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UTILIZATION OF *Prosopis africana* PULP FOR RABBIT FEEDING: 1. EFFECTS ON GROWTH AND ECONOMIC PERFORMANCE

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ABSTRACT

The study was conducted to determine the chemical composition of *Prosopis africana* pulp (PAP) and the effects of PAP on the performance of growing rabbits. The study also highlighted the economic benefits arising from the substitution of maize with PAP in rabbit diets. Thirty (30) rabbits (Dutch X New Zealand white), 5-6 weeks of age and of mixed sexes were used for the study. The rabbits were randomly allotted to five dietary treatments in groups of six, but caged individually. The PAP replaced maize weight for weight at levels of 0, 10, 20, 30 and 40% in diets 1 (control), 2, 3, 4 and 5 respectively. The formulated diets contained similar crude protein content of 18%. The parameters considered were feed intake, growth rate, feed conversion ratio, protein efficiency ratio and the economic performance. The chemical analysis revealed that PAP and maize were similar in nutrient composition and amino acid profile. Highest feed intake (47.36 g/rabbit/day) and total weight gain (1211.67 g/rabbit) were recorded in treatment 3 (20% PAP) which were significantly different (P< 0.05) from treatments 4 (30% PAP) and 5 (40% PAP), but similar (P> 0.05) to treatments I (control) and 2 (10% PAP). The slightly higher daily weight gain (10.3 6 g/rabbit/day), feed conversion ratio (6.83) and protein efficiency ratio (1.14) recorded in treatment 3 (20% PAP) were not significantly different (P>0.05) from those of the other treatments. Although feed cost per kg and feed cost per kg gain were better in treatments 4 and 5, better feed intake and daily gain were obtained in the other treatments. Therefore, diets containing 20% PAP (i.e. 50% maize replacement) could be fed to growing rabbits without compromising the growth performance of the rabbits.

KEYWORDS: *Prosopis africana* pulp, rabbit feeding, performance.

INTRODUCTION

Rabbits have often been described as a good and rapid source of animal protein to the Nigerian populace. They compete favourably with other meat-producing farm animals in efficient conversion of feed into meat for human consumption. The meat has more protein and less fat and calories per gram than beef, pork or lamb (FAO, 1986). Rabbits possess a remarkable ability to survive quite successfully on diets low in grains and high in roughage. Thus, Oyawoye (1988) reported that they can be successfully raised on unlimited green vegetables, roots and hay, but the addition of some cake is always advantageous. They are particularly prolific as a single male and four females can produce as many as 3,000 offspring a year, representing 1450 kg of meat which is equal to an average-sized cow (Abe, 1988).

Non-availability and/or insufficient supply of rabbit pellets may hamper their production (Aduku and Olukosi, 1990), and because the conventional commercial pelletted ration is expensive, there is, therefore the need to look for alternative non-conventional feed ingredients.

The pods of different species of *Prosopis* have been shown to sustain animals for a month or two each year in Peru, Argentina and Chile (Felker and Wayne, 1977) and have a feeding value fairly comparable to that of barley and corn. In the rural areas of semi-arid Nigeria, camels, cattle, sheep and goats derive valuable nutrients (carbohydrate and protein) from the pods of *Prosopis africana*. The seeds and pods are nutritious and high in protein (34–39% as reported by Boren and Poppi (1990). Information on the suitability of *Prosopis africana* pod/pulp for rabbit feeding is, however, not well documented. Therefore the objectives of the study were to evaluate the proximate and amino acid compositions of *Prosopis africana* pods, pulp and seeds, to assess the effect of *Prosopis* pulp on growth and to evaluate the cost effectiveness of including *Prosopis africana* pulp in the diets of growing rabbits.

MATERIALS AND METHODS

The study was conducted at the University of Maiduguri 1ivestock, Teaching and Research Farm, Maiduguri, Borno State, Nigeria. Maiduguri is located between latitude 1l°51' and 12^{o} North and longitude 13^{o}05' and 14^{o} East and at an altitude of 354m above sea level (Alaku, 1983). It falls within the semi-arid zone of West Africa characterized by short duration of rainfall (3–4 months) which varies from 500mm–600mm, with long dry season (7–8 months). Ambient temperatures

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are high during the months of April and May ranging from 40°C and above, while relative humidity at noon ranges from 5–45%.

The *Prosopis africana* pods were obtained from *Prosopis* trees in Potiskum, Yobe State, Nigeria. The pulp is the residue after the extraction of seeds from the pods. Five diets were compounded for the experiment using the ingredients shown in Table 1.

