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Performance of West African Dwarf (WAD) Bucks Fed Pigeon Pea-cassava Peel Based Diets

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Abstract: Twelve weaner bucks aged 5-6 months and averaging 10 kg in weight were randomly divided into 4 groups of 3 animals each and housed individually in cement floored pens. Four experimental diets A, B, C and D were formulated and randomly allocated to the 4 animal groups in a completely randomized design. The diets, compounded from cassava peel, palm kernel cake, brewers' dry grains, bone meal and common salt, contained 0, 10, 20 and 30% pigeon Pea Seed Meal (PSM), respectively. Each group received each diet for 61 days. Parameters measured were Average Daily Gain (ADG), Feed Conversion Ratio (FCR), cost per kg gain and dressing percent for the respective groups. Results showed that ADG differed significantly ($p>0.05$) among diets. The values were 46.81, 69.17, 87.85 and 98.05 g d^{-1} for diets A, B, C and D, respectively. FCR was least for goats fed diet D (4.61) and this did not differ significantly ($p>0.05$) from values obtained for goats fed diets B (6.43) and C (4.83); it however differed significantly ($p<0.05$) from 7.74 which was the corresponding value for goats fed diet A. Feed cost (N) per kilogram gain was similar ($p>0.05$) for groups fed diets A (104.68), B (105.74) and D (107.71) and these values were significantly higher ($p<0.05$) than the value obtained for the group fed diet C (94.61). Dressing Percentage (DP) also differed significantly ($p<0.05$) among treatment groups. Goats fed diets C (52.25) and D (52.63) had comparably higher values than those fed diets A (50.40) and B (50.63). Diet C promoted the cheapest lean and the greatest return on investment. The result of this study would highlight the benefits of rearing goat intensively and encourage goat fattening programmes even among subsistent farmers in our local environments in Nigeria.

Key words: WAD, buck, pigeon pea, diets

INTRODUCTION

In Nigeria, the West African Dwarf (WAD) goat is essentially raised for meat. They are reared extensively in the rainforest belt and derived savanna zone where they are mostly found[1]. The extensive system of goat production in Nigeria with its 'shallow' emphasis on nutrition and health care, imply that goats and indeed the WAD, would mature rather slowly, attaining slaughter weights at some relatively old age.

Most recently, livestock farmers in response to consumer demands are producing young animals for meat. This is beneficial to the farmer in terms of greater turnover, quick returns on investment and the fact that younger animals produce leaner carcasses[2]. Although the WAD goat has not been genetically improved for meat production, its present meat status, if adequately harnessed can, in fact be used to reduce the yawning gap between the animal protein need (25 g d^{-1}) and supply (10 g d^{-1}) in the diet of Nigerians[3]. There is thus a pressing need to increase domestic meat production in Nigeria, including the WAD goat, through rapid multiplication programmes that would ensure better management and cost effectiveness.

One of the major constraints to goat production in Nigeria is inadequate nutrition. The seasonal fluctuations of fodder in quantity and quality[4] make raising of goats on range a timeless and unprofitable venture. Before now, subsistent farmers believed that goats and indeed the WAD, were to be raised in the wild[5] and therefore could not create the enabling environment required for proper domestication and feeding. Any program aimed at improving production of this breed must address the important issue of year round provision of feed. There is, therefore, the need to change or augment the nutrition of these animals with concentrate formulations based on locally available and non competitive feedstuffs. Some of these feed materials, otherwise known as alternative feedstuffs include pigeon pea and cassava peel.

Cassava peel is a kitchen / industrial waste derived from cassava tuberous root (*Manihot utilisima*) processing. Its nutritional content and limitations in ruminant nutrition have been extensively studied[6]. Due to the prevailing demand on the cassava crop as a staple in Nigeria, the by-products, especially the peels, are largely available but grossly under utilized.

Pigeon pea (*Cajanus cajan*) is a grain legume of relatively low human preference and demand in Nigeria. It is only mainly cultivated in the middle belt area as intercrops in cassava and / or yam plots. It grows wild in other parts of Nigeria where little is known of it as a food crop. Consumption is rare even in cultivated areas and

occurs only during scarcity of other conventional grain legumes like soya, groundnut and cowpea. It is rich in nitrogen (21-30% CP)[7].

