RJVS Research Journal of Veterinary Sciences

OPEN ACCESS

Influence of Unilateral Cryptorchidism on Growth Performance and Fertility Indices of West African Dwarf Bucks

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ABSTRACT

Background and Objective: The unorthodox use of unilateral cryptorchid buck affects the production of WAD goats. This study was aimed at investigating the influence of unilateral cryptorchidism on the body weight, gonadal biometry and sperm reserves of WAD bucks. **Materials and Methods:** Sixteen matured WAD bucks were purchased and grouped into: Normal WAD bucks and unilateral cryptorchid WAD bucks. Parameters investigated were body weight (BW), scrotal circumference (SC), testicular weight (TW), testicular length (TL), testicular volume (TV), testicular density (TD), length of caput (CaEL), corpus (CoEL), cauda (CdEL), and whole length of epididymis (WEL), weight of caput (CaEW), corpus (CoEW), cauda (CdEW), and whole epididymis (WEW) as well as sperm concentrations of the testis (TSC), caput (CaESC, corpus (CoESC), cauda (CdESC), whole epididymis (ESC) and testis-epididymis (TESC). Data collected were analyzed using a T-test value. **Results:** The BW, TW, TL, TV, TD and WEL were not affected ($p>0.05$) by unilateral cryptorchidism. The results revealed that unilateral cryptorchidism increase ($p<0.05$) SC, WEW, CaEW, CoEW, and CdEW of bucks but does not affected ($p>0.05$) WEL, CaEL, CoEL, CdEL of bucks. Unilateral cryptorchidism deceases ($p<0.05$) sperm reserves (TSC, ESC, CaESC, CoESC, CdESC, and TESC) of bucks. **Conclusion:** Unilateral cryptorchidism does not influence the growth performance and gonad development of WAD bucks but reduces their sperm reserves. These findings show that normal bucks had better fertility indices and therefore should be used for breeding.

KEYWORDS

West African dwarf bucks, unilateral cryptorchidism, body weight, testes, epididymis, spermatozoa, and fertility

INTRODUCTION

West African Dwarf (WAD) goat (*Capra hircus* L.) is a genetically unimproved breed but shows high resistance to harsh climates and diseases like trypanosomiasis and haemonchosis[1]. Over the years, the production of WAD goats in Africa has improved the livelihood of rural livestock keepers[2]. This breed constituted significantly in the population of goats produced all over Nigeria[3]. Historically, WAD goat is predominantly produced in Southern East Nigeria and 99.97% of goat stocked in this region was kept

ISSN: 2151-786x (Online)
ISSN: 1819-1908 (Print)
https://doi.org/10.3923/rjvs.2025.08.14

Received: 14 Apr. 2023
Accepted: 28 Feb. 2025
Published: 01 Mar. 2025

traditionally while the remaining 0.03% of the goat was commercially produced[4]. However, Kridli *et al*.[5] reported that goat production is constrained by environmental and socio-economic factors as well as poor breeding management. Among these constraints, the unorthodox use of unilateral cryptorchid buck has been identified as the most crucial factor that significantly affects the production of WAD goats in South-East Nigeria[6].

Basically, cryptorchidism is the failure of one or two testes to descend into the scrotum of an animal. A situation where both testes fail to descend into the scrotum is called bilateral cryptorchidism, while a situation one testis fails to descend into the scrotum is called unilateral cryptorchidism. Cryptorchidism has been reported as far back as 1668 as a disorder that majorly causes infertility in humans and animals[7]. Igbokwe[8] observed that bilateral cryptorchids are completely sterile because of the incomplete development of the cryptorchid testes that causes aspermatogenesis (i.e., the inability to produce sperm cells). While Chung and Brock[9] reported that unilateral cryptorchids are fertile due to the ability of the descended testis to develop, release androgens, and produce spermatozoa. Okpe and Anya[10] reported that testosterone regulates reproductive traits like mating behavior, spermatogenesis, maintenance of duct system, functions of accessory glands, and prevention of follicle-stimulating hormone (FSH) in males. Chung and Brock[9] observed that the reserved sperm cells in the cauda epididymidis of the scrotal testis of the unilateral cryptorchids show a commendable degree of fertility efficacy. Igbokwe *et al*.[11] anticipated that the adequate sperm concentration observed in the unilateral cryptorchids was due to the impact of compensatory processes that occurs during spermatogenesis in the descended testis.

