The effect of Kapok (*Ceiba pentandra*) [Linn] [Gaertn] seed meal on Performance, gut morphology and haematology of male rabbits

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Abstract

Twenty grower rabbit bucks of mixed breeds were used in the evaluation of the effects of Kapok seed meal on performance, gut morphology and the haematology of male rabbits to ascertain its suitability as a protein source for rabbits in general and breeding bucks in particular. Five bucks each were randomly assigned to each of 4 isocaloric and isonitrogenous diets containing decorticated Kapok seed meal at 0, 10, 15 and 20% levels. After 8 weeks of *ad libitum* feeding, the results showed that dietary treatment had no significant effect ($P>0.05$) on performance. With regard to GIT morphology, treatments significantly affected the absolute and relative weights of the stomach ($P<0.05$), while all other parameters were unaffected ($P>0.05$) by treatment. The haematology of the animals showed significantly higher ($P<0.05$) Hb and haematocrit values in the animals on the control diet than those on the KSM diets which were all similar ($P>0.05$) to each other. Erythrocyte count in the control diet was significantly higher ($P<0.05$) than in the respective KSM diets while leukocyte count was unaffected by treatment ($P>0.05$). The differential count showed a significant increase ($P<0.05$) in eosinophils in the diet with the highest level of KSM over the other diets which were similar to each other ($P>0.05$). Blood constants were unaffected by treatment ($P>0.05$). All haematological values were within normal ranges. It is concluded from these results that Kapok seed meal as a protein source will support growth, performance and other physiological processes in rabbit bucks.

Key words: Kapok, rabbits, bucks, performance, gut, haematology

Introduction

The advantages of rabbits over other classes of livestock in the humid tropics and their potential to mitigate the twin problems of protein-calorie

malnutrition in these regions of the world have long been documented (Owen, 1981; Cheek, 1984; Adika and Olakosi, 1990). Rabbits convert forages and other agro-industrial by-

products into meat more efficiently than other classes of livestock coupled with the synthesis of B-complex vitamins in their caeca (Carlsanu and Piquer, 1981). This has made rabbits the choice source of animal protein in the diets of people living in developing countries. Moreover, with the ability of rabbits to supplement their protein intake through caecotrophy, rabbits are raised mostly on forages in these countries. However, the seasonal fluctuations in the quantity and quality of some popular forages used in the feeding of rabbits in the guinea savannah such as *Tridax procumbens*, meant for supplementation with other high cost feed stuffs is unavailable.

The Silk cotton tree (*Cesiba pentandra*) [Linn] [Guercia], commonly known as Kapok is a multipurpose tree widely distributed in the tropics, especially the West African sub-region (Irvine, 1961) and is of great economic importance (Burkill, 1985). The uses of Kapok include as timber (Humphries, 1978), vegetable from the leaves and tender pods (Williams *et al.*, 1980), and commercial fibre stuffing for pillows and mattresses (Burkill, 1985). Among the Tiv people in the Benue valley of Nigeria, the Kapok tree (besides other uses) is traditionally seen as a landmark indicating a homestead. Burkill (1985) reported that the wood ash of the tree is also used for soap making in Africa. Even though Kapok seeds are commonly eaten among several peoples of West Africa either as ground or roasted meal (Burkill, 1985), not much is known about the possibility of feeding animals with these seeds which are cheaply available all year round in the sub-region. Thann, *et al.* (1983); Burkill, (1985) and Aduku, (1995) however

reported parts of the Kapok tree (leaves and seeds) to be rich in nutrients and Kapok seeds and seed cake have been successfully fed to different classes of livestock including goats and cattle (Burkill, 1985), pigs (Mashingo *et al.*, 1994), broilers (Thann, *et al.*, 1983) and rabbits (Bite and Shidi, 1999). Thann *et al.* (1983) however found Kapok seeds to be unsuitable in broiler diets at levels higher than 5% as raw seeds as 10% or more were found to be toxic. There is unfortunately at present no established authority on the levels of antinutritional factors in Kapok. There is also a paucity of information on the effects of Kapok seeds as a concentrate and the effect of antinutritional factors in Kapok on the performance and physiology of livestock in general and rabbits in particular. Moreover, the report of Bite and Shidi (1999) was preliminary and limited in scope.

