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THE EFFECT OF FEEDING GRADED LEVELS OF COOKED PIGEON PEA (*CAJANUS CAJAN*) SEED MEAL ON THE PERFORMANCE AND CARCASS CHARACTERISTICS OF GROWING RABBITS.

Ani, A.O.
Department of Animal Science, University of Nigeria, Nsukka, Nigeria.

ABSTRACT
A 56-day feeding trial was conducted to investigate the effect of feeding varying levels of cooked pigeon pea seed meal (PSM) on the performance and carcass characteristics of growing rabbits. Twenty-four, 7-week old hybrid (Chinchilla x New Zealand white) rabbits weighing 950 – 1050g were randomly divided into four groups of 6 rabbits each. Each group was randomly assigned to one of the diets containing 0%, 10%, 20% and 30% cooked PSM, respectively. Results revealed that rabbits fed 20% cooked PSM diet had significantly (P<0.05) higher protein intake, ether extract digestibility values, average daily weight gain, protein efficiency ratio, and lower feed conversion ratio than rabbits fed 10% and 30% cooked PSM diets. Rabbits fed 10% cooked PSM diet had significantly (P<0.05) lower dry matter, crude protein and nitrogen – free extract digestibility values than rabbits fed 0%, 20% and 30% cooked PSM diets. Rabbits fed 10%, 20% and 30% cooked PSM diet had significantly (P<0.05) higher dressed carcass percentage and relative liver weight than those fed the control diet. The results showed that up to 30% of cooked PSM can included in the diets of growing rabbits without any adverse effect on performance.

Key words: cooked pigeon pea, performance, carcass, organ weights, rabbits

INTRODUCTION

It is well known that a typical average Nigerian consumes an average of 15g of animal protein per day as against 54g of animal protein per caput per day in Europe and America (FAO, 1997). The low level of animal protein intake may be attributed to low production of animal protein in relation to human population, and low level of animal productivity. To ensure adequate supply of animal protein in the diet of the average Nigerian, there is need for the production of fast maturing animals like rabbits.

Rabbits are highly prolific and good converters of feed. They have short gestation period (28-32 days) and short generation interval (Aduku and Olukosi, 1990; Fielding, 1991). Although rabbits can be fed forages alone, the feeding of forages and concentrates to rabbits has been shown to improve growth performance (Onwudike, 1995). However, the production of rabbits using concentrate feeds is seriously affected by inadequate and high cost of feed ingredients. Livestock farmers therefore, have resorted to the use of less costly alternative vegetable protein sources. The alternative vegetable protein source being considered in this study to replace a proportion of soybean meal and perhaps maize is the pigeon pea (*Cajanus cajan*). Pigeon pea, which is locally available in many Nigerian markets, is one of the important grain legumes that show great potential in Nigeria (Rachie, 1975). Pigeon pea seed meal has been found useful in the feeding of poultry and rabbits (Ani and Okeke, 2002; Ani and Okeke, 2003; Amaefule *et al.*, 2004); but its use in the feeding of monogastric animals is limited by the presence of such antinutritional factors as trypsin, chymotrypsin and amylase inhibitors in the raw seed (Singh, 1988; Faris and Singh, 1990; Ensminger *et al.*, 1996). It requires heat treatment to remove the inhibitors, which accentuate digestive losses. Liener (1980) as well as Faris and Singh (1990) for instance, showed that the effects of these inhibitors in raw pigeon pea could be drastically reduced or eliminated by cooking for between 40 – 60 minutes. Although, ground pigeon pea had been incorporated in various animal feeds, the effects of heat – treated pigeon pea seed meal on the performance of rabbits have not been fully investigated. This study was therefore designed to investigate the effect of cooked pigeon pea on the performance and carcass characteristics of growing rabbits.

MATERIALS AND METHODS

The study was conducted at the Rabbit Research Unit of the Research and Teaching Farm of the Department of Animal Science, University of Nigeria, Nsukka.

Processing of pigeon pea

Raw pigeon pea seeds were purchased from Orie Orba Market near Nsukka in Enugu State. The pigeon pea seeds were cleaned of dust, and cooked in excess volume of water for 60 minutes at 100^oC for the removal of the antinutritional factors. Timing was taken from the point of boiling (100^oC). The cooked seeds were sun dried for 48hrs, ground into a meal using a hammer mill and stored in a jute bag until used.

Experimental diets

Four diets were formulated such that they contained cooked pigeon pea seed meal (PSM) at 0% (control), 10%, 20% and 30%, respectively. The composition of the diets is presented in Table 1.

