

Dry Matter Intake and Digestibility in West African Dwarf Goats Fed Raw or Processed Pigeon Pea (*Cajanus cajan*) Seed Based Diets

Research Article

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ABSTRACT

Four West African Dwarf (WAD) grower bucks averaging 6 kg in weight and aged between 5-6 months of age were used in a digestive trial to determine the intake and digestibility of raw or processed pigeon pea seed meal based diets. The diets designated RPBD, SPBD, TPBD and BPBD were formulated from cassava peel, palm kernel cake, brewers dry grain, bone meal and common salt to contain 15% of raw, boiled, soaked or toasted pigeon pea seed meal, respectively. The diets were allotted to the 4 animals in a 4×4 latin square design. Results showed that feed and dry matter intake (DMI) (g/d) were influenced ($P<0.05$) by dietary treatments. The values were highest for BPBD followed by RPBD, SPBD and TPBD in that order. The feed and DMI of BPBD differed ($P<0.05$) significantly from values obtained for TPBD but similar with those of other diets. Nitrogen intake (g/d) of goats fed BPBD (7.49), RPBD (7.16) and SPBD (6.36) were similar ($P>0.05$); however, there was a significant difference ($P<0.05$) in nitrogen intake between goats fed BPBD and TPBD (5.90). Fecal nitrogen (g/d) values were fairly comparable ($P>0.05$) but urinary nitrogen (g/d) values were affected ($P<0.05$) by treatments; the value was highest in goats fed RPBD (1.32) which differed ($P<0.05$) from goats fed TPBD (0.76), SPBD (0.41) and BPBD (0.39). Nitrogen balance and nitrogen absorbed were also influenced ($P<0.05$) by dietary treatments; the values for goats fed BPBD (6.09, 6.48) differed significantly from values obtained for those fed TPBD (3.72 and 4.48) but similar with values obtained for RPBD (3.92 and 5.24) and SPBD (4.45 and 4.86).

KEY WORDS

digestibility, feed intake, nitrogen balance, pigeon pea, processing methods, West African dwarf goats.

INTRODUCTION

Scarcity and high cost of conventional energy (Maize, sorghum and millet) and protein (Groundnut cake, soya cake and fish meal) feedstuffs in Nigeria has awakened the need for sustainable husbandry practices as a means of coping and managing the livestock sub sector in Nigeria. Paramount among such innovative practices is the sourcing and utilization of non-conventional energy and protein feedstuffs for cost effective livestock production. Pigeon pea (*Cajanus cajan*) is a grain legume of relatively low human preference and demand in Nigeria. It is mainly cultivated in

the middle belt area of Nigeria as an inter crops in cassava and or yam plots. It grows wild in other parts of Nigeria, where little is known of it as food crop. Consumption is even rare in cultivated areas and occurs only during scarcity of other conventional grains like soya, groundnut and cowpea. It is rich in nitrogen (21-30% CP) (Obioha, 1992; Olomu, 1995; Amaefule and Onwudike, 2000) and at present has no industrial uses. These attributes have elicited interest among animal nutritionist on the need to explore and exploit further use of the crop as an alternative source of plant protein for ruminants and generally for other livestock species in Nigeria (Ahamefule *et al.* 2006).

Earlier attempts at feeding either raw or boiled pigeon pea in a concentrate based diet to ruminants have been reported (Purseglove, 1977; Ahamefule *et al.* 2005, Ahamefule *et al.* 2006). There is however, dearth of information on the best acceptable form of pigeon pea to WAD goats. WE tried to evaluate the intake and digestibility of WAD bucks fed diets containing raw, toasted, soaked and boiled pigeon pea seed meal at same level of inclusion.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Goat Unit of the Teaching and Research Farm of Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. Umudike is located at 05° 28' North and longitude 07° 31' East on an altitude of 122 m above the sea level. The average ambient temperature is 26 °C with a minimum of 22 °C and 32 °C as maximum. Relative humidity (RH) ranges from 57-91%. Average rainfall is 2169.8 mm in 148-155 rain days.

Experimental animals

Four WAD bucks averaging 6.00 kg (range 5.50-6.50 kg) in weight and aged 5-6 months were selected from the goat band of the Michael Okpara University of Agriculture, Umudike, Teaching and Research Farm. The animals were de wormed and purged of external parasites using Ferben-dazole and Pfizona, respectively. Prior to the study, the animals were kept under zero grazing and supplemented with concentrate ration at 1.5% body weight dry matter consumption per animal per day.