On the contrary, the incidence of infertility in unilateral cryptorchids is about 20% or up to 100%[12]. The infertility status of unilateral cryptorchid testes depends on the animal species, location, and duration of cryptorchidism, and whether cryptorchidism is natural or experimental[13,14]. Unilateral cryptorchidism may cause short and/or long-term complications in the development and functions of the cryptorchid testis[15]. Unilateral cryptorchidism may increase the proportion of abnormal spermatozoa in domestic animals[15]. Also, unilateral cryptorchidism may further cause tumors and cancer on the cryptorchid testis of the animal[15]. However, the aforesaid consequences of infertility in unilateral cryptorchids were not common in normal cryptorchids[16].

Despite the complications associated with cryptorchidism, the prevalence of unilateral cryptorchidism in WAD goats is still very high with about 70% in South-Eastern Nigeria[6]. This may be because of the persistent use of cryptorchid bucks for breeding in the region. The prevalence of unilateral cryptorchidism among Sahel bucks in North-Eastern Nigeria was about 0.6%[8] and it has not been reported that Sahel buck with unilateral cryptorchidism is used for breeding in the North-East Region. Currently, the prevalence of unilateral cryptorchidism in WAD goats is attributed to the erroneous belief that the unilateral cryptorchid buck is superior to normal cryptorchid buck in terms of reproductive efficiency. Also, this perception has invariably increased the market value of unilateral cryptorchid bucks more than the normal bucks in South-East Nigeria. The unconventional use of unilateral cryptorchid buck in this region will enormously increase the prevalence of unilateral cryptorchidism to an undesirable level in the nearest future. Based on this belief and the implications of unilateral cryptorchidism as well as the lack of information on the fertility profile of WAD bucks, this study was conducted to investigate the biometry and sperm reserves of the testis and epididymis of unilateral cryptorchid WAD bucks and normal WAD bucks and thus clarify whether, or not the unilateral cryptorchid WAD bucks should be used for breeding.

MATERIALS AND METHODS

Location and duration of the study: This study was conducted at the Goat and Sheep Unit of the Teaching and Research Farm of the University of Nigeria Nsukka, Enugu State. Geographically, Nsukka Town lies in the derived Savannah Region located on Longitude 6°25'N and Latitude 07°24'E, at an altitude of 430 m above sea level[17]. The town is in the South-East Region of Nigeria. The climate of Nsukka is a tropical humid type with relative humidity and annual rainfall of 34 to 78% and 1567.05 to

1846.98 mm, respectively[18]. The natural day-length of Nsukka ranges from 11 hrs and 44 min to 12 hrs and 31 min[19] and the average temperature is 29.7°C[18]. The experiment lasted 8 weeks (16th april to 14th june 2004).

Purchase and management of bucks: A total of sixteen WAD bucks (i.e., eight normal WAD bucks and eight unilateral cryptorchid WAD bucks) of 16 to 17 months old were purchased from a reputable goat dealer in Nsukka local market. The bucks were confirmed healthy after subjecting them to 2 weeks periods of clinical evaluations and acclimatization. The bucks were kept in a housing facility such that the animals were protected from direct solar radiation and provided adequate space. The bucks were fed *ad libitum* with a fresh cut of grasses and a concentrated mixture that comprised palm kernel cake, maize wastes, and grower's mash. The bucks were also given water *ad libitum*. Other procedures carried out in this study complied to the provisions of the University of Nigeria Nsukka Research Policy (2013) on the use of experimental animals.