WAD goats were raised intensively in this study to attain good market weights in the shortest possible time. This was achieved by feeding weaned (buck) kids with balanced affordable nutrition derived mainly from pigeon pea seed and cassava peel. The study objectives were to determine the carcass value, the economics of production as well as the overall performance of goats fed pigeon pea-cassava peel based diets. The result of this study would highlight the benefits of rearing goat intensively and encourage goat fattening programmes even among subsistent farmers in our local environments in Nigeria.

MATERIALS AND METHODS

Animal management: Twelve WAD bucks of 5-6 months of age and averaging 10 kg (range 9-11 kg) in weight were procured from the University environs for this study. Prior to the trial, the animals were first quarantined for 21 days, dewormed with Febendazole and given acaricide bath using pfizona. Each animal was subsequently housed individually in well ventilated cement floored pen equipped with a feeder and waterer. Each animal received 0.5 kg of *Panicum maximum* and 0.5 kg of the control diet (A) (Table 1) for a preliminary period of 21 days. This was done to build up each animal's appetite for a concentrate diet regimen. After the preliminary feeding period, all the animals were weighed and randomly divided into four groups of 3 animals each.

Processing of cassava peel and pigeon pea seed: Cassava peels (variety TMS 30555) from 12-14 month old plants were collected fresh from the commercial 'Garri' processing unit of the National Root Crops Research Institute (NRCRI), Umudike. The lot was subsequently sun-dried for 3 days to about 10% moisture content before being milled and used in this study as dried cassava peel meal.

Pigeon pea (*Cajanus cajan*) seeds (brown variety) were purchased from a grain market in Aba, Abia State of Nigeria. Known quantities of the seed were boiled in batches in mammoth cooking pots at 100°C for 30 min. Water was decanted, the boiled seeds were then sun-dried for 3 days before being milled and used as pigeon pea seed meal (PSM).

Table 1: The composition of pigeon pea-cassava peel based diets

	Diets			
Ingredients (%)	A	B	C	D
Cassava peel	42	42	42	42
Pigeon pea	0	10	20	30
Brewers dry grain	35	25	15	5
Palm kernel cake	20	20	20	20
Bone meal	2	2	2	2
Common salt	1	1	1	1
Total	100	100	100	100

Experimental diets and parameters measured: Four experimental diets designated A, B, C, D were formulated from pigeon pea, cassava peel and other feedstuffs as listed in Table1. Diet A with 0% PSM inclusion served as the control.

The four experimental diets were allotted randomly to the 4 animal groups. Each animal within a group received 1kg of an assigned diet daily for 61 days. Potable drinking water was liberally provided. Daily feed intake and weekly body weights of animals were recorded. Average daily feed intake (ADFI), average daily gain (ADG) and feed conversion ratio (FCR) were computed. The economics of production for each treatment group was also determined. At the end of the feeding trial, three animals per treatment group were slaughtered for carcass evaluation.

Slaughter of goats and handling of carcass: Goats were starved 24 h prior to slaughter. Each animal was weighed just before slaughter, after slaughter and after dressing. The dressed carcasses were chilled in a deep freezer at -5°C for 24 h Dressing percentage was calculated as the weight of dressed chilled carcass in relation to live weight before slaughter. A dressed (chilled) carcass is the weight of the goat after removal of the head, skin, contents of thoracic and pelvic cavities (including the diaphragm and kidney) and the limbs distal to the carpal and tarsal joints. Each gut was weighed, cleansed and re-weighed. The weights of the heart, the liver without the gall bladder, the lungs, the spleen, the kidney and the limbs (four feet) distal to carpals and tarsal, were also recorded.

