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Performance of West African Dwarf (WAD) Goats Fed Raw or processed pigeon pea (*Cajanus cajan*) seed meal based diets.

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Abstract

A study was carried out to evaluate the effect of processing methods of pigeon pea seeds on the performance and carcass quality of goats using 16 weaner West African Dwarf (WAD) goats fed diets containing 15% raw (RPBD), soaked (SPBD), toasted (TPBD) and boiled (BPBD) pigeon pea seed meal. The experiment which lasted for 60 days was laid out in a completely randomized design using diets as treatments. The four diets had same percentage inclusion of every ingredient including pigeon pea seed meal which differed only in process form. Results showed that final weight, total weight, daily weight gain and feed conversion ratio differed significantly (P<0.05) among treatment groups. Goats fed boiled pigeon pea based diet (BPBD) had significantly (P<0.05) heavier final weight (10.87kg) than those fed toasted (8.25kg), soaked (7.56kg) and raw (7.25kg) pigeon pea diets. Total weight gain (kg) followed similar pattern as the final weight with the following values obtained for boiled (4.62kg), toasted (2.13kg), soaked (1.56kg) and raw (1.19kg) pigeon pea seed based diets. BPBD had the least feed conversion ratio relative to other diets. However, total and daily feed consumption did not differ (P>0.05) among treatment groups. The best dressing out percent of 58.07% was obtained for the boiled PBD which differed significantly (P<0.05) from values obtained for goats fed raw (33.05%), soaked (36.96%) and toasted (38.72%) pigeon pea based diets. The least cost per kilogram weight gain was obtained for goats fed BPBD (N300), while the highest (N996.15) was from goats fed RPBD. Carcass / organ evaluation showed that warm carcass, loin, set, lungs, kidney and bone to lean ratio were significantly affected by the dietary treatments, and BPBD gave highest values for all except in kidney, liver and bone to lean ratio. The results above suggest that pigeon pea seed can be used generally to improve performance in WAD goats. However, BPBD promoted superior weight gain and dressing percentage, least production cost and FCR as well as superior carcass characteristics relative to raw, toasted and soaked pigeon pea based diets.

Keywords:

Introduction

Goats provide over 25% of the lean meat consumed in Nigeria (FAO, 1993). The WAD goat is a trypanotolerant meat breed found within the rainforest and derived savannah ecological belt of Nigeria (Eroarome, 2006). The population of this breed put at about 28 million (FAOSTAT, 2006) has continued to increase marginally over the years. This has become a major source of concern to farmers, agriculturists and local husbandmen who rear rather than produce them (Ahamefule, 2005). More worrisome is the lack of commitment on the part of government to legislate towards improvement and multiplication of this prolific hardy breed. Such legislation is expected to proffer intervention in the areas of management, disease control and year round provision of feed.

Nutrition is a major constraint to the production of this breed (Ahamefule *et al.*, 2007). The extensive mode of production which the animals are exposed to guarantees abundant fodder only during the rainy season (April – October); the dry period of November to March, characterized by limited and low quality fodder, expose the animals to severe nutritional stress. Revision of the present production system to a semi-intensive approach where materials gleaned from natural environment could be supplemented with concentrate formulations, especially during the dry months, could perhaps be one of the intervention areas needed to enhance the proliferation of this indigenous breed.

In Nigeria, animal nutritionists, in the bid to reduce competition between man and animals for conventional plant protein sources, are subjecting to nutritional trials, hitherto discarded or non-competitive legume pulses like pigeon pea seed. The essence is to produce cheap and available feed that will meet the nutritional requirement for livestock. and, indeed, for goat production.

Pigeon pea is a leguminous plant whose seed has low human demand in Nigeria. Even though it can be cultivated, it grows wild in certain parts of Nigeria where little is known of it as food crop. It is rich in nitrogen (19-30% CP, Amaefule, 2002). Boiled Pigeon pea has been fed in a concentrate diet to WAD goats at 10% level of inclusion with remarkable results (Ahamefule *et al.*, 2005). However, the relatively high concentration of anti-nutritional factors (heamagglutinins, tannins, cyanogens, phytates, lecithins, protease inhibitors etc) in the seed (Amaefule, 2002; Ahamefule, 2005) limits its utilization by livestock in the raw state. There is dearth of information on the best acceptable form of pigeon pea to WAD goats hence this study was designed to evaluate the influence of different processing methods of pigeon pea on the performance of WAD goats.