Collection of data: Data were collected from the bucks and the collection was done between 7 to 10 am on the last day of the experiment. The body weight (BW) of an individual buck was taken in kg using a weighing balance. Scrotal circumference (SC) was determined at the point of the greatest scrotal-testes complex curvature of the scrotum, using a flexible cloth tape graduated in cm. Thereafter, the bucks were taken to the University farm slaughterhouse where they were slaughtered. The reproductive organs (i.e., testis and epididymis) were collected and kept in an ice pack. The collected samples were transported to the laboratory and then stored in a refrigerator within 30 min before carrying out the laboratory analyses. The testis and its attached epididymis were separated by dissection. The tunica albuginea of the testes, extraneous tissues, and blood clots attached to the testis were also excluded. The data collected from the right and left testes of normal bucks were averaged, while the data measured from the descended testis of unilateral cryptorchid bucks were recorded. Testicular weight (TW) was determined in gramme (g) using a weighing machine scale (Hana, China). Testicular length (TL) was taken by measuring the distance between the caput and the caudal region of the testis without considering the epididymis. The TL measurement was done using a pair of venier calipers (Ohaus, USA) and recorded in cm. Testicular volume (TV) was determined by applying the liquid displacement technique as prescribed by Oyeyemi *et al*.[20] and recorded in cm^3. The testicular density (TD) was calculated by dividing the value of TW with the value obtained in TV and it was recorded in g/cm^3.

The weight (WEW) and the length (WEL) of the whole epididymis were determined in g and cm using a weighing scale and a flexible cloth tape, respectively. Thereafter, the epididymis was sectioned into three major parts, viz., the capus epididymis, the corpus epididymis and the cauda epididymis. The caput (CaEW), corpus (CoEW) and cauda (CdEW) epididymis were separately weighted in g using a weighing scale. The length of the caput (CaEL), corpus (CoEL) and cauda (CdEL) epididymis were also measured using a flexible cloth tape graduated in cm. The testicular parenchyma and other tissues of the epididymis that were not needed during this experiment were thoroughly minced, using scissors and scalpel. The testes and epididymis were soaked in preservative solution (20 mL of 0.9 NaCl solution) for 2-3 min and then filtered twice with clean muslin cloth. The filtrated fluid was evaluated for concentration of sperm cells using Neubauer Haemocytometer as described by Elile *et al*.[21]. The sperm reserves were analyzed for testicular sperm concentration (TSC) and epididymal sperm concentration (ESC). The testicular-epididymal sperm concentration (TESC) was calculated by summing the value of TSC and ESC. Sperm reserves concentration of the capus (CaESC), corpus (CoESC) and cauda (CdESC) epididymidis were also analyzed. Values of sperm concentrations evaluated were adjudged as $\geq 1.10 \times 10^9$ sperm cells.

Statistical analysis: The data collected were analyzed as means and standard deviations using computer software (GraphPad Instat 1993 version, http://www.graphpadinsat.com) and the comparison was carried out using one-way analysis of variance and Student's t-test with the option of SPSS to a predetermined significance level of $p<0.05$.

RESULTS

Body weight, scrotal circumference, and the biometry of testis and epididymis of WAD bucks: Results on body weight (BW), scrotal circumference (SC), the testicular (TW, TL, TV, TD), and epididymal (WEW, CaEW, CoEW, CdEW, WEL, CaEL, CoEL, CdEL) biometry obtained from normal and unilateral cryptorchid bucks are presented in Table 1.

From the results, it was observed that the average body weight BW (15.06±0.36 kg) of normal bucks was similar ($p>0.05$) to the BW (14.71±0.65 kg) obtained from the unilateral cryptorchid bucks. But the mean value (16.32±0.99 cm) of the scrotal circumference (SC) measured from the normal bucks was significantly larger ($p<0.05$) compared to SC value (11.84±0.20 cm) determined from unilateral cryptorchid bucks. The biometry of the testes, the weight (TW), length (TL), volume (TV) and density (TD) of testis collected from unilateral cryptorchid bucks were not influenced ($p>0.05$) by unilateral cryptorchidism when compared to the normal bucks. The results of the epididymal parameters showed that the average weights of the whole (WEW), caput (CaEW), corpus (CoEW) and cauda (CdEW) epididymis of normal bucks nearly doubled ($p<0.05$) the mean value measured in unilateral cryptorchid buck group. However, the length of the whole epididymis (WEL) alongside with the length of caput (CaEL), corpus (CoEL) and cauda (CdEL) epididymis of unilateral cryptorchid bucks were similar ($p>0.05$) to the mean values obtained in the normal bucks.

