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Carcass yield, organ response and cost/benefit evaluation of West African dwarf goats fed yellow root Cassava Peel-Centrosema leaf meal based diets

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Abstract

Thirty six individually housed West African dwarf (WAD) goats of about 8 – 10 months of age and averaging 7.19kg were used for this study. The effect of different levels of yellow root cassava peel - centrosema leaf meal supplementary diet on the carcass yield, organ response and cost/benefit evaluation of WAD goats fed wilted Panicum maximum basal diet. Four supplementary diets designated as T1, T2, T3 and T4 were formulated to contain 0, 10, 20 and 30% Centrosema pubescens leaf meal, respectively in addition to other feedstuffs. The goats were randomly divided into four groups of nine animals each with three goats constituting a replicate. Each group was assigned to one of the four diets in a completely randomized design for 97 days. Data on proximate composition showed that yellow root cassava peel - centrosema leaf meal enhanced the nutrient profile of the diets. Results on carcass and organ characteristics showed significantly (p<0.05) improved warm carcass (6.34kg), dressing percentage (54.42%) and loin (22.11%) for T4 goats while bone to lean ratio (0.28%), end (19.30%) liver (2.11%), kidney (0.43%), lungs (1.72), heart (0.70%) and spleen (0.19%) weights were significantly (p<0.05) higher for the control group.Cost per kg, feed cost/weight gain and cost/benefit ratio were influenced (p<0.05) withT4 goats having better income of benefit of ^3.97 for every ^1nvested. It is concluded that yellow root cassava peel - centrosema leaf meal is rich in essential nutrients and therefore suitable for inclusion in goat diets at level 30% for better carcass yield, organ characteristics and return on investment.

Keywords: WAD goats, Pro-vitamin carotenoids, cassava peel, *Centrosemapubescens, dressing percentage, organ characteristics and economics of production.*

Introduction

Goat (C*apra hircus*) is one of the oldest domesticated livestock which belongs to the order *artiodactyla*, suborder *ruminanta* and family *Bovidae* and are considered to have existed in the mountain area of Western Asia in the 7th and 9th millennium BC. Since history, goats have served socio-economic purposes and major source of animal protein intake to man. The number of goats has increased by almost 50% at world level, cattle increased by just 9% whereas sheep decreased by 4% (Morand-Fehr and Boyazogly, 1999; Devendra, 2001); thus confirming goats as aninestimable livestock of importance. This increment maybe attributed to their high prolificacy, low capital inputs, early maturity, remarkable recovery capacity from drought, unique ability to adapt and maintain itself in harsh environments, ability to trek long distances in search of feed, which helps them in meeting their nutrient requirements easily than other domesticated ruminants. In southern Nigeria (Gefu *et al*., 1994; Idiong and Udom, 2011), goat is a ready source of family income, a good medium of establishing friendship, a common stake

used as an object of fine for restoration of peace in a community and mostly indispensable in marriage and religious rites.

Meat is the major form in which goats are consumed in Nigeria (Ahamefule *et al*., 2005). Goat meat (Chevon) is widely accepted and consumed in Nigeria because there is no religious taboo against it (Anaeto *et al*., 2010). The demand for goat meat is high and usually commands higher market price than beef and pork in towns and villages. According to Idiong and Orok (2008) goat meat is highly preferred than other animal species because of its flavour, tenderness and palatability.

However, due to seasonal variations which are characterized by abundance of feed during the rainy season and scarcity of feed both in quantity and quality during the dry season, necessitated the need for supplemental diets with readily available unconventional materialsto enhance goat production with high weight gain and dressing percentage at a cheaper cost. Yellow root cassava peel and *Centrosema pubescens* leaf meal is the unconventional feedstuff of interest in this study. The readily availability of these materials make them the choice for this experiment. Nigeria is the highest cassava producer in the world today and cassava forms the staple food in the diet of its citizenry. This thus enhances the availability of the peels which are usually discarded as waste (Jiwubaand Ezenwaka, 2016). However, the bio-fortification of cassava with the pro-vitamin A carotenoid resulted to yellow-orange-fleshed cassava cultivars with moderately high concentrations of β - carotene and other pro-vitamin A carotenoids. Carotenoids have extensive applications as antioxidants in dietary supplements, and as colour in foods and beverages as well as pigments in poultry and fish (Jiwuba *et al*., 2016a). The bio-fortification has also resulted to lower cyanide content, lesser processing and cooking time and temperature with higher vitamin A content (Bradbury and Denton, 2011; La Frano *et al*., 2012). Vitamin A, is a fat-soluble vitamin and considered as an essential nutrient for normal growth and development of animals (Guimarãesa *et al*., 2014). Cassava has been reported to contain low protein; hence the need for higher protein diet of about 8-11 % CP to maintain the rumen ecosystem in goats. Leaf meals from Tropical legumes (Esonu *et al*., 2003) remain one of the surest sources of locally cheap protein for ruminants. *Centrosema pubescens leaf meal* has relatively high crude protein content of 23.24% (Nworgu and Egbunike, 2013), which when incorporated in the diet of goats could help improve the palatability and nutritive value of the diet. Information on the use of yellow root 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 cost/benefit and carcass and organ responses of West African dwarf goats fed yellow root 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 28.500^c and relative humidity of about 80% (Jiwuba*et al*., 2016a).