Jointing the carcass (meat cuts): This was carried out according to procedures described in[8]. Each dressed carcass was divided the spinal column by means of a meat saw. Each half was weighed. The left half was subsequently divided various cuts. The leg (thigh) was severed at the attachment of the femur to the acetabulum, the loin consist of the lumbar region plus a pair of ribs, the ends (spare ribs plus belly) consist of six abdominal ribs, the shoulder consist of the scapula and the sets made up of the breast and the neck. Each of the cuts except the sets, was weighed and the weight doubled in each case before being expressed as a percentage of the dressed carcass. The weight of breast was first doubled and subsequently added to the weight of the neck to derive the weight of the sets. The leg plus loin cuts were dissected into muscles and bone with ligaments to obtain the meat/ bone ratio.

Experimental design and analytical procedure: The experiment was a completely randomized design with four diets randomly assigned to four groups of three goats per group. Data obtained were analysed using Analysis Of Variance (ANOVA) procedures[9]. Significant means were separated using Duncan's Multiple Range Test[10]. Proximate compositions of the diets were determined by[11] methods. Meat cuts were expressed as percentages of the chilled carcass while organ / offal weights were expressed as percentages of the empty live weight. Empty live weight is defined as the live weight at slaughter minus gut content.

RESULTS AND DISCUSSION

The proximate constituents of the experimental diets, the cassava peels and pigeon seed meal used in this study are presented in Table 2.

The proximate values for the cassava peel were similar to those reported by Smith and ahmaefule *et al.,*[6,7]. The proximate constituents of the pigeon pea also fell within the range of values obtained by Amaefule[2]. The dry matter percent of the PSM diets (B, C, D) compared favorably with that of the control diet (A). The crude protein and crude fibre contents of the PSM diets were also relatively higher than those of the control diet and tended to increase with increasing levels of pigeon pea seed meal in the diets. Ether extract, ash and energy values declined from diets A-D while the nitrogen-free extract values did not show any consistent trend among the diets.

The performance of WAD goats fed pigeon pea-cassava peel diets are presented in Table 3. Generally, the goats consumed the PSM diets (B, C, D) more than the control (A). Total intake however did not differ significantly ($p>0.05$) among treatments.

Average daily gain (ADG) differed significantly ($p<0.05$) among treatment groups. Goats placed on the control diet gained, on the average, 46.81 g daily which is similar ($p>0.05$) to the value of 69.17 g obtained for goats fed 10% PSM diet, but differed significantly ($p<0.05$) from the corresponding values of 87.85 and 98.05 g recorded for goats fed diets containing 20 and 30% PSM respectively.

Table 2: Chemical compositions of pigeon pea, cassava peel and pigeon pea-cassava peel based diets (%DM)

Diets	A	B	C	D	CSP	PSM
Dry matter (DM)	89.32	89.34	89.32	89.30	90.22	88.50
Crude protein (CP)	13.25	13.30	13.45	13.65	3.05	25.04
Crude fibre (CF)	9.62	10.94	12.42	12.68	14.50	7.50
Ether extract (EE)	4.46	4.32	4.28	4.14	0.70	2.33
Nitrogen free extract (NFE)	51.57	50.94	50.35	50.87	66.47	50.78
Ash	10.42	9.84	8.82	7.96	5.50	2.85
Gross energy (GE) (Kcal g^{-1})*	3.44	3.32	3.21	3.09	1.82	3.95

* Calculated CSP = Cassava peel. PSM = Pigeon pea seed meal

Table 3: Performance of WAD goats fed pigeon pea-cassava peel based diets

Parameters	A	B	C	D	SEM
Mean Initial weight (kg)	10.00	009.33	009.67	010.83	0.73
Mean Final weight (kg)	12.85	013.55	015.03	016.82	1.40
Total feed intake (kg)	21.67	025.79	024.38	027.01	3.18
Feed intake (g/day)	355.17	422.87	399.62	442.74	52.10
Total BW gain (kg)	002.85b	004.22 ab	005.36 a	005.99 a	1.74
ADG (g/day)	046.81b	069.17ab	087.85a	098.08a	15.19
FCR	007.74b	006.43ab	004.83a	004.61a	1.02

[a, b] . Means on the same row with different superscripts differsignificantly ($p<0.05$). SEM = standard error of the mean. ADG = Average daily gain. FCR = Feed conversion ratio.