This work was thus designed to evaluate the effect of decorticated Kapok seed meal on performance, gut morphology and haematology of male rabbits as bucks are of uttermost importance in a planned breeding programme.

Materials and Methods

Location: This study was conducted at the Rabbitry of the Department of Animal Breeding and Physiology, University of Agriculture, Makurdi, Nigeria. Makurdi is located at latitude 7°14'N and longitude 8°21'E. The annual rainfall ranges from 1270-1397mm while the temperature range is 21°C-42°C.

Animals and Management: Twenty grower rabbit bucks of mixed breeds (Chinchilla x California x Newzealand White) between the ages of 9 and

12 weeks with a mean initial weight of 1,300g were used for this study. They were housed in individual cages measuring 1.5m x 1m x 1m with corrugated roofing sheets and wire mesh floor with wooden frames. They were fed a maize based concentrate diet for a week of acclimatization with cool clean drinking water supplied always before the commencement of experimental feeding.

Kapok seed meal: Kapok seeds were obtained from dry, mature pods gathered from Kapok trees of about the same age in the Lower Benue valley. The seeds were sun dried and decorticated using a milling machine, before incorporation into the test diets as Kapok seed meal (KSM).

Experimental Diets: Four isocaloric and isonitrogenous diets were compounded with diet 1 (control) containing no KSM while diets 2, 3, and 4 contained 10, 15 and 20% KSM, respectively. A completely randomized design was used to assign the animals to the experimental diets such that there were 5 bucks on each diet. The animals were fed the diets *ad libitum*. Feed consumption was recorded daily for each animal while the weights of individual rabbits were obtained weekly. The bucks were fed the test diets for 8 weeks.

Sampling:

Samples of each diet were analyzed for proximate chemical composition (AOAC, 1990) and antinutritional factors namely: total gossypol, phytin and tannins. Total gossypol was determined using the method of Pons and Hoffmann (1957). The tannin content was

determined by the method described by Hagerman and Butler (1978) while Phytin was determined by the method of Young (1936).

After the trial, all the animals were starved for 12 hours and thereafter sacrificed by stunning and decapitation. Blood samples were collected into sterile haematological tubes with a pinch of anticoagulant and analyzed as follows:

- (i) Haemoglobin concentration (Hb): 4.00ml. of Drabkin's solution were dispensed into clear test tubes to which were added 0.02ml. of blood samples. The contents were thoroughly mixed and incubated for about 15 minutes at room temperature for colour development, after which the optical density of each sample was read in a colorimeter (green filter) against a blank of Drabkin's solution in a cuvette. The Hb concentration in each sample was then obtained by reference to a readout.
- (ii) Packed Cell Volume (PCV): Haematocrit values were determined by the microhaematocrit method (Mitnick and Rawnsley, 1977). Capillary haematocrit tubes were filled with blood samples and sealed at one end with cristaseal. These were placed in a microhaematocrit centrifuge and centrifuged at 12,000 rpm for 2 min. The heights of the red cells were then read from a haematocrit scale and expressed as a percentage volume of packed cells in whole blood.
- (iii) Red blood cell count (RBC): Blood was drawn to the 0.5 mark in a red blood cell pipette and diluted with Dacie's

fluid to the 191 mark to give a dilution of 1:200. The contents of the pipette were mixed with the aid of a pipette shaker after which 1/5 volume of the solution in the stem part of the pipette were expelled. The individual cells were then counted in five of the middle squares (in a diagonal) of an improved Neubauer haemocytometer and the result multiplied by 10⁶ to obtain the number of erythrocytes.

- (iv) White blood cell count: Blood was drawn to the 0.5 mark on a white blood pipette and diluted in Turk's solution to give a dilution of 1:20. The contents of the pipette were mixed with the aid of a pipette shaker after which 1/5 volume of the solution in the stem part of the pipette were expelled. The total leukocyte count was then made in the four square millimeters of an improved Neubauer haemocytometer and the result multiplied by 50.
- (v) Leukocyte differential count: Smears from freshly collected blood samples were stained with giemsa stain and the leukocytes estimated using a $\times 100$ objective lens. The different leukocytes were identified from their shapes and colour differentiations.

Statistical analysis: Data were subjected to the one way analysis of variance (ANOVA) using the completely randomized design (Minitab 1991), while the Least Significant Difference was used to separate means.