Fresh yellow root cassava peels varieties (TMS011368, TMS011412 and TMS1371) were obtained from Garri processing unit, National Root Crops Research Institute, (NRCRI) Umudike, Abia State, Nigeria. The peels were subsequently sundried to

about 10% moisture content before milling and used in the formulation of yellow root cassava peel - centrosema leaf meal based diets. Fresh green *Centrosema pubescens* leaves were harvested within the College environs. The *Centrosema pubescens* were shade-dried in batches, milled and also used at different levels in the formulation of yellow root 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 flock for this experiment. The goats were randomly divided into four groups of nine animals each with three goats constituting a replicate. The groups were randomly assigned the four experimental diets (T1, T2, T3, and T4) in a completely randomized design (CRD). The animals were housed individually in a well-ventilated cement floored pens equipped with feeders and drinkers. Each animal received a designated treatment diet in the morning for 97 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.

Experimental diets designated as T1, T2, T3 and T4 were formulated from yellow root cassava peel, brewers dried grain, palm kernel meal, wheat offal, *Centrosema pubescens* leaf meal, bone meal, molasses and salt. Diet T1 served as a positive control and contained 0% of *Centrosema pubescens* leaf meal. Diets T2, T3 and T4 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 calculated using the formula $T = 5.72Z_1 + 9.50Z_2 + 4.79Z_3 + 4.03Z_4 \pm 0.9\%$; where T = Gross energy, Z_1 = Crude protein, Z_2 = Crude fat, Z_3 = Crude fibre, Z_4 = Nitrogen free extract (Nehring and Haelein, 1973).

After the 97 days feeding trial, the goats were starved of feed for 24 hours and weighed prior to slaughter. The goats were cut at the throat, and then slaughtered by severing the heads at its articulation with the atlas bone. After dressing, the carcasses were weighed to determine the warm carcass weight. This represented the weight of the goats after removal of head, skin, thoracic, abdominal and pelvic contents and the limb distal to the joints. The dressing out percentages were calculated by dividing the warm carcass weight by the live weight prior to slaughter and multiplied by 100%. Other carcass components, organ, guts and muscles were weighed as well. The empty weights were determined by subtracting the weights of the gut contents from the live weights at slaughter. The warm carcasses were divided into two with a saw through the spinal column. The left halves were cut into various parts. The leg/thigh was severed from the attachment of the femur to the acetabulum.The loinconsisted of the lumber region plus a pair of ribs and the ends (9 spare ribs and the belly) of six abdominal ribs. The shoulder consisted of the scapula, humerus, radius, ulna, carpals while the sets are made up of the breast and the neck. Each of the cut parts was weighed and doubled in each case before being expressed as a percentage of warm carcass weight. The leg and the loin cuts were separated into muscles and bone with ligaments and, were then pooled to obtain the bone to meat ratio.

The prevailing market prices of the feed ingredients at the time of the experiment were used to estimate the unit cost of the experimental diet (N384 = $1 at the time of the experiment). The variable cost of feeding the goats considered as the cost of the feeds and all other costs (i.e. labour, capital investment and housing) were the same for all the treatments. The costs of processing and transporting the yellow root

Table 1: Percentage composition of experimental diets

Ingredients (%)	T1	T2	T3	T4
Yellow root cassava peel	40.00	40.00	40.00	40.00
Centrosema pubescens leaf meal	0.00	10.00	20.00	30.00
Brewers dried grain	38.00	28.00	18.00	8.00
Palm kernel cake	18.00	18.00	18.00	18.00
Bone meal	2.00	2.00	2.00	2.00
Molasses	1.50	1.50	1.50	1.50
Common salt	0.50	0.50	0.50	0.50
Total	100	100	100	100

cassava peel and *Centrosema pubescens* leaf meal were included as the feed cost. Feed cost (^) per kilogram, cost per kilogram of weight gain and cost benefit ratio was calculated accordingly.