Materials and Methods

Experimental Site

The study was carried out at the Goat Unit of the Teaching and Research Farm, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. Umudike bears the co-ordinate of 5°28' North and 7°31' East, and lies at an altitude of 122m above sea level. Located within the tropical rainforest zone, the environment is characterized by an annual rainfall of about 2177mm. The relative humidity during rainy season is well above 72%. Monthly ambient temperature range is 17-36°C. March is the warmest month with an average temperature range from 22-30°C.

Animal Management

Sixteen weaner West African Dwarf (WAD) goats consisting of twelve bucks and four does were procured from Akwa Ibom State of Nigeria. The animals were dewormed and treated against mange and other external parasites using albendazole and asuntol, respectively. The goats were then quarantined for 14 days and fed for a preliminary period of 30 days with forage and supplements of the test diets for acclimatization. They were subsequently divided randomly into 4 groups of 4 animals each, consisting of three bucks and a doe, and housed individually in well ventilated cement floored pens equipped with feeders and waterers.

Experimental Design /Procedures

Four diets were formulated to contain respectively 15% raw, boiled, soaked and toasted pigeon pea seed meal. These diets were randomly assigned to the 4 animals groups in a Completely Randomized Design. Each goat received 1kg daily supplement of an assigned diet for 60 days. Clean portable drinking water was provided for each animal within the period. Voluntary feed intake was determined daily for each animal by subtracting feed refusals (weighed) of the following morning from the previous day's feed supply. Daily feed intake and weekly body weights were recorded for each animal. These were used to derive average daily feed intake, average daily weight gain, feed conversion ratio and economics of production for each treatment group.

Experimental Diets

Four (4) experimental diets containing raw, soaked, toasted and boiled pigeon pea based diets were formulated with other conventional feed stuffs as shown in Table 1

Processing of Pigeon Pea

Pigeon pea (*Cajanus cajan*) seeds (brown variety) were purchased from a grain market in Aba, Abia State and processed as follows:

Soaked: Twenty-five (25) kg of raw pigeon pea seeds were soaked in water (normal temperature) and in batches for 24 hours. The water was decanted and the soaked seeds were sun – dried

Table 1. Percentage composition of the experimental diets

INGREDIENTS	DIETS			
	RPBD	BPBD	SPBD	TPBD
Cassava peel	44.5	44.5	44.5	44.5
Palm kernel cake	20.0	20.0	20.0	20.0
Brewer dried grain	18.0	18.0	18.0	18.0
Pigeon pea	15.0	15.0	15.0	15.0
Bone meal	2.0	2.0	2.0	2.0
Common salt	0.5	0.5	0.5	0.5
Total	100	100	100	100

RPBD = Raw Pigeon pea seed based diet. BPBD = Boiled Pigeon pea seed based diet
SPBD = Soaked Pigeon pea seed based diet. TPBD = Toasted Pigeon pea seed based diet

Table 2: Proximate Compositions of the Experimental Diets (% DM basis)

Parameters (%)	DIETS					
	RPBD	SPBD	TPBD	BPBD	Cassava Peel	Pigeon Pea Seed
Dry matter	88.84	83.58	89.38	85.73	90.22	88.50
Crude protein	13.16	13.07	12.75	13.12	3.05	25.04
Crude fibre	7.25	6.19	4.05	6.25	14.50	7.50
Ether extract	4.82	4.71	4.85	4.90	0.70	2.33
Nitrogen free extract	57.92	54.04	62.32	55.86	66.47	50.78
Ash	5.69	5.27	5.41	5.60	5.50	2.85
*GE (MJ/Kg)	3.89	3.70	3.92	3.78	1.82	3.95

*Calculated PBD = Pigeon pea seed based diet GE = Gross Energy
RPBD = Raw Pigeon pea seed based diet BPBD = Boiled Pigeon pea seed based diet
SPBD = Soaked Pigeon pea seed based diet. TPBD = Toasted Pigeon pea seed based diet.

for 3 days before being milled and used to formulate soaked pigeon pea meal-based diet (SPMD).