Prosopis africana pulp, (PAP) which replaced maize weight for weight was included at 0, 10, 20, 30 and 40% levels in diets 1 (control), 2, 3, 4 and 5 respectively (Table 1). Each diet was formulated to meet the protein requirement (18% CP) of growing rabbits.

The experimental stock consisted of thirty (30) mixed breed (Dutch x New Zealand white) rabbits aged between 5 and 6 weeks. They were obtained from local producers in Maiduguri town, Nigeria. The rabbits were randomly assigned to the five treatments in groups of six rabbits. Each of the rabbits was housed individually in cages measuring 38cm x 33cm x 45cm (length x width x height) respectively. The cages were raised above the floor of the room to allow easy cleaning and collection of droppings.

The rabbits were fed the experimental diets and clean drinking water *ad libitum*. Feed intake was measured daily at 8.00am by weighing the left-over feed and subtracting it from the quantity offered the previous day. Growth performance, on the other hand, was determined by weighing the experimental stock at the beginning of the study (initial weight) and weekly thereafter, while feed conversion ratio (FCR) was calculated as follows:

$$FCR = \frac{\text{Feed intake (g)}}{\text{Weight gain (g)}}$$

Table 1: Ingredients composition of the experimental diets

	Diets				
Ingredients (%)	1	2	3	4	5
Maize	44.85	34.85	24.85	14.85	4.85
PAP	0.00	10.00	20.00	30.00	40.00
Wheat offal	15.00	15.00	15.00	15.00	15.00
Ground haulms	15.00	15.00	15.00	15.00	15.00
Groundnut cake	17.75	17.75	17.75	17.75	17.75
Fish meal	5.00	5.00	5.00	5.00	5.00
Bone meal	2.00	2.00	2.00	2.00	2.00
Salt (NaCl)	0.25	0.25	0.25	0.25	0.25
Premix*	0.15	0.15	0.15	0.15	0.15
Total	100.00	100.00	100.00	100.00	100.00

PAP *Prosopis africana* Pulp

*Premix (Vit. D12 B.P) manufactured by Dizpharm (Nig,), Lagos, supplying the following per kg: Vit. A, 6, 250,000iu, Vit. D_3 1, 250,000iu., Vit. E, 1500iu; Vit. K 1250mg, riboflavin, 3000mg; Pantothenic acid, 5000mg; Pyridoxine. 1750mg: Vit B_1, 1600mg; niacin, 15,000mg, Vit.. B_{12}, 10mg; biotin, 25mg; folic acid, 500mg; choline chloride,150j: antioxidant 62.5g; iron, 50g; manganese 50g; zinc, 50g; Iodine, 0.78g; Cobalt 0.25g; Copper 5.0g; Selenium, 0.05g.

The study lasted for 10 weeks after one week adjustment period. The economic performances were based on the prevailing market prices of the ingredients at the time of the study (February–April, 2003). The feed cost and cost per unit weight gain formed the major indices of assessing economic performance.

The proximate analysis of the *Prosopis africana* pulp, experimental diets and faecal samples were carried out according to AOAC (1980) methods. The crude protein was determined by the Kjeldahl procedure, while ether extract and crude fibre were by Soxhlet extraction and trichloroacetic acid methods respectively. The dry matter was determined by drying samples at 80°C, ashing by the use of electric furnace at 550°C for six hours and nitrogen–free extract (NFE) by difference. Amino acid analysis was carried out using methods described by Spackman *et al.* (1958), while tannin (poly phenol concentration) was estimated spectrophotometrically using the 4-amino antipyrene procedure described in APHA (1985) standard methods.

All data were subjected to analysis of variance (ANOVA) using the randomized complete block design (Steel and Torrie, 1980). Where significant differences ($P< 0.05$) were observed means were separated and compared using Least Significant Difference (LSD).

RESULTS AND DISCUSSION

Chemical Composition

The chemical composition of *Prosopis africana* pods, pulp and seeds as well as maize grain are shown in Table 2. The results indicate that the seeds have crude protein (CP) content of 27.67% whereas pods and pulp have 18.49 and 10.0% CP respectively. FAO (1991) have reported similar values of 9.0, 13.3% and 27.3% CP in leaves, pods and seeds respectively for *Prosopis tamarugo*. Baioa (1987) reported 9.5 and 35.8% CP for *Prosopis juliflora* pods and seeds while Bohra and Ghosh (1980) reported 13.5, 11.0 and 35.2% CP in *Prosopis chilensis* leaves, pods and seeds respectively.