Experimental diets

Four experimental diets containing raw, soaked, toasted and boiled pigeon pea based diets were formulated with other conventional feedstuffs as shown in Table 1.

The four diets were formulated to contain 15% of raw, boiled, soaked and toasted pigeon pea seed meal, respectively.

Processing of pigeon pea

Pigeon pea (*Cajanus cajan*) seeds (brown variety) was purchased in a 100 kg bag from a grain market in Aba, Abia State, Nigeria and processed as follows:

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

Soaked: Twenty-five (25) kg of raw pigeon pea seeds were soaked in batches for 24 hours. The water was decanted and the soaked seeds were sun-dried for 3 days before being milled and used to formulate soaked pigeon pea based diet (SPBD).

Table 1 Constituents of Experimental Diets

Ingredients (%)	RPBD	SPBD	TPBD	BPBD
Cassava peel	45.5	45.5	45.5	45.5
Palm kernel cake	19.0	19.0	19.0	19.0
Brewers dry 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 based diet.
 SPBD=Soaked pigeon pea based diet.
 TPBD=Toasted pigeon pea based diet.
 BPBD=Boiled pigeon pea based diet.

Toasted: Twenty-five (25) kg of raw pigeon pea seeds were toasted in batches in a frying tray for 30 minutes. The product was milled and used to formulate toasted pigeon pea based diet (TPBD).

Boiled: Twenty-five (25) kg of raw pigeon pea seeds were in batches introduced into a mammoth cooking pot containing 40 liters of water which had attained 100 °C of boiling point. The content was allowed to boil for 30 minutes. Water was decanted and the boiled seeds were then sun-dried for 3 days, milled and used to formulate boiled pigeon pea based diet (BPBD).

Experimental design

The animals were transferred to and housed in separate metabolism cages provided with facilities for collection of feces and urine, separately. They were fed the experimental diets in a 4×4 latin square arrangement. Each animal received the experimental diets consecutively in 4 phases. During phase 1, which lasted for 28 days, each animal received 1 kg of an assigned diet. Drinking water was freely provided per animal daily. Daily voluntary feed intake was also determined. Total feces and urine voided by the experimental animals were collected in the last 7 days (22-28) of this initial phase. During phases 2-4, each animal was offered each of the remaining (3 experimental) diets in consecutive periods of 28 days each. The last 7 days in each of the respective phases were used as in phase 1 for total urine and fecal collection.

Leftovers of diets offered to goats were collected after 24-hours, daily, then weighed and used to determine the voluntary intake. Samples of each diet were collected and used for dry matter (DM) determination and chemical composition analysis. Total feces were collected in the mornings before feeding and watering during days 22-28 of each period. The feces were weighed fresh, dried and bulked for each animal. A sub-sample from each animal was dried in forced draft oven at 100-105 °C for 48 h and used for DM determination. Another sample was dried at 60 °C for 48-72 h for determination of proximate composition.

Total urine from each animal was collected daily in the morning before feeding and watering. The urine was trapped in a graduated transparent plastic container placed under each cage and to which 15ml of 25% concentrated sulphuric acid had been added to curtail volatilization of ammonia from the urine (Ahamefule *et al.* 2006). The total volume of urine output per animal was measured and about 10% of the daily outputs were saved in numbered plastic bottles and stored in a deep freezer at -5°C . At the end of each 7 day collection period, the collected samples were subjected to analysis.

Analytical procedure

All feed and faecal samples were analysed for proximate components using AOAC (1990) methods. Nitrogen in urine samples was also determined by AOAC (1990) methods. Gross energy (MJ/Kg) of pigeon pea and experimental diets were calculated using the regression equation:

$$\text{GE} = 5.72Z_1 + 9.50Z_2 + 4.79Z_3 + 4.03Z_4 + 0.9$$

(Nehring and Haelein, 1973)

Where, Z₁, Z₂, Z₃ and Z₄ represent percentage crude protein, crude fat, crude fiber and nitrogen free extract, respectively. The data obtained in this study were subjected to analysis of variance (ANOVA) appropriate for a 4×4 latin square design (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 dry matter percent of diets containing raw (88.84%) and toasted pigeon pea seeds (89.38%) were comparable and differed slightly from value obtained for diet containing soaked pigeon pea seeds (83.58%). Boiled pigeon pea based diet (BPBD) had DM value of 85.73%. These DM values are within the range (80-89%) of what has been reported for pigeon pea based diets in earlier investigations (Ahamefule *et al.* 2006; Okah, 2006).

