

Effect of Graded Levels of Wild Sunflower (*Tithonia diversifolia* Hemsl A. Gray) Meal in Prepubertal Diets on the Morphometric Characteristics of the Genitalia and Some Organs of Isa Brown Cocks at the Pubertal Age

V.A. Togun, G.O. Farinu and R. Olabanji

Department of Animal Production and Health, Faculty of Agricultural Sciences,
Ladoke Akintola University of Technology, P.M.B. 4000, Ogbomoso, Nigeria

Abstract: Two hundred and fifty day-old cockerel chicks of Isa Brown strain were used to study the effect of graded levels of wild sunflower forage meal (WSFM) on the morphometric characteristics of some reproductive and internal organs of Isa Brown cocks. The chicks were randomly allocated to five dietary treatment groups of five replicates each to make fifty cockerels per group. Group diets contained 0 (control), 5, 10, 15 and 20% levels of WSFM inclusion levels in a Complete Randomized Design Experiment. Morphometric characteristics of the cocks' genitalia were studied, when eight cocks per replicate were slaughtered at the pubertal age of 18 weeks. The final live weight decreased significantly ($p < 0.05$) as the level of WSFM inclusion increased from 5%. The control cocks were significantly ($p < 0.05$) superior to all the experimental diets in dressed weight and dressing percentage; testis weight, volume, length and width as well as tunica albuginae weight. The relative weights of the liver, heart and gizzard were significantly ($p < 0.05$) increased as WSFM inclusion levels increased in the diets, relative to the control. There were significant ($p < 0.05$) correlations of live weight and testes weight with testes width, length and parenchyma weights as well as the tunica. The correlation of testes weight with epididymal weight was low, negative and non-significant. It was concluded that WSFM at 5% inclusion level is adequate in a commercial cock production programme, where live cocks are offered for sale based on size and live weight. Inclusion of WSFM at any level did not support the development of the testes and is therefore not recommended for cocks in a poultry breeding programme.

Key words: *Missing*

INTRODUCTION

The poultry industry in Nigeria has been plagued by a variety of problems, which include the search for feed ingredients that are not competed for by man. This has resulted in reduced interest of farmers in the industry, leading to a reduction in animal protein availability for human consumption as a consequence of high cost of production. Provision of feed alone has been reported to account for 60-80% of total cost in any livestock production [1-3].

The price structure of grains and some other feed ingredients have witnessed an upward trend in recent time. Egbunike *et al.* [4] observed that the interest of Nigerian animal producers has been centred mostly on the search for cheaper feed ingredients that are always available and have no competition with man's dietary

demands. Some agro-industrial by-products and plants have been used with varied levels of success. Wild sunflower occurs in Nigeria on road sides and as invader of field crops in the forest savanna transition zone. Wild sunflower leaf and forage meals, as unconventional feedstuff, have been found to generally enhance growth and production in livestock as well as a cheap source of egg-yolk colouration in poultry production [5, 6]. The incorporation of these and some others in poultry diets have been reported to result in compounded feeds with nutrient profiles that compare favourably with feeds of conventional feedstuff and reduce feed cost, as they reduce competition with humans [7-10]. Nutrition is one of the most important environmental factors affecting reproductive performance. Sexual maturity is known to be delayed by a poor nutrient regime during growth [11, 12].

Corresponding Author: Dr. V.A. Togun, Department of Animal Production and Health, Faculty of Agricultural Sciences, Ladoke Akintola University of Technology, P.M.B. 4000, Ogbomoso, Nigeria

The knowledge of basic morphometric characteristics of the reproductive organs in an animal is a valuable information for the evaluation of its breeding soundness and potential fertility. It is an important aspect of the reproductive management practices. Successful poultry breeding programme is related to efficient management of the cock since a single cock is responsible for servicing many breeding hens in the flock at the same time. Growth and testicular development are measurable reproductive criteria of an animal [13, 14]. Testes weight is expected to increase with age in normal animal up to a point. Etches [15] reported that as sexual maturity is attained, the weight of the paired testes of cockerel increases from 2-4 g to 25-35g. According to Perry and Petterson [16], testis size is a good indication of present and future sperm production as well as the breeding quality of the male. Kurbatov *et al.* [17] reported a positive relationship between live weight and sperm production in Koban ganders while Brito *et al.* [18] reported that body weight is a good predictor of sexual maturity.