Table 2: Chemical composition of maize grain and Prosopis africana (Pod, pulp and seed)

Constituents (%)	**Pods**	**Pulp**	**Seeds**	**Maize Grain****
Dry matter	76.00	86.00	85.00	89.00
Crude protein (CP)	18.49	10.00	27.67	10.60
Crude fibre (CF)	15.00	23.00	10.00	1.90
Ether extract (EE)	5.00	3.30	6.00	4.86
Ash	2.00	3.00	5.00	1.30
Nitrogen-free extract (NFE)	48.33	59.08	51.51	81.4
ME (Kcal/kg)*	2801.58	2734.64	3338.4	3670.7
Tannin (%)	-	5.75	-	-
Phytic acid (mg/100g)	-	2.30	-	-

*ME (kcal/kg) = 37 x %CP + 81 x % EE x 35.5 x % NFE (calculated according to the formula of Pauzenga (1985))
**Determined by Gohl (1981)

The nutrient composition of *Prosopis africana* pulp (PAP) is similar to that of maize grains. For instance, PAP has crude protein content of 10.0% and this is similar to the 10.60% CP for maize reported by Gohl (1981). Also, the amino acid values of 3.1, 3.1 and 1.63% for lysine, threonine and methionine respectively (Table 3) compare favourably with the corresponding values of 3.0, 3.8 and 1.1% reported for maize grains (Gohl, 1981). These amino acid levels will no doubt meet the 0.6, 0.5, 0.5 and 0.5% lysine, methionine, cystine and threonine minimum requirements respectively of growing rabbits (Aduku, 1992). This forms the basis for replacing maize with PAP in this study.

The average CP level of 18% for the various experimental diets (Table 4) is adequate to meet the protein requirement of growing rabbits (Lang, 1981; Anugwa *et al.,* 1982 and Adegbola, 1991). The CF levels (11.0–17.66%) which increased with increasing levels of PAP in the diets compare favourably with the required range of 10.0–20.0% CF reported by other workers (Besedina, 1970; Cheeke, 1983, Chaudhury *et al.,* 1995 and Anugwa *et al.,* 1998) as optimal for growing rabbits.

Table 3: Amino acid composition of component parts of *Prosopis africana* (Pod, pulp and seed), *Prosopis juliflora* pod and maize grain.

Amino Acid (%)	**Prosopis africana**			**Prosopis juliflora**	**Maize**
	Pod (a)	Pulp (a)	Seed (a)	Pods (b)	Grain (c)
Lysine	2.86	3.1	2.88	4.43	3.0
Histidine	1.23	1.98	1.66	2.98	3.3
Arginine	3.79	0.52	5.09	14.83	4.6
Aspartic acid	5.98	4.22	5.26	8.43	ND
Threonine	2.42	3.11	3.0	2.64	3.8
Serine	2.22	0.54	2.16	4.49	ND
Glutamic acid	8.77	5.21	9.18	20.04	ND
Proline	1.57	0.66	2.26	6.40	ND
Glycine	3.25	0.86	4.24	4.95	3.6
Alanine	3.01	2.50	3.8	4.41	ND
Cystine	0.75	0.69	1.21	1.32	1.2
Valine	2.20	3.24	2.11	3.98	4.4
Methionine	0.40	1.63	0.79	1.06	1.1
Isoleucine	1.12	2.34	2.74	3.03	3.1
Leucine	4.18	4.55	6.07	7.34	12.7
Tyrosine	2.15	0.84	2.16	2.57	3.7
Phenylalanine	2.96	2.09	3.08	3.91	5.1
Tryptophan	ND	ND	ND	ND	ND

ND = Not determined a = determined in this experiment
b = Baioa (1987) c = Gohl (1981

Table 4: Chemical Composition of the Experimental diets

	Diets/Treatments				
Constituents (%)	1	2	3	4	5
Dry matter	96.03	95.73	95.83	94.4	95.36
Crude protein (CP)	18.11	18.15	18.29	18.25	18.27
Crude fibre (CF)	10.70	13.33	15.10	16.66	17.67
Ether extract (EE)	3.71	3.70	3.56	3.50	3.20
Ash	4.33	4.0	4.16	4.0	4.33
Nitrogen-free extract (NFE)	62.86	60.82	58.99	57.59	56.54
*ME (Kcal/kg)	3202.11	3130.36	3059.24	3003.2	2942.36
Tannin (%)	0.05	0.50	0.55	0.74	0.95
Phytic acid (mg/kg)	25.0	50.0	55.0	140.0	145.0

*ME (Kcal/kg) = 37 x %CP + 81 x % EE + 35.5 x % NFE (Pauzenga, 1985).