The CF and ash values were relatively highest in the raw pigeon pea based diet (RPBD). The crude protein concentrations were fairly similar for boiled, raw and soaked PBDs (13.12, 13.16 and 13.07, respectively). These values were slightly higher than the CP concentration observed for

Table 2 Proximate Constituents of Pigeon pea and Experimental Diets

Constituents (%)	RPBD	SPBD	TPBD	BPBD	Pigeon pea
Dry matter	88.84	83.58	89.38	85.73	90.00
Crude protein	13.16	13.07	12.75	13.12	22.01
Crude fiber	7.25	6.19	4.05	6.25	5.25
Ether extract	4.82	4.71	4.85	4.90	1.84
Nitrogen free extract	57.92	54.04	62.32	55.86	56.40
Ash	5.69	5.27	5.41	5.60	4.50
*Gross energy (MJ/kg)	3.89	3.70	3.92	3.78	3.95

RPBD=Raw pigeon pea based diet.

SPBD=Soaked pigeon pea based diet.

TPBD=Toasted pigeon pea based diet.

BPBD=Boiled pigeon pea based diet.

*Calculated (Nehring and Haenlein, 1973).

the toasted (12.75%) pigeon pea based diet. The apparent lower CP value recorded for the toasted pigeon pea based diet may be attributed to the influence of heat treatment on pigeon pea which perhaps may have resulted in denaturation of some protein components thereby given lower CP values. Toasting as a processing method has been shown to lower the CP content of pigeon pea relative to raw seed (Amaefule, 2002). The CP value of 13.12% obtained for boiled PBD in this study, however, compares with the figure of 13.65% obtained by Ahamefule *et al.* (2006) for a diet of similar composition. The slight disparity may be due to the composition of other feedstuffs. The EE and NFE values of diets containing raw, soaked, toasted and boiled PBD are within the range of what has been reported for pigeon pea based diets (Amaefule, 2002; Ahamefule *et al.* 2006). The same goes for the ash value but the CF value obtained for the BPBD was rather low and was probably so because of the influence of other feed constituents.

Dry matter intake and nitrogen balance

The dry matter intake and nutrient digestibility of WAD goats fed raw or processed PBD's are shown in Table 3.

Dry matter intake was influenced ($P < 0.05$) by dietary treatments within the different animal groups. Intake (g/d) recorded for the raw, soaked, toasted and boiled PBD's were 340.02; 303.99; 289.00 and 256.86, respectively. Dry matter intake expressed as percentage of body weight was 4.68 for the raw and 4.02, 3.53 and 3.28 for the soaked, toasted and boiled PBD, respectively. The differences between the latter values were however not significant ($P > 0.05$). The values generally indicated that the goats on various dietary treatments showed positive DM status by consuming more than 3% of their body weight which is the recommended daily dry matter requirement for meat type goats in the tropics (Devendra and Mcleroy, 1982).

Table 3 Dry Matter Intake and Nitrogen Balance of WAD Goats Fed Experimental Diets

Parameters	RPBD	SPBD	TPBD	BPBD	SEM
Mean final weight (kg)	0.25 ^b	7.56 ^b	8.18 ^b	10.87 ^a	0.69
Feed intake (g/d)	382.73 ^{ab}	363.71 ^{ab}	323.33 ^b	416.27 ^a	32.85
Dry matter intake (g/d)	340.02 ^{ab}	303.99 ^{ab}	289.00 ^b	356.86 ^a	22.34
Dry matter intake as % BW	4.68	4.02	3.53	3.28	0.37
Crude protein intake (g/d)	41.78 ^b	39.73 ^{ab}	36.85 ^{ab}	46.82 ^a	6.87
Nitrogen intake (g/d)	7.16 ^{ab}	6.36 ^{ab}	5.90 ^b	7.49 ^a	1.75
Nitrogen in feces (g/d)	1.92	1.50	1.42	1.01	0.28
Nitrogen in urine (g/d)	1.32 ^a	0.41 ^b	0.76 ^b	0.39 ^b	0.41
Nitrogen balance (g/d)	3.92 ^{ab}	4.45 ^{ab}	3.72 ^b	6.09 ^a	1.38
Nitrogen absorbed (g/d)	5.24 ^{ab}	4.86 ^{ab}	4.48 ^b	6.48 ^a	1.69
Apparent-N-digestibility (%)	73.18 ^b	76.41 ^b	75.93 ^b	86.51 ^a	5.23

^{abc} The means that have at least one common letter in each row, do not have significant difference ($P>0.05$).