Toasted: Twenty-five (25) kg of raw pigeon pea seeds were toasted in batches at 100°C in a frying tray for 30 minutes. The product was milled with 3mm sieve and used to formulate toasted pigeon pea meal-based diet (TPMD).

Boiled: Twenty-five (25) kg of raw pigeon pea seeds were in batches introduced into a mammoth cooking pot containing 20 litres of water which had attained 100°C of boiling point. The content was allowed to boil for 30 minutes. Water was decanted, the boiled seeds were then sun-dried for 3 days, milled as in above and used to formulate boiled pigeon pea meal-based diet (BPMD).

Raw: Twenty-five (25) kg of raw pigeon pea seeds were milled and used to formulate the raw pigeon pea meal based diet (RPMD).

Slaughter Technique

Three goats per treatment group, two bucks and a doe, were starved 24 hours prior to slaughter. They were weighed individually before slaughter. Subsequent weights were taken after slaughter and dressing. Dressing percentage was calculated as the weight of dressed warm carcass in relation to live weight before slaughter. A dressed warm carcass is defined as the weight of the goat after removal of the head, skin, the limbs distal to the carpal and tarsal joints and contents of thoracic and pelvic cavities (including the diaphragm and kidney). The lungs, heads, skin, heart, the liver and the limbs (four feet) distal to carpal and tarsal were weighed also.

Carcass Evaluation

At the end of the feeding trial, three animals per treatment, two bucks and a doe, were slaughtered for carcass evaluation. The carcass was evaluated according to method of Ahamefule (2005). Each dressed warm carcass was divided down the spinal column by means of a meat saw. Each half was weighed. The left half was subsequently divided into various cuts consisting of thigh, loin ends, shoulder and sets. Each of the cuts was weighed and the weight doubled in each case before being expressed as a percentage of the dressed carcass. The leg (thigh) was severed at the attachment of the femur to the acetabulum, the loin consists of the lumber 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. The loin cuts were then dissected into muscles and bone with ligament to obtain the meat to bone ratio.

Analytical Procedure

All feed samples were analyzed for proximate composition using AOAC (1990) methods.

Statistical Analysis

The data obtained from the study were subjected to analysis of variance (ANOVA) procedure (Steel and Torrie, 1980). Significant means were separated using Duncan's Multiple Range Test (Duncan, 1955).

Results and Discussion

Proximate Composition of Experimental Diets

The proximate compositions of the experimental diets are given in Table 2. The proximate values of the cassava peel were within the range of what was earlier reported (DM = 88-90%, CP = 3.9-4.5%, CF = 8.4-9.0%, EE = 8.0-9.0%, NFE = 50-59%, Ash = 10.8-11.50%) by Smith (1988) and Ahamefule (2005). The proximate constituents of the pigeon pea were also similar to values obtained by Amaefule (2002) in a previous investigation (DM = 85%, CP = 25.28%, CF = 4.0%, EE = 2.0%, NFE = 51%, Ash = 11.0%). The dry matter of diets containing raw (88.84%) and toasted pigeon pea seeds (89.38%) were fairly similar but slightly different from values obtained for diets containing soaked (83.58%) and boiled (85.73%) pigeon pea seeds. These DM values are within the range of 80-89% reported for pigeon pea based diets in previous investigations (Ahamefule *et al*., 2006; Okah, 2007).