Similarly, the CF levels also fall within the range of 12–18% recommended by Davidson and Spreadbury (1975) for growing rabbits. Fat level (3.20–3.71%) in the diets were similar to those of Cheeke (1979) who reported that a minimum level of 3% fat is desirable to provide essential fatty acids and therefore adequate to meet the needs of young rabbits.

The metabolisable energy (ME) levels of the diets were 3202.11, 3130.36, 3059.24, 3003.20 and 2942.36 Kcal/kg for diets I (control), 2, 3, 4 and 5 respectively, The decrease in ME with increasing PAP level is attributable to the lower ME of PAP (2734.64 Kcal/kg) compared to 3730.0 Kcal/kg ME of maize grain (Gohl, 1981). The energy levels of the diets were, however, higher than the 2500.00 and 2800.00 Kcal/kg ME levels reported by Aduku and Olukosi (1990) and Anugwa *et al.* (1982) for growing rabbits. From these results therefore all the diets met the minimum levels of ME, CP, CF and fat recommended by NRC (1984) for growing rabbits.

Performance Parameters

The average daily feed intake is presented in Table 5. The highest daily intake of 47.36 g was recorded in treatment 3 which is significantly different (P< 0.05) from treatments 4(43.79 g) and 5 (4l.57g), but similar (P> 0.05) to the control treatment (46.21 g) and treatment 2 (45.5 g). Feed intake increased with increasing levels of PAP up to 20% level of inclusion and declined thereafter. This is contrary to the observations of Ahmed and Abou Ashour (1986) and Chaudhury *et al*. (1995) who found that rabbits given higher fibre consumed more feed (64 g) and gained more weight (13.4 g/day) than rabbits on lower fibre diets.

The average weekly live weight change increased steadily and reached a peak at week four of the study. Although the rabbits continued to gain weight after that period, it was at a decreasing rate. The average daily gain, which ranged between 6.5g and l0.36g/rabbit/day did not differ significantly (P>0.05) among the treatments. However, there were significant differences (P<0.05) in mean total weight gain among the treatments. The mean weight gain of 9.99–10.3g/rabbit/day observed in treatments 1 to 3 are quite comparable to 8.9 g/day reported by Abu and Ekpenyong (1993). Other studies in the same environment gave daily weight gain between 5.20 and 10.0g/rabbit (Igwebuike, 2001). The slightly higher daily weight gain observed in treatments 1 to 3 resulted in a cumulatively superior total weight gain in these treatments. The trend is similar to that of feed intake. Lower, average daily gains of 8.82 and 6.5 g/rabbit/day were obtained in treatments 4 (30% PAP) and 5 (40% PAP) respectively.

Table 5: Performance characteristics of rabbits fed graded levels of *Prosopis africana* pulp (PAP)

Parameter	**Treatments**					
	1	2	3	4	5	SEM
Level of PAP	0	10	20	30	40	-
Number of rabbits	6	6	6	6	6	6
Mean initial body weights (g)	486.67	486.67	486.12	485.33	487.50	8.39^{NS}
Mean final body weight (g)	1186.67^{a}	1208.23^{a}	1211.12^{a}	1102.83^{b}	936.67^{c}	8.32^{NS}
Average daily gain (g)	9.99	10.31	10.36	8.80	6.54	11.04^{NS}
Average daily intake (g)	45.21^{ab}	45.50^{ab}	47.37^{a}	43.74^{b}	41.86^{c}	5.68^{*}
Feed conversion ratio	5.95	6.45	6.83	6.30	6.31	2.53^{NS}
Protein efficiency ratio	1.14	1.19	1.14	1.07	0.83	0.16^{NS}

PAP = Prosopis africana Pulp, NS = Not significant (P> 0.05)

* Significant (P< 0.05)

^{a,b,c} = Means with different superscript in the same row differ significantly (P< 0.05)

SEM = Standard error of means

Feed conversion ratio (FCR) deteriorated with increasing levels of PAP; the poorest value was recorded in treatment 5 (40% PAP). However, there were no significant differences (P>0.05) among the treatments. All the FCR values obtained in this study are much higher than the 3.6 reported by Rastogi (1989)

who fed caged rabbits with pelletted diets. This may be due to enhanced feed intake and better utilization of pelletted diets. The values were however much lower than those reported by Omole (1982), Aduku *et al*. (1986) and Igwebuikc *et al.* (1995) for growing rabbits.

