The effect of Kapok (*Ceiba pentandra*) [Linn] [Gaertn] meal on sperm production rate, gonadal and extragonadal sperm reserves in male rabbits

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Abstract

Twenty grower male rabbits of mixed breeds were used to evaluate the effect of Kapok seed meal on sperm production and sperm storage capacity. Five bucks each were randomly assigned to each of four isocaloric and isonitrogenous diets containing decorticated Kapok seed meal at 0, 10, 15 and 20% levels. After 8 weeks of ad libitum feeding, four bucks per treatment were randomly selected from each treatment group, sacrificed and their testes evaluated for sperm production, the efficiency of spermatogenesis and sperm storage capacity. The results did not show any significant differences ($P > 0.05$) between the treatments in Daily sperm production (DSP), Daily sperm production/ gram testis (DSP/g) as well as in gonadal and extragonadal sperm reserves. These results suggest that decorticated Kapok seed meal had no significant effect on sperm production in breeding bucks at an inclusion level of up to 20%. KSM may thus be a useful source of protein for rabbit bucks.

Key words: Kapok, sperm production, sperm reserves, bucks, rabbits.

Introduction

Rabbit production has gained prominence in the past two decades in the humid tropics due to increased awareness of the beneficial attributes of rabbits and their potential to meet the protein needs of people in these regions (Cheeke, 1984; Aduku and Olukosi, 1990; Fielding, 1991). With a fast growth rate, the ability to convert forages and crop residues as well as other agro-industrial by-products to meat more efficiently than other classes of livestock (Aduku and Olukosi, 1990),

coupled with the quality of its meat and the fact that rabbits are not faced with any religious or social taboos in these areas (Ekpenyong 1988); the rabbit has become an economically important species in the humid and semi humid zones of Africa especially Nigeria. In spite of the importance of rabbits in tropical livestock economy however, the cost of feed still limits profitable rabbit production. This problem is further compounded by the annual “bush burning” by hunters and the seasonal fluctuations

in the quantity and quality of some popular forages used in the feeding of rabbits in the guinea savannah.

The Silk cotton tree, (*Ceiba pentandra*) [Linn][Gaertn], commonly known as-Kapok with an average height of about 60m is widely distributed in the tropics (Irvine, 1961) and is of great economic importance. Irvine (1961) and Burkill (1985) reported several uses of Kapok including timber from the wood, soap making from the leaves and stuffing for pillows and mattresses while the seeds are eaten by several peoples of West Africa as ground or roasted meal. Kapok seeds and seed cake have been reported to be rich in nutrients (Thann *et. al.*, 1983; Burkill, 1985; Aduku, 1993) and have been successfully fed to different classes of livestock (Thann *et. al.*, 1983; Burkill, 1985; Mashingo *et. al.*, 1994; Softyan, *et. al.*, 1994; Bitto and Shidi, 1999). None of these reports however bordered on the possible effects of Kapok seed meal on testis function and related phenomenon in the male animals. Thann *et. al.* (1983) moreover found Kapok seeds to be unsuitable in broiler diets as raw seeds at 10% or more were found to be toxic. Unfortunately, there is at present no established authority on the levels of antinutritional factors in Kapok. Moreover, besides the report of Bitto and Shidi (1999) in rabbits, information on the possible effects of some antinutritional factors that are common to similar seeds on the physiology of livestock especially rabbits is lacking. Gossypol-a polyphenolic compound known to occur naturally in similar seeds for example has long been implicated in severe physiological disorders in the body (Smith, 1957) and is known to

adversely affect the sperm production rates, spermatogenesis and sperm storage (Oko and Hrudka, 1982; Egbunike *et al*, 1999). This work was thus proposed to provide information on the effect of decorticated Kapok seed meal on sperm production rates, gonadal and extragonadal sperm reserves in male rabbits.

Materials and Methods

Location

This study was conducted at the Rabbitry of the Department of Animal Breeding and Physiology, University of Agriculture, Makurdi, Nigeria, located on latitude 7°14N and longitude 8°21E with an annual rainfall ranging from 1270-1397mm and a temperature range of 21°C-42°C.