Earlier studies on wild sunflower have focused on its feeding value in terms of feed intake, weight gain, feed conversion ratio and egg production in poultry. Nothing has been reported so far on the effect of feeding the forage meal on the reproductive performance of cockerels which, in this part of the world, forms a major source of animal protein to the general public and income to women in various communities especially where backyard poultry is encouraged.

Since good reproductive performance is necessary for optimal production and profitability and the need to reduce feed cost is fundamental, this study attempts to investigate the effect of graded levels of wild sunflower (*Tithonia diversifolia*, Hemsl A. Gray) forage meal on the morphometric characteristics of Isa Brown cock genitalia (which could be used to estimate reproductive performance) and some internal organs.

MATERIALS AND METHODS

Experimental Site: The study was conducted at the Teaching and Research farm, Ladoke Akintola University of Technology, Ogbomoso, located in the derived savannah belt of Nigeria.

Preparation of experimental diets: Sunflower leaves and inflorescence were harvested together prior to flowering stage and air dried for 7 days. The air-dried leaves were then milled, using manual grinding machine. Experimental diets were prepared by replacing maize with varying levels of the wild sunflower forage meal. Five

diets were formulated to contain 0% (control), 5, 10, 15 and 20% WSFM for groups 1, 2, 3, 4 and 5, respectively.

Animal management: Two hundred and fifty day-old cockerel chicks of Isa Brown strain were used for the study. The chicks were first maintained on a standard chick mash for one week after which they were randomly allocated to the five dietary treatment groups with wild sunflower forage meal (WSFM) inclusion levels. Each of the 5 replicates per group, with each replicate having 10 chicks was housed in a well ventilated, deep litter house partitioned into 2 x 3.5 m² pens. The experiment lasted eighteen weeks during which the birds were offered feed and clean water *ad-libitum*. Routine poultry production management and health care practices were carried out during the experimental period.

Experimental design: The birds were allocated into five treatment groups of five replicates each containing 10 chicks. There were thus 50 birds per group in the Complete Randomized Design experiment.

Data collection: At the pubertal age of 18 weeks, the birds were weighed and any two birds in each replicate that did not conform to the growth pattern of the replicate group, were discarded. Thus 8 cocks per replicate (40 cocks per group) were sacrificed by severing their jugular veins. The carcasses were properly drained of blood, defathered and eviscerated. The weight of each dressed carcass was recorded.

The testes were removed from the anterior end of the dorsal side of the kidneys and trimmed free of the epididymis and adjoining tissues before they were weighed. Testes volume was measured volumetrically using the Archimedes principles of water displacement in a measuring cylinder. The length and width of each testis were measured using veneer caliper. Tunica albuginea was then peeled off each testis and weighed to know the actual weight of the testicular parenchyma. Each epididymis was weighed after removal from the testis. Each vas deferens was removed and weighed.

$$\text{Testes density} = \frac{\text{Testes weight (g)}}{\text{Testes volume (cc)}}$$

Statistical analysis: Data collected were subjected to analysis of variance (ANOVA) and correlation analysis [19]. The treatment means were tested for significant differences by Duncan's Multiple Range Test [20]. The data were also subjected to correlation analysis.

Table 1: Gross percentage (%) composition of experimental diets (Grower Ration)

Ingredients	Groups				
	1 (0%)	2 (5%)	3 (10%)	4 (15%)	5 (20%)
Maize	63.00	58.00	53.00	48.00	43.00
SFM	0.00	5.00	10.00	15.00	20.00
GNC	18.00	18.00	18.00	18.00	18.00
Wheat offal	14.25	14.25	14.25	14.25	14.25
Bone meal	2.50	2.50	2.50	2.50	2.50
Oyster shell	1.50	1.50	1.50	1.50	1.50
Salt	0.25	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25	0.25
Premix	0.25	0.25	0.25	0.25	0.25
Tatal	100.00	100.00	100.00	100.00	V
Calculated analysis					
% Crude protein	15.61	15.95	16.29	16.63	16.95
ME Kcal kg ⁻¹	2877.00	2812.00	2747.00	2682.00	2617.00