Results and discussion

The chemical compositions of the experimental diets, yellow root cassava peel meal (YRCPM) and *Centrosema pubescens* leaf meal (CPLM) used in this study is shown in Table 2. The proximate compositions of the treatments diets (T2, T3 and T4) are all comparable with the control (T1) diet. The crude protein (CP), ether extract (EE) and ash contents, however, tended to increase with increasing level of CPLM in the diets. Conversely, crude fibre (CF), and Nitrogen free extract (NFE) followed a regular pattern, decreasing with increasing levels of CPLM. The dry matter (DM) and gross energy failed to follow a specific pattern across the treatment groups. This maybe attributed to the lower DM values of the respective diets, thus indicating adirect relationship between DM and energy value of a diet.The proximate composition of the yellow root cassava peel meal revealed high DM and CP concentration. The 90.28% DM and 9.23% CP obtained in this study is higher than the values 88.68%DM and 5.35% for DM and CP reported by Ogundipe and Akinlade (2016). The higher DM and CP reported in this study may be attributed to the yellow root fortification of the cassava roots. Similarly, lower CF value (12.93%) was reported in this study which is lower than 17.18% and 16.60 % CF reported by Asuola *et al*. (2012) and Ukanwoko and Ibeawuchi (2014), respectively for cassava peel meal. The improvement in the proximate compositions of the **YRCPM** could be attributed to the biofortifications that have been carried on the yellow root 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. However, the differences in the proximate compositions could be attributed to the location, season, test ingredients, the level of dryness of the ingredients and processing method used.

The carcass characteristics of WAD goats fed yellow root cassava peel - centrosema leaf meal based diets is shown in Table 3. The slaughter weights, warm carcass weights, dressed percentage, lion, shoulder, ends and bone to lean ratio differed statistically ($P<0.05$) across the treatments. Empty weights, legs, set and abdominal fat were statistically ($P>0.05$) similar across the treatment groups. The slaughter weight was significantly ($p<0.05$) highest for the animals in T4 (11.65kg) compared to the T1 (9.39kg) goats. The differences in slaughter weight of the goats could be attributed to the influence of yellow root cassava peel-centrosema leaf meal based diets in providing essential nutrient elements both

for effective rumen function and for body metabolism by the animals (Norton, 1994) which perhaps may have resulted to better weight gain of the goats fed the respective diets. The warm carcass weights also followed a similar pattern as the slaughter weight, which may be due to better balanced nutrient profile of the diets containing yellow root cassava peel and *Centrosema pubescens* leaf meal. Yellow root cassava is high in vitamin A; which is considered an essential nutrient for normal growth and development of an organism (Guimarãesa *et al.*, 2014). This together with higher CP diets (*Centrosema pubescens* leaf meal) may have enhanced meat (muscle) formation among the animals fed the treatment diets. The dressing percentage is both a yield and value-determining factor and therefore an important index in assessing performance of meat producing animals (Yusuf *et al.*, 2014); hence a major indicator of how much meat a carcass can yield. Animals on T4 recorded the highest dressing percentage (54.42 %) whereas animals on T1 recorded the lowest (39.72%).

Table 2: **Chemical compositions of yellow root cassava peel, *Centrosema pubescens* leaf meal and yellow root cassava peel-centrosema leaf meal based diets**

Parameters	A	B	C	D	YRCPM	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 (Kcal/MJ)	3.90	3.92	3.91	3.95	3.71	3.64