Animals and Management

Twenty Rabbit bucks of mixed breeds (Chinchilla x California x New Zealand White) between the ages of 9 and 12 weeks, with a mean weight of 1300g, were utilized for this investigation. The bucks were randomly assigned to 4 isocaloric and isonitrogenous diets containing raw decorticated Kapok seed at the levels of 0, 10, 15 and 20% respectively, with each dietary treatment having 5 animals. 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 test diets *ad libitum* with cool clean drinking water supplied always. The trial lasted for 8 weeks.

Sampling

Samples of each diet were analyzed for proximate chemical composition (AOAC, 1990) while KSM was analyzed for total gossypol, phytin and tannins. Total gossypol was determined using the method of Pons and Hoffpauir (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).

The antinutritional contents of the respective diets were thereafter estimated by calculation.

At the end of the feeding trial, four bucks per treatment were sacrificed for the investigations after the animals had been starved for 12 hours. The testes were obtained immediately after slaughter, trimmed of fat and adhering tissues

then evaluated for daily sperm production (DSP), daily sperm production/gram testis (DSP/g), gonadal and extragonadal sperm reserves by the homogenate method of Almquist and Amann (1961) as already reported by Bitto and Egbunike (2006). Sperm concentration was determined haemocytometrically after a (1:40v/v) dilution in 0.154M NaCl (Egbunike et. al., 1976). DSP was then obtained by dividing the gonadal sperm reserve by a time divisor of 3.43 proposed for rabbits by Amann (1970).

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 diets are presented in Tables 1 and 2 respectively, while the antinutritional contents of Kapok and the diets as well as the effects of the treatments on sperm production and sperm storage capacity of the animals are summarized in Tables 3, 4 and 5 respectively.

Dietary treatment had no significant effect ($P>0.05$) on spermatogenesis, its efficiency and the sperm storage capacity of the animals. The apparent decrease in sperm numbers with increasing levels of Kapok seed meal inclusion observed in the testis, caput epididymis and cauda epididymis nonetheless suggest that deleterious effects of KSM on testis function might be obtained at a certain higher level of inclusion which needs to be determined from

further experiments. As daily sperm production is highly related to testicular weights, the non effect of dietary treatment on spermatogenesis is explainable by the similarities ($P>0.05$) between the treatment groups in paired testes weights (Table 4).

The screening of Kapok seed meal for antinutritional factors gave appreciable levels of phytin, tannins and gossypol (Table 3). Phytin is known to have adverse effects on the availability of some essential mineral elements (Nwokolo and Bragg, 1977) while tannins are known to

Table 1: Composition of the experimental diets (%)

Ingredients	Diets			
	1(0%K SM)	2(10%KSM)	3(15%K SM)	4(20%KSM)
Maize	38.50	34.00	33.70	30.70
Full fat soyabeans	28.90	18.83	13.60	8.56
Rice Offal	27.86	32.43	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%K SM)	3(15%KSM)	4(20%KSM)
Dry Matter	92.50	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	9.35	9.75	11.35	11.20
Ash	7.50	5.40	5.10	2.25
NFE	47.23	49.76	48.70	53.63
ME (Kcal/K g) *	2645.66	2694.18	2757.36	2767.26

*=Calculated from Pauzenga (1985)

Table 3: The Antinutritional contents of Kapok and the test diets.

Antinutritional Factor	Kapok	Diet			
		1(0%KSM)	2(10%K SM)	3(15%KSM)	4(20%KSM)
Gossypol (%)	0.033	0.00	0.33	0.49	0.66
Phytate (%)	0.203	0.00	2.03	3.04	4.06
Tannins (%)	0.360	0.00	3.60	5.40	0.076

Table 4: The Effect of decorticated Kapok seed meal on Daily sperm production (DSP) and Daily sperm production/ gram testis (DSP/g) in male rabbits (means $\pm$ s.e.m.)⁺