Results and Discussion

The gross and chemical compositions of the experimental diets are presented in Tables 1 and 2 respectively, while the antinutritional contents of kapok seed and the effects of kapok seed meal on performance and the changes in total protein concentration during sperm maturation in the bucks are summarized in Tables 3 and 4 respectively.

The crude protein (CP) and energy (ME) levels in all the diets (Table 2) were within recommended levels for growing rabbits (Lebas, 1980; Adenuga and Olukosi, 1990). As weight gain and feed conversion efficiency in rabbits tend to decrease while feed intake tends to increase with increasing dietary protein (Carnegie and Nisuma, 1983), the similarities ($P>0.05$) between the diets in proximate values (especially CP) obtained in this study implicated KSM as the determinant effect on performance characteristics of the animals like feed intake, weight changes and feed gain ratio rather than CP levels.

With regard to energy, the diets were isocaloric, having energy levels generally higher than levels recommended by Lebas (1980), but suitable when considered per unit of body weight of the animal and the corresponding crude fibre (CF) level. Also as the digestibility of CF fraction by rabbits is low (Ekponyong 1988), whereas fibre aids growth in rabbits due to the stimulation of feed intake resulting from increased caeco-colonic motility (Champre and Maurice, 1980), the apparent steady increases ($P>0.05$) in CF (and ME) levels with increasing levels of KSM inclusion obtained in this study are unlikely to have limited performance as CP values were within levels recommended within the environment (Adenuga and Olukosi, 1990).

Table 1: Composition of the experimental diets (%)

Ingredients	Diets			
	1 (0%KSM)	2 (10%KSM)	3 (15%KSM)	4 (20%KSM)
Maize	38.50	34.00	23.70	30.70
Full fat soyabean	28.90	18.03	13.60	8.56
Rice offal	27.86	32.03	32.96	36.00
Decorticated Kapok	0.00	10.00	15.00	20.00
Bone meal	3.00	3.00	3.00	3.00
Vit. Premix	1.00	1.00	1.00	1.00
Salt	0.50	0.50	0.50	0.50
Methionine	0.24	0.24	0.24	0.24
Total	100.00	100.00	100.00	100.00

Table 2: Chemical composition of the experimental diets

Parameters	Diets			
	1 (0%KSM)	2 (10%KSM)	3 (15%KSM)	4 (20%KSM)
Dry Matter	93.50	94.60	94.90	97.75
Crude protein*	16.00	16.01	16.02	16.03
Crude fibre*	12.42	13.68	13.73	14.64
Ether extract*	9.15	9.75	11.35	11.20
Ash*	7.50	5.40	5.10	2.25
NFE*	47.73	49.76	48.70	51.60
ME (Kcal/Kg) ⁻¹	2645.66	2694.18	2757.36	2767.26

* = % DM

Calculated from Pazungu (1985)

Table 3: The antinutritional contents of Kapok seed and the test diets

Antinutritional Factor	Diet				
	Kapok	1(0%KSM)	2(10%KSM)	3(15%KSM)	4(20%KSM)
Gossypol (%)	0.035	0.00	0.33	0.19	0.66
Phytate (%)	0.202	0.00	2.03	3.94	4.96
Tannins (%)	0.360	0.00	5.50	5.40	7.20

Table 4: The effect of deoiled Kapok seed meal on performance of male rabbits (means $\pm$ s.e.m.)¹

Parameter	1 (0% KSM)	2 (10% KSM)	Diets 3 (15% KSM)	4 (20% KSM)	S.E.M.
Initial weight (g)	1937.50	1824.00	1625.00	1965.66	± 66.83
Final weight (g)	2112.50	2250.00	2053.75	2250.00	± 44.65
Weight changes (g)	225.00	426.00	418.75	333.33	± 40.05
Feed intake (g)	9.54	9.92	8.96	9.82	± 0.19
Daily weight gain (g)	4.24	7.36	8.14	5.37	± 0.75
Feed: gain ratio	3.47	1.55	1.23	1.89	± 0.05
Mortality	0.00	0.00	0.00	0.00	± 0.00

s.e.m. = Standard error of mean; ¹ = ($P > 0.05$).