The PSM diets generally supported more live weight gains in this study than the control diet, with diet C (20% PSM) performing relatively better than the others. For instance, even though there were similarities ($p>0.05$) in total weight gain, ADG and FCR values for goats fed diets B, C and D (PSM diets) in this study (Table 3), goats fed diet C however, consumed less feed than those fed either diets B or D for each kilogram weight gain (Table 4) and therefore had significant ($p<0.05$) least cost per kilogram weight gain in relation to the other groups. Meanwhile the ADG value of 46.8 g obtained for animals on control diet fell within the range of 35-65 g reported for WAD goats within first 12 months of life[1], but is lower than the mean value of 84.92 g obtained for WAD goats fed PSM diets.

The non-concurrent values within breed may be due to differences in management. Results reported by[1] were obtained from a survey study of animals on range. The present results were obtained from WAD goats on intensive management.

Table 4 shows the economics of feeding goats with pigeon pea-cassava peel based diets. Cost of production per kilogram of feed for the control diet was similar ($p>0.05$) to that of diet B but differed significantly ($p<0.05$) from those of diets C and D. As the inclusion levels of PSM in the diets increased from 0% in the control diet to 30% in diet D, total cost of feed consumed as well as total weight gain per group also differed significantly ($p<0.05$). Feed cost per kg gain was lowest for goats fed the 20% PSM diet and this differed significantly ($p<0.05$) from the corresponding costs derived for goats fed 0,10 and 30% PSM diets.

The implication of this result is that fattening or feeding WAD goats with cassava peel based diets containing PSM at levels higher or lower than 20% may not necessarily differ from control group ($p>0.05$) in terms of profitability, but at 20% level however, there will be relative minimum feed intake, maximum feed utilization via weight gain, as well as greatest return on investment.

Table 5 summarizes the carcass yield of WAD goats in this study. Live weight at slaughter, empty live weight and cold carcass weight were generally higher for goats fed the PSM diets than the control.

Table 4: Economics of feeding WAD goats with Pigeon pea-cassava peels diets.

	Diets				
Ingredients (N)	A	B	C	D	SEM
Cassava peel	210	210	210	210	
Pigeon pea	0	550	1100	1650	
Brewers dried grain	700	500	300	100	
Palm kernel cake	240	240	240	240	
Bone meal	180	180	180	180	
Salt	50	50	50	50	
Cost per 100kg diet	1380.00^{d}	1730.00^{c}	2080.00^{b}	2430.00^{a}	143.00
Cost per kg diet	13.80^{c}	17.30^{bc}	20.80^{a,b}	24.30^{a}	1.40
Total feed consumed (kg)	64.99^{c}	77.38^{bc}	73.13^{b}	81.00^{a}	2.00
Total cost of feed	896.86^{d}	1338.67^{c}	1521.10^{b}	1968.78^{a}	132.00
Total weight gain (kg)	8.56^{c}	12.65^{b}	16.07^{a}	17.94^{a}	2.25
Feed cost per kg gain	104.68^{a}	105.74^{a}	94.61^{b}	109.71^{a}	3.05

^{abcd} Means on the same row with different superscripts differ significantly ($p<0.05$)

Table 5: Carcass, organ and offal yield of WAD goats fed Pigeon pea-Cassava peel based diets

	Diets				
Parameters	A	B	C	D	SEM
Live wt at slaughter (kg)	12.85	13.55	15.02	16.82	1.40
Empty live wt (kg)	9.80	10.36	11.60	13.26	0.97
Cold carcass (kg)	6.48	6.86	7.89	9.04	0.73
Dressing %	50.40^{b}	50.63^{b}	52.25^{a}	52.63^{a}	0.24
Leg (g)	1924.67	1992.67	2509.67	2730.33	228.06
Loin (g)	1108.00	1144.67	1152.67	1434.33	88.93
Sets (g)	844.33	931.67	1134.33	1208.00	97.37
Ends (g)	710	808.00	902.00	1222.33	93.17
Shoulder (g)	1899.67	1997.33	2192.67	2356.00	244.53
Abdominal fat (g)	126.67	150.00	166.67	243.33	32.16
Bone to lean ratio	0.29^{a}	0.28^{a}	0.21^{b}	0.25^{b}	0.03
Head (g)	1145.67	1083.33	1173.67	1221.67	103.75
Skin (g)	1040.00	950.00	1057.33	1200.00	64.88
Feet (g)	427.33	400.00	396.67	441.67	34.98
Full gut (g)	3382.00	3193.00	3421.33	3558.00	465.66
Empty gut (g)	1275.67	994.67	1214.00	1254.00	161.32
Liver (g)	200.00^{b}	216.67^{b}	225.00^{b}	260.00^{a}	5.61
Kidney (g)	50.00^{c}	75.00b^{c}	91.67^{b}	241.67^{a}	6.80
Heart (g)	75.00	75.00	75.00	75.00	0.00
Spleen (g)	25.00	25.00	27.33	33.33	2.44
Lungs (g)	181.67	189.67	180.00	181.33	5.80

