 mm and a prevailing temperature condition of 28.50^0c and relative humidity of about 80%.

Fresh β-carotene cassava peels varieties (TMS011368, TMS011412 and TMS1371) were obtained from National Root Crops Research Institute, Umudike, Abia State, Nigeria. The peels were subsequently dried to about 10% moisture content before milling and used in the formulation of β-carotene cassava peel - centrosema leaf meal based diets. Fresh green *Centrosema pubescens* leaves were harvested within the College. The *Centrosema pubescens* were shade-dried in batches, milled and also used at different levels in the formulation of β-carotene cassava peel - centrosema leaf meal based diets.

Thirty six (36) WAD goats of about 8 – 10 months of age and averaging 7.19kg in weight were selected from the College herd for this experiment. The goats were randomly divided into four (4) groups of nine (9) animals each with 3 goats constituting a replicate. The groups were randomly assigned the 4 experimental diets (A, B, C and D) in a completely randomized design (CRD). The animals were housed individually in well ventilated cement floored pens equipped with feeders and drinkers. Each animal received a designated treatment diet in the morning for 74 days. Feed offered was based on 3.5% body weight per day; the animals in addition were fed 2kg wilted *Panicum maximum* later in the day. Regular access to fresh drinking water was made available. Feed offered and refusals were recorded on a daily basis. Initial weights of the animals were taken at the beginning of the trial and weekly subsequently.

Experimental diets designated as A, B, C and D were formulated from β-carotene cassava peel, brewers dried grain, palm kernel meal, wheat offal, *Centrosema pubescens* leaf meal, bone meal, molasses and salt. Diet A served as a positive control and contained 0% of *Centrosema pubescens* leaf meal. Diets B, C and D contain 10%, 20% and 30% inclusion levels *Centrosema pubescens* leaf meal respectively as illustrated in Table 1. All feeds and test ingredients were analyzed for proximate compositions using the method of AOAC (2000). Gross energy was determined according to Nehring and Haelein (1973).

Each treatment group comprising four West African Dwarf goats were transferred to and housed in separate metabolism cages with facilities for collecting faeces and urine. Each animal was fed one of the four experimental diets (Table 1) in a 4 x 4 Latin square design. During phase 1 which lasted for 21 days, each animal received 1 kg of one of the 4 experimental diets. Fresh water was offered *ad libitum* to each animal daily. Daily voluntary feed intake was determined by weighing the quantity offered and refused. Total faeces

and urine voided by the experimental animals were collected during the last 7 days (21st – 28th). In phases 2-4 each animal was offered each of the remaining 3 experimental diets in rotational periods of 28 days each. The last 7 days in each of the feeding period, was also used for total urine and faecal collection. Total faeces were collected in the mornings before feeding and watering during days 21–28 of each period. Faecal samples were collected and bulked for each animal. A sub sample from each animal was dried in forced draft oven at 100-105°C for 48 hours and used for dry matter determination. Another sample was dried at 60°C for 48-72 hours for determination of proximate composition. Apparent coefficient digestibility for nutrients was determined as given below:

$$\frac{\text{Nutrient in feed- nutrient in faeces}}{\text{Nutrient in feed}} \times \frac{100}{1}$$

The results were analyzed using the Special Package for Social Sciences Window 17.0. One -way analysis of variance (ANOVA) was employed to determine the means and standard error. Treatment means were compared using Duncan's new multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Proximate compositions

The chemical compositions of the experimental diets, β-carotene cassava peel meal and *centrosema pubescens* leaf meal (CPLM) used in this study is presented in table 2. The proximate values for the β-carotene cassava peel meal showed a higher crude protein (CP), ash and ether extract (EE) and lower crude fibre (CF) values compared to the reports of Ahamefule *et al*. (2005) for cassava peel meal. The differences could be attributed to the improvements that have been carried on the β-carotene cassava. The proximate compositions of the *Centrosema pubescens* leaf meal in this study are comparable with the findings of Nworgu and Egbunike (2013) for the same leaf meal. The dry matter levels of the test diets (B, C and D) compared favourably well with the control diet (A). The CP, ash and ether extract of the test diets were higher than the control diet and tended to increase with the increasing levels of CLM in the diets. The fibre content on the other hand is higher in the control diet and tended to decrease with increasing levels of CPLM. The nitrogen free extract and gross energy did not show any specific trend among the diets.