There were no significant differences ($P > 0.05$) between diets in performance indices, thus indicating that adequate nutrients were available to the animals on all the diets to support growth. These results also suggests the suitability of KSM in the feeding of rabbits and imply that Kapok seeds with a crude protein level comparable to full-fat soybeans and antinutritional factors at the levels available in the diets in the present study did not impair both digestion and the absorption of nutrients.

With regard to gut morphology, there were no differences ($P > 0.05$) between the diets in all parameters except in the absolute and relative weights of the stomach where significant differences ($P < 0.05$) occurred between the control and all the Kapok containing diets. As Kapok levels were similar between the diets, the significantly higher weights of the stomach in the kapok diets couldn't be attributable to fibre levels. It could however be that during the trial, ingesta lasted longer in the stomachs of the animals on the kapok diets (probably due to the presence of antinutritional factors) leading to expansion (with a regular supply of nutrients).

With the non effect of dietary treatment on gut morphology generally however, one would expect normal physiology of digestion when rabbits are raised on KSM.

The effect of diet on haematology (Table 6) showed significantly higher ($P < 0.05$) Hb, PCV and erythrocyte counts in animals on the control diet than in each of those on KSM. There were similarities between the diets in leukocyte and leukocyte differential counts ($P > 0.05$) except in the proportion of eosinophils which were similar ($P > 0.05$) between the control diet and the diets containing Kapok seed meal at 10% and 15% all of which differed significantly ($P < 0.05$) from the diet with the highest level of KSM inclusion (20%). Basophiles were completely absent in circulation in all animals (in all dietary treatments). Mean corpuscular volume (MCV), Mean corpuscular haemoglobin (MCH) and Mean corpuscular haemoglobin concentration (MCHC) were likewise similar ($P > 0.05$) between dietary treatments.

Haematological values obtained in the present study generally fell within the normal levels (Mitraka and Rawnsley, 1977) following

Table 5: The effect of decontaminated Kapek seed meal on gut dimensions and weights in male rabbits (means $\pm$ s.e.m.)^a.

Parameters	Diets				SEM
	0% KSM	2(10% KSM)	3(15% KSM)	4(20% KSM)	
Wgt. of GIT (g)	191.18	195.35	111.93	109.49	2.06
%Wgt. of GIT					
Wgt. of oesophagus (g)	7.37	7.22	1.99	2.55	0.10
%Wgt. of oesophagus	0.19	0.19	0.19	0.11	0.06
Wgt. of stomach (g)	14.37 ^a	19.35 ^b	26.35 ^b	20.45 ^b	1.32
%Wgt. of stomach	0.67	0.88	1.81	0.91	0.06
Wgt. of caecum (g)	25.97	25.77	13.87	25.62	0.66
%Wgt. of caecum	1.26	1.11	1.14	1.14	0.04
Wgt. of small intestine (g)	29.52	29.22	13.40	20.42	0.82
%Wgt. of small intestine	1.29	1.1	1.65	1.24	0.07
Wgt. of large intestine (g)	29.53	29.33	15.46	39.02	0.82
%Wgt. of large intestine	1.18	1.27	1.2	0.91	0.05
Oesophagus length (cm)	11.12	15.75	12.75	12.62	0.21
% of oesophagus length	0.18	0.19	0.09	0.11	0.02
Stomach length (cm)	8.67	8.87	8.10	8.75	0.14
% of stomach length	0.67	0.88	1.81	0.91	0.06
Small intestine length (cm)	296.53	313.75	396.17	287.25	5.10
% of small intestine length	60.81	61.13	60.91	58.72	0.95
Large intestine length (cm)	118.99	123.00	175.37	177.00	5.84
% of large intestine length	24.49	25.50	25.48	27.73	1.93

Wgt.=weight, % = As % of total GIT length

a,b: values in the same row bearing different superscripts differ significantly ($p < 0.05$)

s.e.m. = Standard error of mean.