^{a,b,c} Means on the same row with different superscripts differ significantly ($p<0.05$)

These values however, did not differ ($p>0.05$) significantly among treatment groups.

Dressing Percentage (DP) differed significantly ($p<0.05$) among treatment groups. Animals fed the control diet had the lowest DP which was similar ($p>0.05$) to that recorded for goats fed diet B but differed significantly ($p<0.05$) from values obtained for goats fed diets C and D. Goats that consumed diets C and D had similar and significantly lower ($p<0.05$) feed conversion ratios (4.83; 4.61) (Table 3) than the control diet A which may be responsible for the observed higher and similar DP recorded for these two groups (Table 5). However, the DP values obtained for animals fed the control ration and diet B did not differ ($p>0.05$) significantly. Meanwhile the DP of the control and the PSM fed goats compared favorably with the range (45-52%) and value (50%) reported by[1] respectively, for WAD goats.

The meat cuts differentiated into leg, loin, sets, ends and shoulder (Table 5) also did not differ ($p>0.05$) among treatment groups but tended to be heavier for goats fed PSM diets than the control group. PSM therefore can be used effectively in goat fattening programs to enhance the weight of meat cuts. Meat cut values obtained for both the control and PSM fed groups are in consonance with values obtained by[13] for WAD goats. The average meat cuts (kg) per treatment, expressed as percentage of the mean chilled carcass weight (Table 6) ranged from 30.11 – 38.18% for the leg, 14.06 – 19.04% for the loin, 10.10 – 15.90% for the sets, 7.03 – 16.86% for the ends and 30.31 – 38.17% for the shoulder.

The bone to lean (meat) ratio differed ($p<0.05$) significantly among treatment groups in the present study (Table 5). Animals fed control diet A had the highest bone to lean ratio which was similar ($p>0.05$) to the value for goats fed 10% PSM diet, but differed ($p<0.05$) significantly from those of goats fed 20 and 30% PSM diets. The higher bone to lean ratio observed for the control and diet B groups indicate poor meat conversion within animals in these groups. This observation is further collaborated by the relatively higher but comparable feed conversion ratios also recorded for these two treatment groups (Table 3) in this study. High feed conversion ratios usually portray inability of animals to maximize feed intake by failure to optimally utilize feed for meat production. Animals consuming the 30% PSM diet had the least bone to lean ratio which is evidence of high feed utilization efficiency of the group.

Table 6: Average weight of meat cuts, organ and offal weights expressed as percentages of chilled carcass or empty live weight.

		Treatments				
Type	Percent of	1	2	3	4	X
Meat cut						
Leg	Chilled	29.7	28.92	31.8	30.2	30.15
Loin	Carcass	17.09	16.61	14.6	15.87	16.04
Sets		13.02	13.52	14.37	13.36	13.56
ends		10.95	11.73	11.43	13.52	11.9
Shoulder		29.31	28.49	27.79	26.06	27.91
Offals						
Head	Empty	11.69	10.45	10.11	9.21	10.36
Skin	Live weight	10.61	9.16	9.11	8.29	9.29
Feet		4.36	3.86	3.14	3.31	3.73
Empty gut		13.01	9.6	10.46	9.45	10.63
Organs						
Liver	Empty	2.04	2.09	1.93	1.96	2
Kidney	Live weight	0.51	0.72	0.79	1.82	0.96
Heart		0.76	0.72	0.64	0.56	0.67
Spleen		0.25	0.24	0.23	0.25	0.24
lungs		1.85	1.83	1.5	1.15	1.58