Testicular and epididymal sperm reserves of WAD bucks: The sperm reserves of the normal and unilateral cryptorchid WAD bucks are presented Table 2.

Table 1: Body weight, scrotal circumference, and the biometry of the testis and epididymis of normal and unilateral cryptorchid WAD bucks

Parameter	Normal WAD buck	Unilateral cryptorchid WAD buck
Body weight and scrotal circumference		
Body weight of bucks, BW (kg)	15.06±0.36^{ns}	14.71±0.65^{ns}
Scrotal circumference, SC (cm)	16.32±0.99^{a}	11.84±0.20^{b}
Testicular and epididymal biometry		
Testis weight, TW (g)	50.78±1.63^{ns}	42.39±6.28^{ns}
Testicular length, TL (cm)	5.54±0.15^{ns}	6.41±1.10^{ns}
Testis volume, TV (cm^3)	37.59±3.28^{ns}	42.39±6.28^{ns}
Testis density, TD (g/dm^3)	1.35±0.08^{ns}	1.00±0.38^{ns}
Whole epididymal weight, WEW (g)	13.53±0.71^{a}	7.44±0.26^{b}
Caput epididymal weight, CaEW (g)	6.69±0.21^{a}	3.97±0.26^{b}
Corpus epididymal weight, CoEW (g)	2.34±0.10^{a}	1.34±0.87^{b}
Cauda epididymal weight, CdEW (g)	4.20±0.41^{a}	2.31±0.08^{b}
Whole epididymal length, WEL (cm)	10.07±0.38^{ns}	10.43±0.39^{ns}
Caput epididymal length, CaEL (cm)	2.92±0.08^{ns}	3.04±0.20^{ns}
Corpus epididymal length, CoEL (cm)	5.08±0.14^{ns}	5.23±0.43^{ns}
Cauda epididymal length, CdEL (cm)	1.87±0.30^{ns}	2.16±0.42^{ns}

^{abcd}Means on the same row with different superscript are significantly ($p<0.05$) different, ^{ns}Means with non-significant ($p<0.05$) and SEM: Standard error of the mean

Table 2: Testicular and epididymal sperm concentrations of the normal and unilateral cryptorchid WAD bucks

Reserved sperm concentration	Normal WAD bucks	Unilateral cryptorchid WAD bucks
Testicular sperm concentration, TSC ($\times10^9$)	0.76±1.15^{a}	0.42±0.15^{b}
Whole epididymal sperm concentration ESC ($\times10^9$)	3.65±0.29^{a}	2.38±0.21^{b}
Caput epididymal sperm concentration, CaESC ($\times10^9$)	0.55±0.08^{a}	0.37±0.01^{b}
Corpus epididymal sperm concentration, CoESC ($\times10^9$)	0.33±0.08^{a}	0.30±0.06^{b}
Cauda epididymal sperm concentration, CdESC ($\times10^9$)	2.77±0.30^{a}	2.53±0.30^{b}
Testicular-epididymal sperm concentration (TESC) ($\times10^9$)	4.31±0.14^{a}	3.02±0.28^{a}

^{abcd}Means on the same row with different superscript are significantly ($p<0.05$) different and SEM: Standard error of the mean

The testicular sperm concentration (TSC) of $0.76\pm1.15\times10^9$ and testicular-epididymal sperm concentration (TESC) of $4.31\pm0.14\times10^9$ obtained from normal bucks was higher ($p<0.05$) than the TSC ($0.42\pm0.15\times10^9$) and TESC ($3.02\pm0.28\times10^9$) value of unilateral cryptorchid bucks, respectively. Similarly, the mean values of sperm reserve of the whole (ESC), caput (CaESC), corpus (CoESC) and cauda (CoESC) epididymis of the normal bucks were significantly higher ($p<0.05$) than average values obtained from unilateral cryptorchid bucks.