• Premix composition (per kg diet). Vit A 4,000,000, Vit D3 1,000,000 i.u, Vit E 4,800 i.u k3 1,000 mg, vitamin B, 800 mg, Vit B2 2,200 mg Vit B6 1,600 mg Vit B12 8 mg Nicotinic acid 14,000 mg, Pantothenic acid 4,000 mg/Folic acid 160 mg, Biotin 20 mg, chlorine 120,000 mg, cobalt 200 mg, copper 3,200 mg, Iron 20,000 mg Antioxidant 1000 mg

Table 2: Proximate composition of wild sunflower forage meal (%) *

Crude protein	18.40
Crude fibre	12.00
Ether extract	5.00
Ash	14.00
NFE	50.60

*Standard methods of analysis [32] were used to determine the proximate composition of wild sunflower forage meal

RESULTS

Table 1 shows the gross percentage composition of the experimental diets and Table 2, the proximate composition of the wild sunflower forage meal used in this study.

Table 3 shows the mean live, carcass and relative organ weights of the different groups of the cocks. The

inclusion of WSFM in the diet at 5% level did not result in any significant difference from the control diet in final live weight of the cocks at the pubertal age of 18 weeks. The inclusion levels of WSFM in the diets of groups 3 & 4 cocks resulted in significantly ($p<0.05$) lower final live weight than the control and group 2 cocks. The mean value observed in group 5 cocks, was significantly ($p<0.05$) lower than all other groups. In reality, the mean live weight of groups 2, 3, 4 and 5 cocks were 95, 62, 68 and 31% respectively of the control cocks' value.

The control group was significantly ($p<0.05$) superior to group 2 in carcass weight. Group 2 cocks had significantly ($p<0.05$) higher carcass weight than groups 3 & 4, which were both significantly ($p<0.05$) superior to group 5 cocks. Dressing percentage was significantly ($p<0.05$) higher in the control than in all the

Table 3: Live, carcass and relative internal organs' weights of cocks fed graded levels of WSFM

	Groups				
	1 (0%)	2 (5%)	3 (10%)	4(15%)	5 (20%)
Live weight (g)	1726.00±16.61 ^a	1640.00±100 ^a	1070.00±70 ^b	1178.00±70 ^b	874.00±20 ^c
Dressed weight (g)	1382.30±9.78 ^a	1205.05±99.4 ^b	754.60±37.44 ^{cd}	844.38±38.14 ^c	49.38±19.58 ^d
Dressing percentage (%)	77.60±1.70 ^a	73.50±1.06 ^b	70.50±1.87 ^b	71.60±1.84 ^b	74.60±1.00 ^b
Liver weight (PCW)	4.18±9.12 ^c	4.36±0.36 ^c	5.11±0.41 ^b	5.44±0.40 ^a	5.57±0.22 ^a
Gizzard weight (PCW)	2.12±0.13 ^c	2.44±0.04 ^b	2.70±0.07 ^a	2.56±0.12 ^{ab}	2.66±0.08 ^a
Heart weight (PCW)	0.61±10.02 ^b	0.63±0.02 ^{ab}	0.67±0.02 ^a	0.71±0.02 ^a	0.66±0.01 ^a

WSFM - Wild sunflower meal

Table 4: Morphometric characteristics of reproductive organs of cocks at 18 weeks

Measurement	Groups				
	1 (0% WSFM)	2 (5% WSFM)	3 (10% WSFM)	4 (15% WSFM)	5 (20%WSFM)
PTW (g)	5.72±2.43 ^a	1.87 ^b ±0.63 ^b	0.46±0.05 ^b	0.48±0.18 ^b	0.20±0.03 ^b
Ptun. wt. (g)	0.37±0.08 ^a	0.08±0.01 ^b	0.03±0.01 ^b	0.03±0.01 ^b	0.01±0.00 ^b
Mean testes lt (cm)	2.69±0.29 ^a	1.96±0.26 ^b	1.50±0.01 ^b	1.42±0.16 ^{bc}	1.13±0.11 ^c
Means testes width (cm)	1.44±0.28 ^a	0.99±0.09 ^{ab}	0.67±0.10 ^{bc}	0.65±0.12 ^{bc}	0.42±0.02 ^c
Paired testes vol. (ml)	9.04±3.00 ^a	3.83±1.01 ^b	1.40±0.41 ^b	1.19±0.23 ^b	0.18±0.02 ^b
Mean testes dens. (g ml ⁻¹)	0.62±0.12 ^{abc}	0.48±0.03 ^c	0.52±0.17 ^{bc}	1.03±0.21 ^{ab}	1.13±0.02 ^a
Paired epid. wt. (g)	0.23±0.06 ^{ab}	0.34±0.03 ^a	0.18±0.03 ^b	0.24±0.06 ^{ab}	0.16±0.02 ^b
Mean vas def wt. (g)	8.80±0.39 ^{ab}	9.64±0.72 ^a	7.74±0.37 ^b	8.53±0.35 ^{ab}	7.64±0.10 ^b

