Effect of baobab fruit pulp meal on testosterone concentration and gonadal and epididymal morphometry of rabbit bucks in a hot environment

Anoh, K. U.

Department of Animal Science, Ahmadu Bello University Zaria

Abstract

Corresponding E-mail: Kevin2us.man@gmail.com

The aim of the study was to evaluate the effect of baobab fruit pulp meal on testosterone concentration and gonadal and epididymal morphometry of rabbit bucks during hot season in Nigeria. A total of 25 bucks of 10-12 months old were used. There were five (5) rabbits per group grouped as follows; T₁ (control) and T₂-T₅ (Diets with graded levels of BFPM at 2.5%, 3.5%, 4.5% and 5.5% inclusion levels, respectively). The experiment lasted for nine weeks. All management practices were duly observed. Three bucks were selected from each treatment group and slaughtered. The two testes of each of the rabbits were carefully removed and evaluated for their morphometric. The weight, length and volume of each testis were determined. It was found that the treatments with 3.5 – 5.5% BFPM significantly ($P < 0.05$) increased testosterone concentration, weight and size of the gonad and the epididymis. It was concluded that BFPM is more effective in ameliorating heat stress in rabbit production and reproduction and can be used up to 5.5% inclusion level.

Keywords: Heat stress, rabbit bucks, gonads

Introduction

Most developing countries like Nigeria are mostly localized in tropical and subtropical regions. These regions are characterized by high ambient temperature which leads to heat stress. Despite this constraint, there is the need to increase and multiply rabbit in these regions to bridge the gap of protein intake and supply. One of the important organs of reproduction in male mammals is the testis. The testes are seen as biological industry in male species involved in spermatogenesis and hormonal secretions (Obidi *et al.*, 2008). Testicular development in domestic animals has been related to their short and long-term reproductive functions (Wilson *et al.*, 1965; Romero-Sanchez *et al.*, 2007) although about 60% of this is controlled by genetic factors (Barbato, 1999), while 40% can be controlled by the environment (feed, weather conditions, management practices etc) because gene and environment make up the phenotype. Photoperiod (Umeda *et al.*, 1992) and nutrition (Omole, 1982; Lisowski and Bednarczyk, 2005; Romero-

Sanchez *et al.*, 2007) influences testicular development, epididymal development and spermatogenesis (Rekwot *et al.*, 1987). The combined influences of these important control factors may result greatly in enhancing or inhibiting reproductive efficiency in the male, depending on the balance between the negative and positive control factors. The positive correlation between scrotal size and sperm production has been reported. Many experiments have been made to study the effect of heat stress on body weight and physiological parameters in rabbits and to suggest some methods to alleviate heat stress on them. The use of vitamin C and other antioxidants were recommended to be used as supplements for rabbits during hot periods (Marai *et al.*, 2001). Plant sources of vitamin C may be biologically safe for livestock production. Baobab fruit pulp meal can easily be recognized by local farmers and may not have any hazardous effects on the animals and the secondary consumers. The white, powdery pulp is reported to have a high content of vitamin C

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(Agbessi Dos-Santos, 1987). The aim of this study was to investigate baobab fruit pulp meal on changes in gonadal and epididymal morphometry and testosterone concentration of heat stressed rabbit bucks.

Materials and methods

Experimental site

This study was carried out at the Rabbit Unit of the National Animal Production Research Institute (NAPRI), Shika-Zaria Nigeria. Shika-Zaria lies between 11° 12' 42" N and 7° 33' 14" E at an altitude of 691m above sea level (Ovimaps, 2014).

Experimental animals, diets and design

A total of twenty five Hyla crosses bucks with average weight of 2.7 kg were used in this study. The bucks were about 8 months old. The rabbits were randomly allotted into the experimental treatments of five treatment groups with five (5) rabbits per treatment in a completely randomized design. Rabbits in the first group (T₁) served as the control; rabbits in treatment 2 – 5 were fed diets containing graded levels of Baobab Fruit Pulp Meal (BFPM). Feed and water were served *ad libitum*. All recommended managerial practices were dully observed.