Experimental animals and management

Twenty-four, 7-week old hybrid (Chinchilla x New Zealand white) rabbits weighing 950 – 1050g were randomly divided into four groups of 6 rabbits each. Each group which was further sub divided into 3 replicates of 2 rabbits per replicate was randomly assigned to one of the four treatment diets in a completely randomized design (CRD). Each replicate was placed in a two-tier rabbit cage, which had a total of 6 hutches per tier. Each hutch measured 15cm x 10cm x 10cm. The cage was located inside a rabbit building equipped with vents and windows for proper ventilation. Each hutch, which accommodated 2 rabbits, was fitted with drinkers and feeders. The rabbits were fed twice daily in the morning (7.30 – 8.00a.m) and in the afternoon (2.00 – 3.00p.m), and given water *ad libitum* for a period of eight weeks. The rabbits were also fed daily with equal quantity of fresh *Centrosema pubescens* as forage supplement in the diets.

Data collection

The rabbits were weighed at the beginning of the experimental feeding and subsequently on a weekly basis. The quantity of feed that was offered to the rabbits daily and leftover, when available was weighed with a 10kg capacity Top-loading scale to determine daily feed intake. Parameters measured were initial body weight feed intake and final mature weight. Feed conversion ratio (FCR) was calculated as feed intake divided by weight gain, (g) 0protein intake was calculated from feed intake values and protein efficiency ratio (PER) as weight gain divided by protein intake. Feed cost per kg weight gain was calculated as feed cost per kg x FCR.

Nutrient digestibility determination

The digestibility of experimental diets, which lasted for eight days, was carried out at the seventh week of the experiment. The first three days were for adaptation of the animals to the new environment. The rabbits were fasted for 24hrs and thereafter fed 90% of their *ad libitum* intake for 5 days. Faeces arising from the 5-day feeding plus that from another 24-hr fasting period were collected. This was to ensure total collection of faecal droppings associated with the feed consumed. Faecal droppings collected each day were oven-dried at 60^oC, put in a plastic bag and stored in a refrigerator. At the end of the collection, all droppings collected from each replicate were pooled together and samples taken for determination of proximate composition.

Carcass and organ evaluation

Three rabbits from each treatment were selected, weighed and starved over night to clear the guts. Each rabbit was stunned and slaughtered by cutting the jugular vein with a sharp knife. During the evisceration, the internal organs were carefully removed and weighed. The dressed carcass was weighed and expressed as percentage of the live weight.

Proximate and statistical analyses

Experimental diets and faecal droppings were analyzed for proximate composition using the method of AOAC (1990). All data collected were subjected to analysis of variance (ANOVA) for a CRD (Steel and Torrie, 1980). Significant differences between treatment means were determined using Duncan's New Multiple Range Test (Duncan, 1955).

Table 1: Percentage composition of experimental diets

Ingredients (%)	Cooked pigeon pea seed meal levels (%)			
	0	10	20	30
Maize	60.0	53.0	46.0	40.0
Wheat offal	10.0	10.0	10.0	10.0
Soybean meal	14.0	11.0	8.0	4.0
Pigeon pea seed meal	0.0	10.0	20.0	30.0
Palm kernel cake	11.0	11.0	11.0	11.0
Fish meal	0.80	0.80	0.80	0.80
Bone meal	2.5	2.5	2.5	2.5
Oyster shell	1.2	1.2	1.2	1.2
Premix	0.25	0.25	0.25	0.25
Salt	0.25	0.25	0.25	0.25
Total	**100.00**	**100.00**	**100.00**	**100.00**
Calculated composition:				
Crude protein (%)	15.61	15.73	15.84	15.61
Energy (MJ/kg) of ME	12.01	12.09	12.26	12.3