PTW - Paired testes weight, PTun wt. - Paired Tunica weight

other groups, which did not significantly ($p<0.05$) differ from one another.

Mean relative liver weight was significantly ($p<0.05$) lower in the control and group 2 cocks than all the other groups. Mean relative weight of gizzard was significantly ($p<0.05$) higher in cocks with higher WSFM inclusion levels than 5% inclusion, which was in turn significantly ($p<0.05$) higher than in the cocks on the control diet. The mean relative weight of the heart was significantly ($p<0.05$) higher in the cocks on the WSFM inclusion levels than the control cocks, which did not significantly differ from the 5% inclusion level.

Table 4 shows the morphometric characteristics of the genitalia of the cocks at their pubertal age of 18 weeks. All the inclusion levels resulted in significantly ($p<0.05$) lower morphometric values than the control group. The paired testes weight, paired testes volume and paired tunica albuginea weight all follow the same trend of significantly ($p<0.05$) lower value in the cocks fed varying inclusion levels of WSFM than the control cocks. The testes of control cocks were 3.06; 12.43; 11.92 and 28.6 times as heavy as the groups 2; 3; 4 and 5 cocks, respectively. There was no significant ($p>0.05$) difference between the cocks at all the levels of inclusion.

The mean testis length was significantly higher in the control cocks than all other groups while group 5 cocks had a significantly ($p<0.05$) lower value than group 2 cocks but not groups 3 and 4 cocks. Mean testis width of the control cocks was significantly ($p<0.05$) larger than all the WSFM groups except the 5% inclusion, which did not differ from groups 3 and 4 but was also significantly larger than group 5 cocks. The mean testis density, epididymal and vas deferens weights did not show a definite pattern from the control all through the WSFM groups.

The correlation coefficients of live weight with testes weight, length and width were 0.55, 0.76 and 0.71,

respectively. The correlation coefficients of testes weight with testes width and length, epididymal and tunica albuginea weights were 0.92, 0.88, **0.07** and 0.93, respectively.

DISCUSSION

The crude protein value (18.4%) observed for the test ingredient in this study was slightly higher than the 16.6% reported by Odunsi *et al.* [5] but the other nutrients were similar. The difference is likely due to the stage of growth at harvest as well as the processing method.

The decrease in live weight across the dietary treatment groups (1-5) observed in this study implied a reduction in growth rate and consequent final weight of the experimental birds at the pubertal age of 18 weeks. This decrease is similar to that reported by Dagbir *et al.* [21] for cultivated sunflower meal. Odunsi *et al.* [5] have observed a reduction in feed consumption of birds fed rations containing WSFM. In this study, such lower feed consumption is complicated by the increased bulkiness of the feed as the WSFM inclusion increased in the diet. According to Dagbir *et al.* [21], such bulkiness of feed results in the birds not being able to satisfy their energy and protein requirements. Dutta *et al.* [22] reported that growth reduction could be due to the presence of anti-nutrients in wild sunflower meal. Farinu *et al.* [23] and Olayeni [24] reported that the reduction in feed consumption on diets containing WSFM could be attributed to the bitter taste of the leaves as well as an alteration in the texture, colour and odour of the finished feed. All these would create a palatability problem, which would likely affect the consumption of the finished feeds. The obvious result is the observed growth reduction in this study. However the