Testosterone hormonal assay

Blood samples (5 ml) were collected through the ear vein, randomly selected from the treatment groups, from each group of rabbits, respectively into a bottle without anticoagulant and allowed to clot. The blood samples were centrifuged at 3000 rpm for 15 minutes. The serum harvested was stored at -10°C until analyzed. The concentrations of testosterone in blood serum were determined using commercially available ELISA kits (Diagnostic Procedure Corp., Los Angeles, CA, USA) according to the manufacturer's instructions.

Evaluation of epididymal and gonadal sperm reserves

Three bucks were selected from each treatment group and slaughtered. The two testes of each of the rabbits were carefully removed and evaluated for their testicular and epididymal morphometry. The weight, length and volume of each testis were determined, and it was done according to the methods of (Rekwot *et al.*, 1994).

Statistical analysis

Data obtained from the study were subjected to analysis of variance, using the general liner model procedure of SAS (2002). Significant differences among treatment means were separated using the pair wise difference in the SAS package.

Results and discussion

Testosterone level at the commencement of the experiment was lower than that recorded at the end of the experiment (Fig. 1). There was no significant difference in initial testosterone level among the treatments but treatment with 5.5% BFPM significantly ($P<0.05$) increased testosterone level from 7.4 ml/ng to 13.7ml/ng. Treatment of rabbits with 2.5% BFPM increased testosterone level from 7.4 ml/ng to 12.24ml/ng. The significant increase recorded in the treatments with BFPM could be that the vitamin in BFPM counteracted free radicals that may impaired the Leydig cell functioning and also suppress heat stress. Vitamin C has been reported to be an effective antioxidant. Heat stress causes the degeneration of the germinal epithelium and partial atrophy of seminiferous tubules (Marai *et al.*, 2002). Increasing the temperature of the testes can prevent spermatogenesis; reduce testosterone secretion by causing degeneration of most cells like the Leydig cells and cells of the seminiferous tubules besides the spermatogonia (de Kretser 2004).

The treatment with 3.5% BFPM (Table 1) significantly ($P<0.05$) increase testicular

length, testicular weight and filtrate volume. The values were similar with those recorded in rabbits treated with 4.5 and 5.5% BFPM, compared to the rest of the treatments. Across the treatments the values of the right testis were generally higher than those of the left testis, but the weight of the left testis did not show any significant difference. The reduction in testis weight in

the control group may be attributed to heat stress. The effect of heat stress on scrotal temperature has been reported to be a decrease in testis weight (Finzi *et al.*, 2000) and the testis can remain reduced if there is severe heat stress (Habeeb *et al.*, 1993). The effect has been reported for mice (Habeeb *et al.*, 1993; Jannes *et al.*, 1998), rats and rabbits (Hamada *et al.*, 2011).

Fig. 1 Effect of Graded Levels of BFPM on Testosterone Levels in Rabbit Bucks

This reduction suggests degeneration in the germinal epithelium and partial atrophy in the seminiferous tubules (El-Shery *et al.*, 1980). The improvement in gonadal morphomery in the treatments with BFPM suggests that the content of vitamin C content in BFPM may be involved in the reduction of the negative effects of heat stress on the variables. This reduction may decrease the damage caused by reactive species of oxygen, or by sparing the effects

of enzymes, involved in the antioxidant systems of the testicle. In Table 2, the result shows that BFPM (3.5%) significantly ($P < 0.05$) increase epididymis length and epididymis weight (right) while the control, 2.5 and 5.5% significantly increased epididymis filtrate volume. The weight of the left epididymis, length of caput and corpus epididymis (right) and weight of the caput and corpus epididymis, did not show any significant difference.

Table 1: Effect of Graded Levels of BFPM on Gonadal Morphometric of Bucks

Parameters	Control	2.5%	3.5%	4.5%	5.5%	SEM
Testis Length (cm)						
Right	2.40 ^b	2.47 ^b	3.16 ^a	2.73 ^{ab}	2.63 ^b	0.11
Left	2.30 ^b	2.70 ^{ab}	3.33 ^a	3.07 ^a	2.67 ^{ab}	0.17
Testis weight (g)						
Right	0.53 ^c	1.48 ^{abc}	2.40 ^a	2.22 ^{ab}	1.11 ^b	0.26
Left	0.45	1.28	1.64	1.89	1.12	0.34
Filtrate Volume (ml)						
Right	8.67 ^b	9.00 ^{ab}	9.16 ^{ab}	9.17 ^{ab}	9.47 ^a	0.99
Left	8.33 ^{bc}	8.00 ^c	9.63 ^a	9.00 ^{ab}	9.60 ^a	0.83