The dressing percentage range of 39.72 to 54.42 % reported in this present study is comparable with 50.40 – 52.60% and 50.16 – 51.12% reported by Ahamefule (2005) and Ukanwoko and Onuoha (2011), respectively. The dressing percentage of 39.72 - 54.42% in this study fall within the literature reported range of 38 - 56% for goats (Anjaneyulu and Joshi, 1995; Getahun, 2001). The variation in the dressing percentage of the various treatments in this study may be attributed to nutrition, slaughter weight, age and body conformation of the goats. The meat cuts are expressed as percentage of warm carcass weight. The lion weights showed a linear increase with increasing level of the test ingredient. The lion weight of goats fed T4 gave the highest value (22.11%) but was similar (P>0.05) to that of goats on T3 (20.92%). Goats fed diets T3 and T4 yielded significantly (P<0.05) superior values compared to those fed diet T1 and T2. This thus indicated that inclusion of *Centrosema pubescens* leaf meal at 20% and 30% level in diets of WAD goats enhanced the weight of the lion. T2 diet showed a superior (p<0.05) shoulder weight than other treatment groups. This suggests that the T2 diet influenced the development of shoulder better than other treatment groups. The values obtained in this study are comparable with 25.40% reported by Adebowale and Ademosun (1981) but higher than the range of 13.11 – 14.15% reported by Ukanwoko and Onuoha (2011). The factors that may have attributed to the variations in the shoulder weights include age, slaughter weight and body condition of the goats. The range of values of 16.17 – 19.30% for end obtained in this study is lower than 21.15 - 23.59% reported by *Odoemelam et al. (2014) but higher than 4.20 – 6.10% reported by* Ukanwoko and Onuoha (2011). The control diet however produced the highest end

weight in this present study indicated that the control diet favoured the growth of this meat cut. The end comprises mostly of the rib cage, thus an indication that the muscle deposition on this part of the goats were impaired by the treatments. The goats fed T1 and T2 diets had the highest value for bone to lean ratio. The significantly ($p<0.05$) low bone to lean ratio observed for goats on T4 diets indicates the quality of the diet which was effectively converted to meat. This is evidentin the higher dressing percentage (54.42%) observed compared to other treatment groups.

The offal weight expressed as % of the warm carcass weight of WAD goats fed yellow root cassava peel - centrosema leaf meal based diets is shown in Table 4. All the parameters examined are statistically ($p>0.05$) similar across the treatment groups. The similarities on the offal weights clearly suggest that the diets had no effect on the offal weights of WAD goats fed the experimental diets.

The organ characteristics of WAD goats fed yellow root cassava peel - centrosema leaf meal based diets is presented in Table 5. All the internal organs expressed as % of the empty weight were significantly ($P<0.05$) influenced by the treatment diets. The treatments diets (T2, T3 and T4) percentage contributed to lower liver, lungs, heart, kidney and spleen, weights when compared to the goats on the control diet (T1). The decrease in percentages of lungs, heart, kidney, liver and spleen among the treatment diets reported in this present study, have been previously observed (Marichala *et al*., 2003; *Odoemelam et al., 2014;* Ifut *et al*., 2015). This may indicate the absence or tolerable levels of toxic factors among the goats fed the respective diets or consequently, due to lesser deposition of reserve substances such as glycogen.

Table 3: Carcass weight of WAD goats fed yellow root cassava peel - centrosema leaf meal based diets

	Diets				
Parameters	**T1**	**T2**	**T3**	**T4**	**SEM**
Live weights at slaughter (kg)	9.39^{b}	10.12^{ab}	10.51^{ab}	11.65^{a}	0.27
Empty weight (kg)	5.51	8.02	8.21	8.71	0.21
Warm carcass weight (kg)	3.73^{c}	4.66^{b}	5.11^{ab}	6.34^{a}	0.37
Dressed percentage (%)	39.72^{c}	46.05^{b}	48.62^{b}	54.42^{a}	1.87
Meat cuts as % of warm carcass weight					
Leg	20.21	20.00	21.10	21.91	0.18
Loin	19.00^{b}	19.17^{b}	20.92^{a}	22.11^{a}	0.36
Set	15.28	16.64	16.04	16.11	0.24
Shoulder	23.38^{b}	25.08^{a}	23.01^{b}	23.37^{b}	0.32
End	19.30^{a}	16.49^{ab}	16.17^{b}	16.19^{b}	0.54
Abdominal fat	1.60	1.08	1.59	1.00	0.21
Bone to lean ratio	0.28^{a}	0.28^{a}	0.26^{ab}	0.23^{b}	0.01

^{a,b} means on the same row with different superscripts are significant ($P<0.05$)

Table 4: Offal weights of WAD goats fed yellow root cassava peel - centrosema leaf meal based diets