The FCR and DP of this group (30% PSM) which is the lowest (Table 3) and highest (Table 5) respectively, also support this view. Despite these outstanding performance of diet D, goats fed diets C compared fairly well ($p>0.05$) with diet D in terms feed conversion ratio (Table 3), bone to lean ratio and dressing percentage (Table 5), but had comparative advantage over diet D in producing the cheapest lean or least cost per kg weight gain (Table 4).

The offals differentiated into weights of head, skin, feet, full gut and empty gut (Table 5) did not differ ($p>0.05$) among treatment groups. Mohammed[14] also did not observe any effect of diets on offal weights when dry *Acacia albida* pods were supplemented in the diets of Bornu White goats. Offal weights expressed as percentages of empty live weight (Table 6) ranged from 9.21 – 11.69% with a mean of 10.36% for the head, 8.29 – 10.61% (mean 9.29%) for the skin, 3.31- 4.36% (mean 3.73%) for the feet and 9.45 – 13.01% with a mean of 10.63% for the empty gut.

The mean organ weights for the different treatment groups are also shown in Table 5. Save for the weights of the liver and kidney, all other organs (the heart, the spleen and the lungs) did not differ ($p>0.05$) significantly in weight among treatment groups. The liver weight of goats fed the control diet compared favorably ($p>0.05$) with those of goats placed on diets B and C. The animals fed diet D had the heaviest liver weight which differed ($p<0.05$) significantly from those fed diets A, B and C. Kidney weight was also significantly ($p<0.05$) heaviest for goats fed diet D.

It is a common practice in feeding trials to use weight of some internal organs like liver and kidney as indicators of toxicity in feed. Bone[15] reported that if there is any toxic element in diets used in feeding trials, abnormalities in the weights of these organs will be observed. The abnormalities will arise because of increased metabolic rate of these organs in an attempt to reduce these toxic elements or anti-nutritional factors to non-toxic materials.

The cassava peel and pigeon pea seed used in this study contained some toxic or anti-nutritional properties in their raw state which limit their use in livestock nutrition. Drying for cassava peel[7]and boiling for pigeon pea seed[12] are effective methods of detoxifying the anti-nutritional properties in these feedstuffs, but these processing methods, according to[16] however, do not completely eliminate, but only reduce the concentrations of these anti-nutritional properties to a tolerable level in the feedstuffs. The remnants are further brought to a non-lethal level in the body by the dual action of the liver and the kidney. Depending on the concentration of these remnants in feedstuff and consequently in formulated rations, the size of the liver and kidney may enlarge as they increase their metabolic activities to reduce toxicity.

Though sun-drying and boiling were used as processing methods for cassava and pigeon pea seeds respectively in this study, these methods may have left traces of anti-nutritional properties in the feedstuffs and consequently in the experimental diets, with the result that diet D which had the highest PSM inclusion (30%) probably also had the highest concentrations of these anti-nutritional properties. This invariably may explain the significantly superior liver and kidney weights recorded for goats fed diet D. Meanwhile, organ weights expressed as percentages of empty live weight (Table 6) are in agreement with reports of[17] for WAD goats and ranged from 1.96 – 2.09% with a mean of 2.0% for the liver, 0.51 – 1.52 with a mean of 0.96% for the kidney, 0.56 – 0.76% with a mean of 0.67% for the heart, 0.23 – 0.25% with a mean of 0.24% for the spleen and 1.15 – 1.85% with a mean of 1.58% for the lung.

CONCLUSIONS

Pigeon pea and cassava peel, in combination with other locally available feedstuffs can be exploited to a good advantage to improve nutrition of WAD goats in Nigeria. This study has shown that the traditional goat production systems can be replaced with simple feasible intensive goat rearing programmes based on locally available and non-competitive feedstuffs. Such programmes can gainfully be executed 5-6 times in a year, thereby increasing production of WAD goats and placing animal protein within the reach of the average Nigerian.

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