non significant difference between the control and group 2 cocks, which contained 5% WFSM inclusion level in the diet, is an indication of a level of tolerance to WFSM by the cocks at such a level of inclusion. All other inclusion levels resulted in significantly ($p < 0.05$) lower live weight in an inclusion level - dependent fashion. The significantly higher mean dressed weight as well as the mean dressing percentage of the control cocks, over all the WFSM diets shows the superiority of the control cocks over all the other groups, especially when the cocks are to be dressed before they are marketed. The significantly higher dressed weight of the group 2 cocks over the other WFSM groups indicates that the presence of WFSM at 5% is still tolerable for the dressed market. However the non significant difference in the dressing percentage of all the WFSM inclusion groups indicates the fact that the superiority of group 2 cocks was only a consequence of the mean final live weight of the group. The dressing percentage range of between 70.5 and 77.6% obtained for the cocks in all the dietary treatment groups, is wider than the range of between 68 and 70% recorded by Salami *et al.* [25] for finishing cockerels that were fed diets containing 18-22% crude protein.

The significantly higher relative weights of the internal organs of the cocks on diets with varying levels of WFSM over the control diet could be explained by the fact that the first available nutrients in these feeds even when the feeds were unpalatable, were initially utilized first to satisfy the need for developing the internal organs, which are fundamental to life at the expense of body growth during the early stage of cocks' development. This caused a higher growth of the organs at the expense of the body muscle in the experimental cocks' while the control cocks would develop normally. The relatively higher gizzard weight could also be accounted for in addition, by the need for a more efficient grinding action in the experimental cocks as a result of the high fibre content of the WFSM. The relative increase in liver weight, as the level of WFSM inclusion level increased, indicated the possibility of liver overload due to the effect of anti-nutrients in the wild sunflower meal [22] as well as the bulkiness of the feed [21].

The knowledge of the ability of the testis to produce spermatozoa is of paramount importance in a poultry breeding programme. The significantly lower mean paired testes weight of all the groups with varying levels of WFSM inclusion in their diets show that WFSM, at any level of inclusion in the cocks' diets, did not support testicular growth. This implies that the inclusion was detrimental to the development of the spermatogenic

potential of the cocks as it has accounted for significantly lower values in the morphometric characteristics of the genitalia of these cocks. Perry and Petterson [16] and Togun and Egbunike [26] reported that testis size is a good indicator of the present and future spermatozoa production, while the knowledge of basic morphometric characteristics of reproductive organs have been found to be a valuable information in the evaluation of breeding soundness and potential fertility of an animal. That the paired testes weight of the control cocks was 3 times the value of the group with the least level of WFSM inclusion and 29 times the value of the group with the highest inclusion level confirms the poor quality of these testes relative to the control in relation to spermatogenesis. Medeve and Turchanov [27], Galmessa *et al.* [28], Brito *et al.* [18] have reported that heavier testes produced more spermatozoa than smaller testes. Berdtsen *et al.* [29] reported that testes, which possess greater number of sertoli cells, were heavier and produced more spermatozoa than testes with fewer sertoli cells. The significantly smaller testes of all the cocks on all the inclusion levels of WFSM in this study would mean that these testes would contain fewer seminiferous tubules (the environment where spermatogenesis takes place), fewer leydig cells (the source of testosterone, which is the male hormone responsible for spermatogenesis), fewer sertoli cells (which are responsible for maintaining the level of testosterone in the seminiferous tubule) and fewer spermatogenic cells (which develop to finally become spermatozoa). The significant correlations between live weight and testis morphometric characteristics studied are in agreement with the report of Togun [31, 32] and indicate an active, continuous growth of these body parts, up to the pubertal age. It also supports the fact that body weight can be relevant at predicting testes weight to a very marginal extent. This agrees with Almquist and Amann [32] and Amann [33] that the correlation between paired testes weight and body weight was not high enough to predict testes weight from body weight. The correlation coefficient between live weight and testes weight was lower than that observed in bulls [34]. The significant correlation coefficients observed for live weight with testes length and width was higher than those observed in bulls [34]. This could be due to difference in species. The highly significant correlation coefficient observed between testes weight and tunica albuginea, mean testes length and width suggested that despite a significant correlation between body weight and testes weight, the body weight is inferior to testes characteristics in estimating testes size. The low, negative

and non-significant correlation coefficient observed for testes weight with epididymal weight suggests that testes weight cannot be accurately predicted from epididymal weight.