Parameter	Diets			
	1 (0%K SM)	2 (10%K SM)	3 (15% KSM)	4 (20%K SM)
*PTW (g)	3.06 $\pm$ 0.27	3.15 $\pm$ 0.19	2.78 $\pm$ 0.41	2.76 $\pm$ 0.27
DSP (x 10 ⁹)	0.38 $\pm$ 0.020	0.34 $\pm$ 0.013	0.32 $\pm$ 0.010	0.28 $\pm$ 0.015
DSP/G (x 10 ⁸)	0.15 $\pm$ 0.02	0.11 $\pm$ 0.01	0.12 $\pm$ 0.06	0.10 $\pm$ 0.01

s.e.m. = Standard error of mean; * = Paired testes weight; + = (P > 0.05)

affect food proteins, altering the digestibility leading to retardation in growth (Jambunathan and Mertz, 1973) and gossypol has many deleterious effects on the physiology of the animal including anorexia, dyspnea, oedema of the lungs, hydroperitoneum, hepatic degeneration, hypertrophy and dilation of the heart (Smith, 1957) as well as its well known antispermatic effects (Okon and Hrudka, 1982; Shandilya, *et al.*, 1982; Egbunike *et al.*, 1999). The levels of phytin, tannins and gossypol

in raw decorticated Kapok seeds and the levels estimated in the respective diets in the present study thus appear to be safe for male rabbits up to an inclusion level of 20% as the adverse effects of these antinutritional factors were not observed in the present study. It does appear from the results of this study however that the effect of gossypol on the physiology of reproduction in animals might be species specific. It is noteworthy that whereas high doses of gossypol: 20mg/kg body weight/day for 2-30 days in the

Table 5: The Effect of decorticated Kapok seed meal on gonadal and extragonadal sperm reserve rabbits (means $\pm$ s.e.m.)^{*}.

Parameters	Diets			
	1 (0%K SM)	2 (10%K SM)	3 (15%KSM)	4 (20%KSM)
Gonadal sperm reserves (x 10 ⁹)	1.40 $\pm$ 0.01	1.26 $\pm$ 0.02	1.11 $\pm$ 0.02	1.10 $\pm$ 0.01
Caput sperm reserves (x 10 ⁸)	0.50 $\pm$ 0.01	0.40 $\pm$ 0.05	0.36 $\pm$ 0.03	0.33 $\pm$ 0.02
Corpus sperm reserves (x 10 ⁸)	0.04 $\pm$ 0.00	0.05 $\pm$ 0.003	0.03 $\pm$ 0.001	0.04 $\pm$ 0.001
Cauda sperm reserves (x 10 ⁸)	2.44 $\pm$ 0.14	2.26 $\pm$ 0.22	2.10 $\pm$ 0.07	1.80 $\pm$ 0.09
Ductus sperm reserves (x 10 ⁸)	0.03 $\pm$ 0.002	0.04 $\pm$ 0.002	0.02 $\pm$ 0.005	0.02 $\pm$ 0.00

s.e.m. = Standard error of mean

report of Oko and Hrudka (1982) produced lesions of the sperm tail after 9 days in all spermatozoa and a cessation of motility after 30 days even as 25mg/kg body weight of gossypol acetic acid/day in the report of Egbunike *et. al.* (1999) reduced the diameters of seminiferous tubules and epididymal segments as well as depressed efficiency of spermatogenesis and epididymal sperm reserves in rats: Baimuranov *et. al.* (1989) on the other hand reported that diets containing about 0.03% only of gossypol had adverse effects on reproduction in pigs. With the estimated levels of gossypol in the KSM diets in the present study being higher than the levels that induced adverse effects in pigs (Baimuranov *et. al.*, 1989) but much lower than the toxic levels in rats (Oko and Hrudka, 1982; Egbunike *et. al.*, 1999), it becomes obvious that species differences may exist in the effects of gossypol on the reproductive physiology of animals. This would stand to reason as the kinetics of spermatogenesis is species specific (Swierstra and Foote, 1963). Further experiments are therefore required to determine the effects of toxic levels of dietary gossypol (and other antinutritional factors in Kapok) in rabbit bucks.

Conclusions

These results imply that:

- Kapok seed meal up to a level of 20% does not adversely affect spermatogenesis in rabbits.
- KSM up to 20% level of inclusion appears unlikely to impair testicular function generally in breeding bucks.
- Breeding males could therefore be raised on Kapok seed meal based diets in the tropics.

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