The highest crude fibre (%) and ash values were obtained in the raw pigeon pea diet (RPBD). The crude protein (%) concentrations were fairly similar for all diets (13.07-13.16%) except for the toasted pigeon pea based diet which was slightly lower (12.75%). This may be attributed to the influence of heat treatment on the test seed which perhaps may have denatured some of the protein components thereby given lower CP value. Toasting, as a processing method has been shown (Amaefule, 2002) to lower the CP content of pigeon pea relative to the raw seed. The CP value of BPBD (13.12%) in this study compares with 13.65% obtained by Ahamefule *et al.* (2006) for a diet of similar composition. The EE, NFE and ash values of raw, soaked, toasted and boiled pigeon pea diets are within the range of what has been reported (Amaefule, 2002; Ahamefule *et al*., 2006) for diets of similar compositions in earlier experiments. The CF obtained for the TPBD was the lowest probably because of the effect of raw heat on the seed coat. The gross energy was comparable for all diets.

Performance of WAD Goats

The performance of WAD goats fed raw and processed pigeon pea based diets are shown in Table 3. The final weights promoted by the raw (7.25kg), soaked (7.56kg) and toasted (8.25kg) pigeon pea based diets did not differ significantly ($P>0.05$). The diet containing the boiled pigeon pea however produced goats of higher and significant ($P<0.05$) final weight (10.87kg). This

Table 3. Performance of WAD Goats Fed Raw or Processed Pigeon Pea Seed Based Diets.

	Diets				
Parameters	RPBD	SPBD	TPBD	BPBD	SEM
Initial weight/goat (kg)	6.06	6.00	6.12	6.25	0.70
Final weight / goat (kg)	7.25^{b}	7.56^{b}	8.25^{b}	10.87^{a}	0.69*
Total weight gain / goat (kg)	1.19^{b}	1.56^{b}	2.31^{b}	4.62^{a}	0.60*
Total feed consumed / goat (kg)	22.96	21.82	19.39	24.97	2.72
Daily weight gain / goat (g/d)	19.83^{c}	26.00^{c}	35.50^{b}	77.00^{a}	0.32*
Daily feed consumed/goat (g/d)	382.66	363.66	323.16	416.16	1.09
FCR	19.29^{a}	13.98^{ab}	9.10^{b}	5.40^{c}	1.06*

[abc] Means on the same row with different superscripts differ significantly ($P<0.05$)
RPBD = Raw Pigeon pea seed based diet. BPBD = Boiled Pigeon pea seed based diet
SPBD = Soaked Pigeon pea seed based diet. TPBD = Toasted Pigeon pea seed based diet

Table 4. Feed economy of WAD goats fed raw and processed pigeon pea based diets.

	Diets			
Parameters	RPBD	SPBD	TPBD	BPBD
Cost per kg feed (N)	51.63	52.63	57.63	55.63
Daily feed intake (g/d)	382.66	363.66	323.16	416.16
Total feed intake/goat (kg)	22.96	21.82	19.39	24.97
Total cost of feed (N)	1,185.42	1,148.38	1,117.44	1,389.08
Daily weight gain (g/d)	19.83	26.00	35.5	77.0
Total weight gain (kg)	1.19	1.56	2.13	4.62
Feed Conversion ratio	19.29	13.98	9.10	5.40
Cost/kg weight gain (N)	996.15	736.14	524.61	300.66

RPBD = Raw Pigeon pea seed based diet. BPBD = Boiled Pigeon pea seed based diet
SPBD = Soaked Pigeon pea seed based diet. TPBD = Toasted Pigeon pea seed based diet

final weight obtained for WAD goats fed BPBD compares favourably with the value of 13.55kg obtained by Ahamefule (2005) when he fed similar diet to WAD goats in a previous experiment. All the same, the apparent weight gain observed for WAD goats fed either the raw or processed PBDs suggest that pigeon pea could be a potential feedstuff and indeed a plant protein source in (WAD) goat nutrition.

Total weight gain (kg) also followed similar pattern as in final weight. Goats fed raw soaked and toasted PBDs had similar ($P>0.05$) total weight gains of 1.19kg, 1.52kg, 2.31kg, respectively which differed significantly ($P<0.05$) from 4.62kg obtained for goats fed BPBD. Ahamefule (2005) obtained a higher average total weight gain of 5.36kg when he fed similar diet to WAD goat. The disparity may be due to season of study ; both studies were conducted at two different seasons. The high ambient temperature of the dry season, with its consequent low feed intake may have contributed to the relatively lower weight gain for WAD goats in this study.