CONCLUSION

Wild sunflower meal inclusion at 5% level in the diet of commercial cocks is adequate for growth. The inclusion at any level is however significantly detrimental to testicular growth and hence spermatogenesis. Therefore WSFM is not recommended in any poultry breeding programme, where the fertility of the cocks is fundamental to productivity.

REFERENCES

1. Tewe, O.O., 1997. Sustainability and development paradigms from Nigeria Livestock industry. Inaugural lecture delivered on behalf of the Faculty of Agriculture and Forestry, University of Ibadan, Nigeria.
2. Oluyemi, J.A. and F.A. Roberts, 2000. Poultry Production in warm climate. Macmillan Press Ltd., London, pp: 69.
3. Agbede, J.O. and V.A. Aletor, 2003. Evaluation of fishmeal replaced with leaf protein concentrate in diets of broiler chicks. Effects on performance, muscle growth, hematology and serum metabolism. Intl. J. Poultry Sci., 2: 14-19.
4. Egbunike, G.N., M.O. Sadiku and O.E. Okebiyorun, 2000. Sperm production and related phenomena in rats fed diets containing pawpaw peels, seeds and leaves. Trop. J. Anim. Sci., 3: 77: 78.
5. Odunsi, A.A., G.O. Farinu and J.O. Akinola, 1996. Influence of dietary wild Sunflower (*Tithonia diversifolia* Hemsl A. Gray) leaf meal on layers Performance and egg quality. Nig. J. Anim. Prod., 23: 28-32.
6. Odunsi, A.A., G.O. Farinu, J.O. Akinola and V.A. Togun, 1999. Growth, carcass characteristics and body composition of broiler chickens fed wild sunflower (*Tithonia diversifolia*) forage meal. Trop. Anim. Prod., 2: 205-211.
7. Oladejo, J.A., W.A. Sanusi, I.O. Ojedapo, A.O. Iwe and L.O. Adesanya, 2006. Comparative analysis of poultry feed production using alternative and conventional ingredients in Ibadan metropolis. Proc. 31st Ann. Com. Nig. Soc. Anim. Sci. (NSAP) Kano, Nigeria.
8. Shiitu, A.A., G.O. Olayode, O.M. Bamirko and F.M. Aderemi, 2004. Effect of using non-conventional feedstuffs on the production and cost of eggs in farms in Ibadan, Nigeria. Nig. J. Anim. Prod., 319: 65-78.
9. Ani, O.A. and A.U. Okorie, 2005. The effects of graded levels of dehauled and cooked castor oil (*Ricinu communis*) meal on performance of broiler starter. Nig. J. Anim. Prod., 32: 54-60.
10. Duruma, C.S., A.B.I. Udedibie and G.A. Anyawu, 1999. Combination of maize-sorghum based dried brewers grains, cocoa yam corn and cassava tuber meals as substitute for maize in the diets of laying hens. J. Agric. Biotechnol. & Environment, 1: 1-7.
11. Omole, T.A., 1982. The effects of levels of dietary protein on growth and reproductive performance in rabbits. J. Appl. Rabbit Res., 52: 83-88.
12. Lebas, F., P.R. Coudeit and H. De Rockham Beau, 1986. The Rabbit. Husbandry, health and production. Annual Human Series No. 21 F.A.O of United Nations, Rome, pp: 1-65.
13. Osinowo, E.O., E.C. Molokwu and D.C. Osori, 1981. Growth and testicular development in Bunaji bulls. J. Anim. Res., 16: 55-67.
14. Daudu, C.S. and V. Shoyinka, 1983. Scrotal circumference, daily sperm production and epididymal spermatozoa of the indigenous Bunaji and Sokoto Gudali bulls in Nigeria. Brit. Vet. J., 139: 487-490.
15. Ethces, R.J., 1996. Reproduction on poultry. CAB International, pp: 99-208.
16. Perry, G. and D. Petterson, 2001. Determining reproductive fertility in herd bulls. University of Missouri Agricultural Publication, G. 2011: 1-8.
17. Kurbatov, A.D., R.G. Tsarenko and I.I. Papov, 1976. VIIIth International Congress on Animal Reproduction and Artificial Insemination, Krakow. Proceedngs Vol 1. Communication Abstracts: 315.
18. Brito, I.F.C., A.E.D.F. Silva, M.M. Unanian, M.A.N. Dode, R.T. Barbos and J.P. Kastelic, 2004. Sexual development in early - and late maturing Bos indicus and Bos indicus x Bos taurus crossbred bulls in Brazil. Theriogenology. Elsevier Science Inc., New York, USA., 62: 1177-1217.
19. Steel, R.G.D. and J.H. Torrie, 1980. Principles and procedures of Statistics. A Biometrical Approach, 2nd edition Mc Graw-Hill Book Co., New York.