RESULTS AND DISCUSSION

Table2 shows the proximate composition of the experimental diets while the effect of the experimental diets on growth performance of the rabbits is shown in Table3. There were significant differences (P<0.05) among treatments in final body weight (FBW), average daily weight gain (ADWG) and average daily feed intake (ADFI). Rabbits fed 20% cooked pigeon pea seed meal (PSM) diet had similar FBW and ADWG with those fed 0% cooked PSM diet, and this was significantly (P<0.05) higher than that of rabbits fed 10 and 30% PSM diets. Rabbits fed 0 and 20% cooked PSM diets had similar FBW and ADWG (P>0.05). These results agree with that of Arijeniwa and Igene (2002), and with that of Amaefule *et al*. (2004). However the values of ADWG obtained in this study are higher than the values reported by Amaefule and Nwaokoro (2002) but lower than the values reported by Arijeniwa and Igene (2002). This tends to suggest that the inclusion of 30% of cooked PSM in the diets of growing rabbits supported normal growth. Rabbits fed 0% cooked PSM diet had significantly (P<0.05) higher ADFI than rabbits fed 10 and 20% PSM diets. Rabbits fed 0 and 30% PSM diets had similar ADFI. These results contradict that of Amaefule *et al*. (2004) and also that of Arijeniwa and Igene (2002). Moreover, the values (86.1 – 87.4g/d) of feed intake obtained in this study are higher than the values (75.02 – 75.76g/d) and (23.04 – 23.75g/d) reported by Amaefule *et al.* (2004) and Arijeniwa and Igene (2002), respectively. The observed disparity in performance may be attributed to the use of raw PSM by the previous authors. The results obtained in the present study tend to suggest that growing rabbits consume more cooked PSM than raw PSM. Perhaps cooking may have enhanced the palatability of dietary PSM. This corroborates earlier report that cooking tends to make the final product of this legume palatable, especially when the cooking water is changed severally due to the acid taste of the seed coat (Adeparasi, 1994). The enhanced growth performance of the rabbits that consumed the processed PSM may therefore, be attributed to improved feed intake, since feed intake is a major factor that influences weight gain (Ani and Okeke, 2002). The rabbits might have obtained enough nutrients from the feed consumed for normal growth. It is interesting to note that the inclusion of cooked PSM in the diets of rabbits at 10, 20 and 30% levels resulted in the replacement of 11.67, 23.33 and 33.33% maize, respectively and corresponding 21.43, 42.86 and 71.43% soybean meal, respectively (Table 1). This agrees with the reported observation of Amaefule and Nwaokoro (2002). There were also significant differences (P<0.05) among treatments in feed conversion ratio (FCR), daily protein intake (DPI) and protein efficiency ratio (PER). Rabbits fed 20% cooked PSM diet had significantly (P<0.05) higher DPI than those fed 0, 10 and 30% PSM diets. Rabbits fed 20% cooked PSM diet also had higher PER (P<0.05),and lower FCR (P<0.05) than those fed 10 and 30% PSM diets. However, the FCR, DPI and PER of rabbits fed 0, 10 and 30% PSM diets were similar (P>0.05). The observed results contradict earlier reports (Arijeniwa and Igene, 2002; Amaefule *et al*., 2004).

Table 2: Proximate composition of experimental diets

Components (%)	Cooked pigeon pea seed meal levels (%)			
	0	10	20	30
Dry matter	88.15	85.70	87.85	89.00
Crude protein	17.26	15.10	17.21	17.30
Crude fibre	3.85	4.85	4.25	4.60
Ash	24.90	22.15	28.00	26.70
Ether extract	6.20	6.80	6.10	6.65
Nitrogen – free extract	39.94	45.95	32.29	35.75

Table 3: Performance of rabbits fed the experiment diets.

Parameters (g)	Cooked pigeon pea seed meal level (%)				
	0	10	20	30	SEM
Av initial body weight	1050	1008	958	992	19.10
Av final body weight	1487^{a}	1407^{bc}	1460^{ab}	1393^{c}	22.05
Av daily weight gain	15.6^{ab}	14.2^{bc}	17.9^{ab}	14.4^{c}	0.85
Av daily feed intake	87.4^{a}	86.7^{bc}	86.1^{c}	87.0^{ab}	0.14
Feed conversion ratio	5.6^{ab}	6.1^{a}	4.8^{b}	6.1^{a}	0.31
Daily protein intake	13.6^{b}	13.6^{b}	13.8^{a}	13.6^{b}	0.05
Protein efficiency ratio	1.16^{ab}	1.04^{b}	1.30^{a}	1.08^{b}	0.06

SEM: Standard error of the mean
^{a,bc}Means on the same role with different superscripts are significantly different (P<0.05).

Nutrient digestibility

The rabbits fed 0, 20 and 30% PSM diets had similar dry matter (DM), crude protein (CP) and nitrogen-free extract (NFE) digestibility values and these were significantly (P<0.05) higher than those of rabbits fed 10% PSM diets. Rabbits fed 20% cooked PSM diets had the highest ether extract digestibility value, while rabbits fed 0% PSM diet had the lowest value. There were no significant differences (P>0.05) among treatments in crude fiber digestibility. The observed results tend to suggest that inclusion of cooked PSM in rabbit diets did not have any negative effect on the digestibility of nutrients. This corroborates earlier report (Amaefule *et al*., 2004). Perhaps cooking might have played an effective role in detoxifying the anti-nutritional factors in the raw seed. Anti-nutritional factors in raw legumes are known to cause reduction in nutrient digestibility and the absorption of nutrients in the ingesta, thereby resulting in digestive losses (Singh and Eggum 1984; Liener, 1986; Faris and Singh 1990; Ensminger, 1996).