Table 6: The Effect of decontaminated Kapek seed meal on the haematology of female rabbits (means $\pm$ s.e.m.)^a

Parameters	Diets			
	0% KSM	2(10% KSM)	3(15% KSM)	4(20% KSM)
Hb (g/dl)	16.83 $\pm$ 0.84	12.39 $\pm$ 1.91	10.80 $\pm$ 1.73	11.75 $\pm$ 0.20
PCV (%)	49.53 $\pm$ 1.73	36.45 $\pm$ 2.76	31.77 $\pm$ 4.19	34.58 $\pm$ 5.34
RBC (x10 ¹² /mm ³)	301 $\pm$ 0.10	3.90 $\pm$ 0.58	2.40 $\pm$ 0.29	3.70 $\pm$ 0.16
WBC (x10 ⁹ /mm ³)	8.20 $\pm$ 0.57	8.50 $\pm$ 1.87	7.86 $\pm$ 1.10	6.90 $\pm$ 0.44
Neutrophils (%)	51.00 $\pm$ 1.65	50.33 $\pm$ 5.53	51.33 $\pm$ 3.99	49.33 $\pm$ 3.48
Lymphocytes (%)	0.50 $\pm$ 0.04 ^a	1.50 $\pm$ 0.83 ^a	1.50 $\pm$ 0.50 ^a	1.51 $\pm$ 0.00 ^b
Eosinophils (%)	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00	0.00 $\pm$ 0.00
Monocytes (%)	41.30 $\pm$ 3.68	44.30 $\pm$ 6.01	42.85 $\pm$ 4.57	42.39 $\pm$ 2.73
Monocytes (%)	7.30 $\pm$ 1.64	7.00 $\pm$ 0.71	4.36 $\pm$ 0.74	3.00 $\pm$ 0.95
MCH (pg)	63.43 $\pm$ 2.28	93.45 $\pm$ 13.00	93.44 $\pm$ 4.71	93.46 $\pm$ 3.95
MCHC (g)	31.73 $\pm$ 1.34	51.77 $\pm$ 2.60	31.76 $\pm$ 1.256	21.75 $\pm$ 1.72
MCHC (%)	32.98 $\pm$ 1.60	34.00 $\pm$ 1.94	24.11 $\pm$ 3.52	35.83 $\pm$ 2.00

^a = ($P < 0.05$)

dietary treatment, thus indicating the suitability of KSM as a protein source for rabbits. Even though the control diet was superior to the KSM diets in terms of haematocrit values and erythrocyte counts, values for PCV, Hb and RBC in the animals on KSM were all within the normal range for rabbits and supported normal growth and performance (Table 3). These results however suggest that the use of KSM as a concentrate for rabbits may be limited to a certain critical optimal level which needs to be determined from further studies with higher levels of KSM inclusion.

Haematocrit, Hb and leukocyte values obtained in the present study were generally higher than values reported by Bitto and Gemade (2001) in male rabbits, Bitto and Tsebe (2006) in female rabbits and Bitto *et al.* (2006) in female rabbits under similar conditions in the same environment. These differences are not unexpected as considerable variations are known to exist in haematological values of rabbits. Sex for example is a more important factor than breed in the haematology of rabbits (Mitraka and Rawnsley, 1977) which might explain the higher values in the present study than corresponding values in the reports of Bitto and Tsebe (2006) and Bitto *et al.* (2006) who fed female rabbits in a similar age group with paw paw peel meal based diets. The higher values of these parameters in the present study than in male rabbits in the report of Bitto and Gemade (2001) can be adduced to age as the animals in the present study were older than those in the earlier report. The disparity in the WBC counts on the other hand may be due to diurnal variations as seasons differed in the same environment between the present study and the earlier ones.

The significant increase in eosinophils in the animals on the diet with the highest level of KSM indicates a multiplication of these cells to fight substances (antinutritional factors) perceived to be toxic to the body. The complete absence of basophiles in circulation in all animals in all treatments on the other hand implies that the animals were not anaemic (Deeie and Lewis, 1977). Blood constants obtained in the present study were all within normal values (Mitraka and Rawnsley, 1977). Coupled with the non effect of treatment on MCV, MCH and MCHC, the erythrocytes of the animals on all the diets could thus be classified as normochromic, indicating the suitability of KSM for the feeding of rabbits.

Conclusion

As decorticated KSM up to 20% level of inclusion supported growth and performance, gut morphology and the haematology of male rabbits, we conclude thus:

- Bucks can be raised on KSM based diets up to 20% level of inclusion.
- KSM could partially replace the expensive conventional protein sources in the diets of rabbits (like soybean meal or ground nut cake).

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