	Diets				
Parameters	**T1**	**T2**	**T3**	**T4**	**SEM**
Head	8.86	8.53	8.87	8.84	0.55
Limbs	3.97	3.91	4.27	4.33	0.83
Skin	7.41	7.74	8.42	8.30	0.19
Tail	0.12	0.11	0.14	0.12	0.01
Empty gut	8.70	8.36	8.02	9.33	0.15
Testes	0.97	0.92	0.69	0.94	0.01

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

Table 5: Organ characteristics of WAD goats fed yellow root cassava peel - centrosema leaf meal based diets

	Diets				
Parameters	**T1**	**T2**	**T3**	**T4**	**SEM**
Liver	2.11[a]	1.67[b]	1.73[b]	1.69[b]	0.09
Lungs	1.72[a]	1.50[b]	1.16[c]	1.47[b]	0.06
Heart	0.70[a]	0.59[b]	0.57[b]	0.59[b]	0.03
Kidney	0.43[a]	0.41[a]	0.30[c]	0.35[b]	0.02
Spleen	0.19[a]	0.14[bc]	0.15[b]	0.12[c]	0.01

[a,b,c] means on the same row with different superscripts are significant (P<0.05)

The cost/100kg of feed showed (P<0.05) significantly difference among the treatment groups and however decreases with increasing levels of yellow root cassava peel - centrosema leaf meal in the diets. Similarly, cost/kg feed followed a similarly trend with Cost/100kg differing (p<0.05) with increasing levels of the test ingredient. The total cost of feed also differed significantly (p<0.05) with T4 having the lowest value and T1 having the highest value. In this study, the cost of producing feed for the experimental goats decreased from T4 to T1. This significant (p<0.05) decrease in the cost of producing feed for the animalsmaybe attributed to the inclusion of alternative feedstuffs in the diets. This is in agreement with the observation by Jiwuba et al. (2016b) who noted that the inclusion of unconventional feedstuff like Moringa oleifera leaf meal in the diets for goats significantly reduced the cost of feed. The values for feed cost/weight gain was lowest for the goats fed T4 diet (^252.01) and correspondingly highest for T1 animals (^480.33). This implies that feeding (WAD) goats with higher levels (30%) of Centrosema pubescens leaf meal yielded higher meat at lower feed cost. Cost/benefit ratio showed significant (p<0.05) differences with goats on diet T4 having the best value. This result was in agreement with the results of earlier studies by Jiwuba et al. (2016b). The result demonstrated the qualitative benefits and financial returns of using yellow root cassava peel - centrosema leaf meal diets; with T4 having the highest ratio and T1 the lowest value. This entails an expected benefit of ^3.97 (three naira ninety seven kobo) for every ^1 in cost for T4 diet.

Table 6: Economics of production of WAD goats fed yellow root cassava peel - centrosema leaf meal based diets

Cost/100kg feed (^)	4756.00[a]	4662.00[b]	4445.00[c]	4267.00[d]	17.03
Cost/kg feed (^)	47.56[a]	46.62[ab]	44.45[b]	42.67[c]	1.51
Total feed consumed (kg)	23.33	23.52	23.78	23.86	1.23
Total cost of feed (^)	1109.57[a]	1096.50[a]	1057.02[b]	1018.11[b]	11.01
Daily feed cost (^)	12.33	12.18	11.74	11.31	0.76
Total weight gain (kg)	2.31[c]	2.94[c]	3.37[b]	4.04[a]	0.16
Feed cost/weight gain	480.33[a]	372.96[b]	313.66[c]	252.01[d]	7.92
Cost/kg live weight	1000	1000	1000	1000	0.00
Cost benefit ratio	1:2.08	1:2.68	1:3.19	1:3.97	

[a-d] means on the same row with different superscripts are significant (P<0.05)

Conclusion

It can be concluded from the results that yellow root cassava peel - centrosema leaf meal could be used as dry season supplement for WAD goats. The supplement yielded better dressing percentage, meat cuts, cheaper cost per weight gain and best cost/benefit ratio. Results from organ characteristics proved the safety of the supplement for WAD bucks; since the anti-nutrients were tolerable for the goats as evidenced by

lesser organ weights in comparison with the control animals. The diet is therefore recommended for WAD goat production because of its rich vitamin A, high nutrient profile, better dressing percentage and cheaper cost of production.

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