Carcass Quality

Data on dressed carcass percentage and relative organ weights of rabbits are presented in Table 5. While the spleen, kidneys and heart were unaffected by the dietary treatments, significant differences (P<0.05) existed among treatments in dressed carcass percentage and relative weights of liver and lungs. Rabbits fed 10, 20 and 30% cooked PSM diets had higher

Nutrient digestibility by rabbits fed the experimental diets is shown in Table 4.

dressed carcass percentage and relative liver weight than rabbits fed control diet. Rabbits fed 10 and 30% PSM diets had similar relative weight of lungs and this was significantly (P<0.05) higher than that of rabbits fed 0 and 20% PSM diets. The results obtained in this sandy contradict the findings of Arijeniwa and Igene (2002) and Amaefule *et al*. (2004), which showed that dressed carcass percentage, relative liver and lung weights were not significantly (P<0.05) affected by the inclusion of PSM in the diets of growing rabbits. Although rabbits fed 10, 20 and 30% PSM diets had higher relative weight of liver than those on control diet, the values (3.03, 2.88, and 3.15%) for relative weight of liver obtained in the present study were similar to the values (3.24, 3.00, 2.93, 2.90%) reported by Arijeniwa and Igene (2002). However, the increase in relative liver weight could be attributed to the role the liver might have played in the detoxification of any residual anti nutritional factors that might be present in the processed PSM.

Cost of feeding dietary PSM to rabbits The implication of feeding processed PSM diets to rabbits is presented in Table 6. The result shows that there were significant differences (P <0.05) among treatments in cost of daily feed intake, cost of total feed consumed and cost of feed per kg weight gain. Rabbits fed 20 and 30% cooked PSM diets had significantly (P<0.05) lower cost of daily feed intake than those fed 10% PSM diet. Rabbits fed 0 and 10% PSM diets had significantly (P<0.05) higher cost of total feed consumed and cost of feed per kg weight gain than those fed 20 and 30% PSM diets. This shows that there were significant reductions in cost of total feed consumed and in cost of feed per kg weight gain as the level of PSM in the diets increased above 10%. It also shows that the inclusion of 20 and 30% PSM in the diet of rabbits can be very economical.

Table 4: Digestibility coefficient of cooked pigeon pea seed meal diets fed to rabbits.

Parameters	Cooked pigeon pea seed meal level (%)				
	0	10	20	30	SEM
Dry matter	66.15[a]	57.35[b]	64.2[a]	61.2[a]	3.14
Crude protein	62.2[a]	53.5[b]	60.3[a]	55.6[a]	2.73
Crude fibre	61.5	52.4	61.2	54.45	4.00
Ether Extract	88.6[c]	90.2[b]	92.3[a]	90.3[b]	0.50
Nitrogen – free extract	62.9[a]	55.2[b]	62.8[a]	60.3[a]	2.01

SEM: Standard error of the mean
[a,b]Means on the same row with different superscripts are significantly different (P<0.05).

Table 5: Effect of cooked pigeon pea seed meal on carcass yield and relative organ weights of rabbits.

Parameters	Cooked pigeon pea seed meal level (%)				
	0	10	20	30	SEM
Dressed Carcass (20%) live weight	70.35[b]	75.1[a]	77.89[a]	74.95[a]	1.00
Liver (% live weight)	1.59[b]	3.03[a]	2.88[a]	3.15[a]	0.3
Spleen (% live weight)	0.07	0.08	0.07	0.07	0.02
Kidney (% live weight)	0.59	0.66	0.7	0.66	0.71
Lungs (% live weight)	0.76[b]	0.96[a]	0.67[b]	0.95[a]	0.06
Heat (% live weight)	0.18	0.22	0.21	0.26	0.04

SEM: Standard error of the mean
[a,b]Means on the same row with different superscripts are significantly different (P<0.05).

Table 6: Cost of feeding graded levels of cooked pigeon pea seed meal to rabbits.

Parameters (g)	Cooked pigeon pea seed meal level (%)				
	0	10	20	30	SEM
Total feed intake (g)	4895[a]	4820[b]	4767[ab]	4872[ab]	23.25
Cost of feed per kg (₦)	61.70	62.95	59.70	58.90	-
Cost of daily feed intake per animal (N)	5.40[ab]	5.46[a]	5.10[b]	5.11[b]	0.10
Cost of total feed consumed (N)	302[a]	305.7[a]	285.80[b]	286.00[b]	5.24
Total weight gain (g)	436.5[ab]	365.5[b]	501.70[a]	401.70[b]	28.96
Cost of feed per kg weight gain (N)	364[a]	384[a]	286[b]	258[b]	21.40

SEM: Standard error of the mean
[a,b]Means on the same row with different superscripts are significantly different (P<0.05).

CONCLUSION

The results showed that up to 30% of cooked PSM can be included in the diets of growing rabbits to replace 33.33% of maize and 71.4% of soybean meal, thereby reducing the cost of rabbit production.

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