RPBD=Raw pigeon pea based diet, SPBD=Soaked pigeon pea based diet, TPBD=Toasted pigeon pea based diet, BPBD=Boiled pigeon pea based diet.

Nitrogen intake values (g/d) differed significantly ($P<0.05$) between the BPBD and the TPBDs but were fairly similar ($P>0.05$) for the raw and soaked pigeon pea based diets. The values were 7.16, 6.36, 5.90 and 7.49, respectively. Nitrogen intake value for the RPBD compared favorably well with the soaked and the toasted ($P>0.05$) PBDs but differed significant ($P<0.05$) from the boiled PBD. It would appear that the nitrogen in the BPBD was the most available which probably was the reason for the diet being consumed most. It is possible that the processing method (boiling) may have rendered the diet more palatable and utilizable by WAD goats. This observation is further expressed by the fact that goats fed with BPBD had the least feed conversion ratio. Fecal nitrogen (g/d) did not differ significantly ($P>0.05$) among goats subjected to different dietary treatments. This observation agrees with the findings of Black *et al.* (1978) that fecal nitrogen was not significantly affected by nitrogen intake. On the other hand, urinary nitrogen values were influenced ($P<0.05$) by dietary regiment and the observed values were lower ($P<0.05$) for the processed PBD's relative to the raw.

It is also possible that the deamination process in the rumen may have resulted in less ammonia production from the processed PBD (SPBD, TPBD and BPBD) as opposed to the raw (RPBD), probably due to the nature and quality of their dietary protein. Ranjah (1980) had observed that the concentration of ammonia, and hence nitrogen in the rumen depends on the quantity and solubility of protein fed to the animal. Nitrogen excreted in urine would depend on urea recycling and the efficiency of utilization of ammonia produced in the rumen by microbes for microbial protein synt-

ained for the group fed the toasted PBD (3.72); these values, however, did not differ significantly ($P>0.05$) from those fed soaked PBD (4.45). The boiled PBD promoted the highest N-balance value (7.14) among treatment groups, relatively. The positive values obtained for all treatment groups suggest that the maintenance requirements of the experimental animals were adequately met by the diets and this is expressed by the fact that none of the experimental animals experienced weight loss during the digestive trial.

The values for the absorbed nitrogen (g/d) similarly were affected by the diets ($P<0.05$). The values were 5.24, 4.86, 4.48 and 6.48 for the raw, soaked, toasted and boiled PBD's, respectively. The highest value was recorded for goats fed BPBD. Nitrogen absorbed in the farm animals is a function of nitrogen consumed and excreted in the urine and feces. The more the nitrogen consumed, the more the nitrogen absorbed, and vice versa (Ahamefule *et al.* 2000).

Apparent-N-digestibility (%) value was significantly different ($P<0.05$) for goats fed the boiled (86.51) relative to raw (73.18), toasted (75.93) and soaked (76.41) pigeon pea based diets. Studies (McDonald *et al.* 2002; Ahamefule, 2005) have shown that an inverse relationship existed between nutrient consumption and digestibility. This observation however was not in consonance with the apparent-N-digestibility values obtained in this study when compared to the nitrogen intake of goats within the various treatment groups. This discordance may have arisen due to nature and quality of the dietary proteins, which even with minimal retention time in the rumen, still remained highly digestible. Apparent-N-digestibility values for the diets were quite high, ranging from 73.18% in the RPBD to 86.51% in

BPBD. This may be an indication that quality of pigeon peaprotein is high.

In conclusion, the incorporation of processed (soaked, toasted and boiled) pigeon pea seed in the diet of WAD goat generally improved performance in WAD goats. However, boiled pigeon pea based diet would be preferred by WAD goats relative to others because it promoted superior records in terms of nitrogen intake, fecal and urinary nitrogen, nitrogen balance as well as absorbed nitrogen and apparent-N-digestibility.

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