Daily weight gain also differed significantly ($P<0.05$) among the treatments. WAD goats fed BPBD had the highest daily weight gain (77.00g), the values for raw (19.83g) and soaked (26.00g) however did not differ. Daily weight gain for goats fed BPBD in this study was almost twice the value obtained for the toasted, almost thrice the value obtained for the soaked and almost 4 times the value obtained for the raw. Also the average daily weight gain of 39.45g generally obtained for WAD goats fed all PBDs in this study fell within the range of 35-65g/d reported for WAD goats in first 12 months of life (Nuru, 1985).

Total feed intake was not influenced by treatment ($P>0.05$) and so also the daily feed intake (g/d). Feed conversion ratio was lowest for animals fed BPBD (5.40) while the highest (19.29) was obtained for goats fed RPBD. This suggests that in fattening WAD goats for meat production, boiled pigeon pea relative to raw, soaked or toasted, is likely to bring the best returns on investment when used to formulate diets or rations for WAD goats.

Feed economy

Table 4 shows the feed economy of feeding WAD goats with raw or processed pigeon pea based diets. Daily feed consumption by WAD goats was not influenced by diets ($P>0.05$). However goats fed BPBD consumed more feed per day (416.16g) than goats fed other treatment diets. Raw PBD supported the least weight gain of 19.83 g/d on an average feed consumption of 382.66 g/d while goats fed soaked PBD gained 26.00g/d even though they consumed 363.66 g/d. The goats fed boiled PBD supported highest daily weight gain (77.00 g/d) while goats fed toasted PBD gained averagely 35.50 per day. The average daily weight gain by goats fed raw and soaked PBDs were lower than the range of 35-65 g/d reported (Nuru, 1985) for WAD goats. The production costs of all the diets were roughly the same as evidenced in the cost of a kilogram of the raw (N51.63), soaked (N52.63), toasted (N57.63) and boiled (N55.63) pigeon pea based diets. The different processing methods attracted additional cost, thereby leading to higher cost of producing one kilogram of soaked, toasted or boiled PBD relative to the raw. Goats fed boiled PBD differed significantly ($P<0.05$) in their feed conversion ratio (5.4) when compared with goats fed raw (19.29), soaked (13.98) or toasted (9.1) PBD. Boiled PBD had superior FCR value relative to others. Cost per kg weight gain of N300.00 for goats fed boiled PBD was the lowest relative to values obtained for goats fed toasted (N524.61); soaked (N736.14) and raw (N996.45) PBD. This makes boiled BPD the best diet relatively for production of WAD goats

Carcass Characteristics of WAD Goats fed pigeon pea diets.

Carcass characteristics of the WAD goats fed raw or processed pigeon pea-seed based diets are shown in Table 5. The warm carcass value of 5.38 kg obtained for animals fed boiled PBD was significantly ($P<0.05$) different from the values of 1.98kg, 2.51kg and 3.24kg recorded for goats fed raw, soaked or toasted PBDs, respectively. Goats fed raw, soaked or toasted PBD did not show any significant difference ($P>0.05$) in their warm carcass weights, even though the toasted supported a higher numerical carcass weight.

Table 5. Carcass Characteristics of WAD goats fed raw or processed Pigeon pea based diets.