Means within rows with different superscripts are significantly different: $P < 0.05$

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The values of the right epididymis across the treatments were larger than those of the left epididymis. The trend in epididymis morphometry is a reflection of the values for gonadal morphometry of rabbits fed graded levels of BFPM in this study. It was observed that the values of gonadal weight and length of the right testis were higher than those of the left. Heat stress may be responsible for the reduction in weight and length of the epididymis. El-Shery *et al.* (1980) attribute the reduction in gonadal and epididymal weight to heat stress caused by the degeneration in the germinal epithelium and partial atrophy in the seminiferous tubules. The improvements in epididymal morphometry in the treatments with BFPM

suggest that the vitamin C content in BFPM may have reduced the negative effect of heat stress on these variables. This reduction apparently results in decrease in the damage caused by reactive species of oxygen or by sparing the effect of enzymes, involved in the antioxidant systems of the testicle.

Conclusion

This study revealed that heat stress can adversely affect testosterone secretion as well gonadal and epididymal morphometric of buck rabbits. Vitamin C was proven to effectively alleviate these parameters. BFPM being very high in vitamin C may be more biologically safe to use in animal production during hot periods.

Table 2: Effect of Graded Levels of BFPM on Epididymis Morphometry of rabbit Bucks

Parameters	Control	2.5%	3.5%	4.5%	5.5%	SEM
Epididymis Length (cm)						
Right	3.42 ^b	5.10 ^{ab}	6.50 ^a	5.77 ^{ab}	3.92 ^a	0.69
Left	2.88 ^b	4.67 ^{ab}	7.17 ^a	6.50 ^{ab}	4.21 ^{ab}	0.91
Epididymis Weight (g)						
Right	0.38 ^c	0.79 ^{bc}	1.18 ^a	1.10 ^{ab}	0.55 ^b	0.13
Left	0.55	0.71	0.92	0.95	0.85	0.16
Caput Length (cm)						
Right	1.27	1.37	1.67	1.67	1.64	0.17
Left	1.00 ^c	1.10 ^b	1.37 ^a	1.27 ^{ab}	1.13 ^b	0.05
Corpus Length (cm)						
Right	2.77	2.17	2.47	2.07	2.60	0.71
Left	1.70 ^{ab}	1.47 ^b	2.27 ^a	1.73 ^{ab}	1.70 ^{ab}	0.20
Cauda Length (cm)						
Right	1.23 ^b	1.28 ^b	1.70 ^a	1.50 ^{ab}	1.40 ^{ab}	0.08
Left	1.57	1.57	1.67	1.53	1.68	0.09
Caput Weight (g)						
Right	1.13	0.22	0.30	0.30	1.17	0.50
Left	0.10	0.80	0.46	0.40	0.22	0.05
Corpus Weight (g)						
Right	0.04	0.02	0.04	0.05	0.03	0.01
Left	0.01	0.01	0.01	0.02	0.01	0.01
Cauda Weight						
Right	0.36 ^b	0.47 ^b	0.65 ^a	0.66 ^a	0.46 ^{ab}	0.06
Left	0.28 ^b	0.43 ^{ab}	0.65 ^a	0.61 ^a	0.42 ^{ab}	0.07
Epididymis Filtrate Volume (cm)						
Caput						
Right	4.27 ^{ab}	4.17 ^{ab}	4.37 ^{ab}	4.00 ^b	4.57 ^a	0.13
Left Corpus	4.73 ^a	4.77 ^a	4.50 ^{ab}	3.79 ^b	4.23 ^{ab}	0.17
Right	4.33	5.00	4.56	3.90	4.67	0.28
Left	4.76 ^a	4.73 ^a	4.60 ^{ab}	3.90 ^b	4.37 ^{ab}	0.19
Cauda						
Right	4.53 ^{ab}	4.00 ^b	4.37 ^{abc}	3.87 ^c	4.63 ^a	0.13
Left	4.66 ^a	4.70 ^a	4.40 ^{ab}	3.90 ^b	4.20 ^b	0.15

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Received: 7th February, 2017

Accepted: 21st June, 2017