Protein efficiency ratio (PER) followed the same pattern with feed intake and daily weight gain, although there was no significant difference (P>0.05) among the treatment groups (Table 5). The values increased with increasing levels of PAP up to 20% and declined afterwards. It then follows that PAP higher than 20% in the diets are capable of depressing protein and amino acid utilization.

The lower feed intake, average daily gain, feed conversion ratio and protein efficiency ratio observed in this study may be due, in part, to the tannin content of the feeds, which increased with increasing quantity of PAP in the diets. Negative effects of tannins on feed intake, daily weight gain and protein efficiency ratio were reported by Mole (1986) and Jansman (1993), and feed conversion ratio by Jambunathan *et al*. (1986). Furthermore, the effect of high ambient temperature could also be a factor. Temperature range of 30°C–42°C were recorded during the study period and these were higher than the 16–19°C reported as the comfort zone for rabbits (Fielding, 1991). However, no mortality was recorded throughout the study period.

The economics of feeding rabbits on varying levels of PAP are presented in Table 6. The cost per kilogram feed were ₦52 09, ₦42.68, ₦32.79, ₦22.84 and ₦12.94 in diets I (control), 2, 3, 4 and 5 respectively. The feed costs per kilogram gain were ₦240.64, ₦188.35, ₦149.24, ₦113.29 and ₦83.73 respectively. The cost reduction is attributed to the price differential between maize and PAP (₦100.0/kg and N1.60/kg respectively) at the time of the study. Both cost per kilogram of feed and feed cost per kilogram weight gain were significantly (P<0.05) better in the groups receiving PAP in their diets. On economic grounds therefore, diet 5 (40% PAP) is much better than the others. However, the significantly lower intake and weight gain in treatments 4 and 5 seem to suggest that the best biological and economic returns were obtained in treatment 3 (20% PAP).

CONCLUSION

Prosopis africana, a leguminous plant growing in drier environments, is nutritious in terms of carbohydrate, protein, fat and minerals, It can be used to replace up to 100% maize grains in rabbit diets without adverse effects on performance of growing rabbits. However, better performance was obtained by replacing 50% of the maize with PAP (20% PAP inclusion) in the diets of growing rabbits. Therefore diets containing 20% PAP could be fed to growing rabbits without compromising the growth and economic performance of young rabbits. More research is recommended on ways of eliminating tannins which is a major limiting factor in the use of *Prosopis africana* pulp.

Table 6: Economic performance of rabbits fed graded of *Prosopis africana* pulp (PAP)

Parameter	**Treatments**					
	1	2	3	4	5	
Level of PAP	0	10	20	30	40	SEM
Number of rabbits	6	6	6	6	6	6
Mean initial body weights (g)	486.67	486.57	486.12	485.33	487.50	8.392^{NS}
Mean final body weight (g)	1186.67^{ab}	1208.23^{a}	1211.12^{a}	1002.03^{b}	936.67^{b}	1.43
Total weight gain (g)	700^{ab}	721.66^{a}	725.00^{a}	617.50^{b}	449.17^{c}	5.4^{*}
Total fed intake (kg)	3.23^{a}	3.19^{ab}	3.32^{a}	3.06^{b}	2.91^{e}	0.27^{*}
Feed cost per kg (₦/kg)	52.09^{a}	42.68^{b}	32.79^{c}	22.84^{d}	2.94^{e}	0.032^{*}
Total feed cost (₦/kg)	168.45^{a}	135.92^{b}	108.71^{c}	69.90^{d}	37.61^{e}	0.032
% Reduction in feed cost	-	19.31	35.47	58.50	77.67	-
Feed cost/kg gain (₦/kg)	240.64^{a}	188.35^{a}	149.94^{a}	113.29^{b}	83.73^{c}	-
% Reduction in cost/kg gain	-	21.73	37.69	52.92	65.21	-

– = Not analyzed statistically
NS = Not significant (P> 0.05)
* = Significant (P< 0.05)
a,b,c,d,e = Means with different superscripts in the same row differ significantly (P< 0.05).
Cost per kilogram of the various ingredient used in compounding the experimental diets Prosopis africana pulp (PAP), ₦1.60; Maize ₦100.00; wheat bran ₦70.00. groundnut haulms ₦3.00; groundnut cake, ₦30.00; fishmeal, ₦60.00; bone meal, ₦2. 00; salt, ₦3.00 and premix, N300.00.

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