Parameters	Diets				
	RPBD	SPBD	TPBD	BPBD	SEM
Fasted Live weight (kg)	6.00	6.85	8.36	9.27	1.39
Bled weight (kg)	5.63^{b}	6.61^{ab}	8.00^{ab}	8.92^{a}	1.31
Empty live weight (kg)	4.35	5.11	6.90	6.95	0.73
Warm carcass (kg)	1.98^{b}	2.51^{b}	3.24^{b}	5.38^{a}	0.38
Dressing (%)	33.05^{b}	36.96b	38.72^{b}	58.07^{a}	1.20
Leg (g)	508.06	564.20	686.66	727.33	3.68
Loin (g)	290.71^{b}	429.78^{ab}	605.00^{a}	629.33^{a}	2.32
Set (g)	194.26^{b}	313.58^{ab}	366.53^{ab}	478.66^{a}	9.90
Ends (g)	598.33	524.33	608.66	640.00	8.23
Shoulder (g)	371.56	530.66	585.00	657.33	2.65
Head (g)	550.00	552.66	693.33	679.00	9.34
Skin (g)	381.33	441.00	640.00	582.66	1.80
Feet (g)	171.66	202.66	186.66	236.66	2.90
Full gut (kg)	1.65	1.74	1.46	2.32	0.10
Empty gut (g)	566.66	556.66	630.00	636.33	2.05
Heart (g)	36.50	42.21	45.53	43.23	8.81
Lungs (g)	54.77^{b}	85.08^{a}	92.53^{a}	86.06^{a}	9.42
Liver	130.20	135.51	120.15	118.10	8.83
Spleen (g)	7.90	9.78	11.55	10.18	3.53
Kidney (g)	27.11	28.03	26.95	20.95	4.80
Bone to lean ratio	0.40^{c}	0.40^{c}	0.30^{b}	0.20^{a}	0.001

[abc]Means on the same row with different superscripts differ significantly ($P<0.05$)

Dressing percent (DP) also followed the same pattern; animals fed boiled diet had a dressing out percent of 58.07% which was significantly different ($P<0.05$) from those of goats fed other treatment diets (toasted, 38.7%; soaked, 36.69% and raw, 33.05%). Boiled PBD as earlier observed supported the best FCR (5.40), and this perhaps is responsible for the relatively higher dressing percentage (DP) recorded for goats fed boiled PBD. Dressing percentages recorded for goats fed raw, soaked and toasted PBD were all lower than the observed range of 45-52% reported by Nuru (1985), 50-52% by Ahamefule (2005) and 48-54% by Akinsoyinu (1974) for WAD goats in different nutritional trials. The present value of 58.07% derived for goats fed boiled diet in this study is, however, above the range reported by these authors.

Meat cut values for WAD goats also shown in Table 5 indicated that loin and sets of all the jointed parts, (shoulder, leg, loin, sets, ends) were significantly different ($P<0.05$) among the treatment groups. The loins of animals fed boiled (629.33g), toasted (605g) and soaked (429.78g) PBDs did not differ significantly ($P>0.05$) in weight but the values for the TPBD and BPBD were superior ($P<0.05$) to the loin of goats fed raw (290.71g) PBD. The highest set value was also realized with the BPBD (478.66g) Generally, goats fed BPBD showed superior meat cuts in absolute figures relative to others suggesting that it was the best utilized of all the rations.

The value of bone to lean meat ratio in Table 5 showed that boiled PBD which supported the best feed conversion ratio had the lowest bone to lean meat ratio of 0.2. This observation is in line with the findings of Ahamefule (2005). The relative difference from goats fed raw (0.4), soaked (0.4) and toasted (0.3) PBDs, is an indication of the relative ease of conversion of feed to meat for goats subsisting on BPBD.

The incorporation of processed (soaked, toasted and boiled) pigeon pea seed in the diets of WAD goat generally improved performance in WAD goats. However, boiled pigeon pea-based diet gave remarkably better improvement in growth and carcass characteristics of WAD goats. For goat fattening programmes therefore, boiled pigeon pea seed at 15% level of inclusion is recommended because it produced the cheapest cost per kg weight gain and also promoted highest dressing percentage. This study has also proved that given the right nutrition, WAD goats can be fattened to market weight in 60 days, which indicates that a farmer could carry out fattening operations 6 times in a year. This would ensure good income for the farmer. Considering the relatively small capital required to raise WAD goats profitably as demonstrated in this study, it is suggested that extension services should be improved to enlighten the rural dwellers who keep about 95% of the small ruminants, to practice semi- intensive rearing of goats.

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