Table 2: The chemical compositions of yellow root cassava peel, Centrosema leaf meal and yellow root cassava peel-centrosema leaf meal based diets

	Dietary levels (%)					
Parameters	**A**	**B**	**C**	**D**	**βCCPM**	**CPLM**
Dry matter (%)	91.32	91.54	91.37	91.74	90.28	86.03
Crude protein (%)	12.11	12.78	13.41	14.32	9.23	20.44
Crude fibre (%)	14.36	14.65	13.13	13.07	12.93	10.32
Ether extract (%)	4.83	5.11	5.97	5.99	3.41	2.09
Ash (%)	9.01	9.63	10.17	10.19	9.74	6.95
Nitrogen free extract (%)	51.01	49.37	48.69	48.17	55.67	44.22
Gross energy	3.90	3.92	3.91	3.95	3.71	3.64

βCCPM = β-carotene cassava peel meal; CPLM = *centrosema pubescens* leaf meal

Growth performance

The growth performance and feed intake of WAD goats fed β-carotene cassava peel-centrosema leaf meal based diets is presented in Table 3. The average daily feed intake was significantly ($P<0.05$) influenced by the test diets. The values for the goats fed diets C and D were significantly ($P<0.05$) higher and better than the goats fed diets A and B. The higher average daily feed intakes of the C and D goats over A and B goats may be attributed

to higher dietary protein, and greater palatability of the diets; hence diets higher in dietary protein tend to improve intakes. This is in line with the result obtained by M'hamed *et al*. (2001) that diets with higher protein content increase feed intake. Supplementation of *Panicum maximum* with β-carotene cassava peel-centrosema leaf meal based diets improved total voluntary feed intake of the goats. The improved feed intake for β-carotene cassava peel-centrosema leaf meal based diets could have resulted due to faster rumen outflow rate and the provision of more degradable organic matter (Yousuf *et al*. 2007). β-carotene cassava peel-centrosema leaf meal based diets were readily consumed by the goats and was well accepted. The voluntary intake was enhanced with incremental levels of supplementation with β-carotene cassava peel-centrosema leaf meal based diets. The average daily weight gain also showed a significant ($P<0.05$) difference with goats on diets C and D significantly ($P<0.05$) influenced over animals on diets A and B. The difference may be attributed to the higher intakes of animals on diets C and D relative to A and B animals. Goats on D diet had the highest ($P<0.05$) average daily weight gain of 54.60 g/day while the A diet animals had the lowest ($P<0.05$) average daily weight gain of 31.22 g/day. The differences in average daily weight gain of the goats could be attributed to the influence of β-carotene cassava peel-centrosema leaf meal based diets in providing essential nutrients and vitamin elements both for effective rumen function and for body metabolism by the animals (Norton, 1994).
The efficiency of the utilization of a diet are largely determined by the relative balances of glycogenic energy, long chain fatty acids and essential amino acids and minerals absorbed by the animals (FAO, 1995). It could then mean that diets with β-carotene cassava peel-centrosema leaf meal inclusion contained a balanced of nutrients, which efficiently interacted to give a better feed conversion ratio. However, the lowest and best feed conversion ratio recorded for goats on diet D is in line with the result which stated that feed to gain decreased linearly with increasing protein intake (Tyler *et al*., 1993).

Table 3: Growth performance and feed intake of West African Dwarf goats fed β-carotene cassava peel-centrosema leaf meal based diets

	Dietary levels (%)				
Parameters	**A**	**B**	**C**	**D**	**SEM**
Initial body weight (kg)	7.02	6.98	7.14	7.61	0.31
Final body weight (kg)	9.33^{c}	10.12^{a}	10.51^{b}	11.65	0.22
Total weight gain (kg)	2.31^{c}	2.94^{c}	3.37^{b}	4.04^{a}	0.16
Av. Body weight gain (g/day).	31.22^{c}	39.73^{b}	45.54^{b}	54.60^{a}	2.09
Total feed intake (kg)	23.33	23.52	23.78	23.86	1.23
Av. Daily feed intake (g/day).	315.27^{b}	317.84^{b}	321.35^{a}	322.43^{a}	6.02
Feed conversion ratio	10.10^{a}	8.00^{b}	7.06^{c}	5.91^{d}	0.17

$^{a, b, c}$ means in the row with different superscripts are significantly different ($P<0.05$)