20. Duncan, D.R., 1955. Multiple Range and Multiple F-Test. *Biometrics*, 11: 1-42.
21. Dagbir, N.J., M.A. Rad and M. Uwadyjan, 1980. Studies on utilization of full fat sunflower seed in broiler ration. *Poultry Sci.*, 59: 2273-2278.
22. Dutta, P., P.R. Bhattacharyya, I.C. Rabha, O.N. Bordolon, N. Barna, P.K. Chowdurry, P.R. Sharma and J.N. Barna, 1986. Feeding deterrents for *Philosamia ricini* (Samia Cynthia, sub sp. Ricini) from *Tithonia diversifolia*. *Phytoparasitica*, 14: 77-80.
23. Farinu, G.O., O.O. Ojebiyi, J.A. Akinlade and T.A.O. Laogun, 2005. Effect of graded levels of WFSM on performance of pullet chicks and growing pullets. *Proceedings of the 10th Annual Conf. Anim. Sci. Ado Ekiti, Nigeria*, pp: 217-219.
24. Olayeni, T.B., 2005. Effects of wild sun flower (*Tithonia diversifolia*) leaf meal on growth performance, blood and carcass characteristics of weaner pigs. M. Tech. Thesis. Department of Animal production and Health, Ladoko Akintola University of Technology, Ogbomoso, Nigeria.
25. Salami, R.I., O.G. Longe and J.A. Oluyemi, 2004. Effect of dietary protein levels on the performance and carcass characteristics of cockerel finishers. *Nig. J. Anim. Prod.*, 31: 27-31.
26. Togun, V.A. and G.N. Egbunike, 2006. Seasonal variations in the sperm production characteristics of Zebu (White Fulani) cattle genitalia in the humid tropical environment. *Middle-East J. Sci. Res.*, 1: (1) In Press.
27. Medvev, G. and S. Turchanov, 1999. Effect of morphological development of sexual glands on fertility of bulls. *Vesti Akademii Agrarnykh Navuk Respubliki Belarus*, 2: 68-72.
28. Galmessa, U., V.S. Raina, T.K. Mohanti and A.K. Gupta, 2003. Seminal attributes related to age and scrotal circumference in dairy bulls. *India J. Dairy Sci.*, 56: 376-379.
29. Berndtson, W.E., G. Igboeli and B.W. Pickett, 1987. Relationship between absolute numbers of sertoli cells to testicular size and spermatogenesis in young beef bulls. *J. Animal Sci.*, 64: 241-246.
30. Togun, V.A., 2006. Morphometric characteristics of the genitalia of white Fulani bulls extensively managed in the humid tropics. *Research Communications in Animal Science* 1: 1-7.
31. Togun, V.A., 2006. Live weight related changes in the sperm production capacity of White Fulani (*Bos indicus*) bulls. I: *Testicular histomorphometry*. *Pak. J. Biol. Sci.*, (In Press)
32. Almquist, J.O. and R.P. Amann, 1961. Reproductive capacity of dairy bulls. II. Gonadal and extragonadal sperm reserves by direct counts and depletion trials; dimensions and weight of genitalia. *J. Dairy Sci.*, 44: 1668-1678.
33. Amann, R.P., 1970. Sperm production rates. In A.D. Johnson, W.R. Gomes and N.L. Van Demark (eds). *The Testis*. Vol. 1 Acaedmy Press. New York.
34. Togun, V.A., 1981. Testis characteristics in *Bos indicus* and *Bos Taurus* in Ibadan. A Ph.D. thesis, Department of Animal Science, University of Ibadan, Nigeria.
35. A.O.A.C., 1990. Association of Official Analtical Chemists. Official methods of analysis. 15th edition. Washington, D.C., pp: 69-88.