Apparent nutrient digestibility

The results of apparent nutrient digestibility coefficients of WAD goats fed β-carotene cassava peel-centrosema leaf meal based diets are presented in Table 4. The varying levels of β-carotene cassava peel-centrosema leaf meal based diets significantly ($P<0.05$) influenced the dry matter (DM), crude protein (CP), crude fibre (CF) and ether extract (EE) digestibilities while ash and nitrogen free extract (NFE) were not affected ($P>0.05$) by the dietary treatments. The DM digestibility of this study ranged between 62.13-74.21% and compared well with the range of 66.55 - 77.32% Okafor *et al*. (2012) for Red Sokoto goats fed dried Gmelina *(Gmelina arborea roxb)* leaves as replacement forage to groundnut haulms, but higher than the reported range of 40.57-56% for WAD goats fed maize bran, wheat offal and rice bran (Alikwe *et al*., 2012) and lower than range of 78.00-80.63% for WAD goats fed mango (*Mangifera indica*), ficus (*Ficus thionningii*), gliricidia (*Gliricidia sepium*) foliages and concentrates as supplements to basal diet of guinea grass (*Panicum maximum*) as reported by Ajayi *et al*. (2005). The differences may be attributed to different test ingredients and physiological status of the animals. However, the lower DM digestibility in diet A animals compared to the treatment groups in this study tended to increase with incremental levels of *Centrosema pubescens* leaf meal; this might be related to the

lower CP of the diet A. This could be explained by the fact that feeds rich in protein content promotes high microbial population and facilitates rumen fermentation (McDonald *et al*., 2002).

Crude protein (CP) and crude fibre digestibility coefficients followed a similar trend as the dry matter (DM), increasing from treatment diets A – D. CP and CF were least digested in A (70.58% and 69.63%) and best digested in D (83.76%) and (81.47%), respectively. The highest digestibility coefficient of crude protein obtained in treatment D showed that the dietary protein was better utilized by the animals fed diet D relative to others. This perhaps could be due to *Centrosema pubescens* leaf meal inclusion which was highest in D (30%) and which may have influenced the highest digestibility recorded for diet D animals. Dietary protein has been shown to enhance digestibilty (Ahamefule, 2005). The results of crude fibre digestibility in this study showed that crude protein content of diets was positively correlated with the crude protein digestibility (CPD) and crude fibre digestibility (CFD). This agrees with earlier reports (Olaleru and Adegbola, 2001; Fasae *et al*., 2005) that CFD and CPD decrease with decreasing level of CP in diets. A very important consideration in the utilization of nutrients by animals may be the synchronization of nutrients especially protein and energy. This had earlier been observed by French *et al.* (2001). This may explain why the digestibility coefficient of CP and CF increased from treatment A to D, in the same pattern with DM. Diet A, B and D were similar ($p>0.05$) but differed significantly ($p<0.05$) from the values obtained for diet C animals for Ether extract (EE) digestibility coefficients. The relative high level of ether extract resulting from the control diet may have impaired CP, CF and hence DM digestibilities. 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.

Table 4: Apparent digestibility coefficient of WAD goats fed β-carotene cassava peel-centrosema leaf meal based diets

	Dietary levels (%)				
PARAMETERS	**A**	**B**	**C**	**D**	**SEM**
Dry matter	62.13[b]	63.02[b]	71.52[a]	74.21[a]	0.79
Crude protein	70.58[c]	75.07 [b]	81.24[a]	83.76[a]	1.43
Crude fibre	69.63[c]	73.78[b]	79.11 [a]	81.47[a]	0.77
Ether extract	54.91[a]	53.31[a]	51.71 [a]	44.51[b]	0.68
Nitrogen free extract	51.83	52.72	53.12	53.44	0.71
Ash	41.42	41.89	43.09	42.99	0.48

[a- c], means on the same row with different superscripts are significantly different at ($p<0.05$)

Conclusion

The quality of feed can be evaluated through laboratory analysis, digestibility study and feeding trail. The feeding trial gives an idea on the effect of the diet on the general performance of the host animal while the digestibility study gives an insight as to what is available to the animal after digestion for its physiological functions. In this study therefore, is was observed that goat on the treatment diets performed better than the animals on the control diet. It could be concluded that inclusion of β-carotene cassava peel-centrosema leaf meal based diets at 30% had no adverse effect and should therefore recommended for optimum goat production.

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