DISCUSSION

In the present study, the body weight of the unilateral cryptorchid and normal bucks were similar which shows that unilateral cryptorchidism does not affect the growth performance of WAD bucks. This is because the descended testis of the unilateral cryptorchid buck is capable of releasing the level of testosterone concentration that can stimulate the development and maintenance of the physical or masculine posture of a vibrant quality breeder which was also observed in normal WAD buck. This suggestion was in line with the documentation of Maksimova and Korochkina[22] on the functions of testosterone in males. On the contrary, Özyiğit[23] affirmed that bilateral cryptorchids do not build up the masculine feature of the animal. The decrease in the scrotal circumference of unilateral cryptorchid WAD bucks was caused by the presence of only one testis that occupied the scrotal space meant for two testes as seen in the scrotum of normal WAD bucks with expanded scrotal-testis complex curvature. This finding is in accordance with the report of Alade *et al*.[24] who worked on the relationships between body weight, testicular weight, age, and the scrotal circumference of goats in the semi-arid part of Nigeria.

Mean testicular weight (TW), length (TL), volume (TV), and density (TD) obtained from unilateral cryptorchids and normal WAD bucks were similar. The physiological explanation for this observation perhaps may be because the Leydig cells that produce androgen hormones responsible for the development of the gonads were not affected in the descended testis of unilateral cryptorchid bucks. This finding is in agreement with the reports of Amann and Veeramachaneni[25] but conflicted with the report of Adeyeye and Wakkala[26] who regarded this observation as the impact of compensatory hypertrophy of the contralateral testes of the unilateral cryptochid testes. Also, the values of these testicular parameters were within the range reported by Okpe and Ezeasor[6] on WAD goats but were slightly lower compared to the values obtained by Atawalna *et al*.[27]. The differences in testicular biometric values reported by these authors may be allied to the age and strain of the goats used. Furthermore, the weights of the whole and sectional epididymis were reduced, while the lengths of the whole and the various parts of epididymis were not affected in unilateral cryptorchid WAD bucks. These shows that unilateral cryptorchidism slows down spermatogenesis (production of sperm cells). This finding is in accordance with the report published by Moon *et al*.[28] and Cobellis *et al*.[29].

The sperm reserves of the whole testis and the whole epididymis alongside the sperm reserves of the caput, corpus, and cauda epididymis of unilateral cryptorchid WAD bucks were significantly lower than normal WAD bucks. These observations show that unilateral cryptorchidism delays the spermatogenic processes that occur in the descended testis of buck in a negligible manner when compared to the normal WAD buck. This is because the descended testis is still able to secrete testosterone, as earlier discussed. However, the values of testicular and epididymal sperm reserves of normal and unilateral cryptorchid bucks obtained in this work are within the range of sperm reserves reported by Okpe and Ezeasor[6], but were slightly higher than the values obtained by Atawalna *et al*.[27]. The differences that were noticed in sperm reserves may be associated with methods of analysis, the age of the animals, and the season in which the study was carried out[30]. Surprisingly, the sperm reserves of the testis and epididymis of normal and unilateral cryptorchid WAD bucks were in conformity with the fertility index recommended by Oyeyemi *et al*.[30].

CONCLUSION

Unilateral cryptorchidism does not influence the body weight and the biometry of the testis as well as the length of the epididymis but reduces the scrotal circumference, weight of epididymis, and the reserved spermatozoa of bucks. These findings show that the index of sperm reserves of normal WAD bucks is better than that of unilateral cryptorchid WAD bucks. Therefore, these observations contradict the folk belief of unilateral cryptorchid buck being a superior breeder. Based on the results thereof, normal WAD buck should be used for breeding, and this will go a long way to forestall the increasing prevalence and complications associated with cryptorchidism disorder in the production of WAD goats.

SIGNIFICANCE STATEMENT

The use of unilateral cryptorchid buck for breeding has become a tradition for most rural farmers in South-East Nigeria. This is because they believe that unilateral cryptorchid buck performs better in growth and reproduction than normal bucks. This unconventional practice has consequently increased the population and market value of unilateral cryptorchid bucks in the region. This study was conducted to investigate the influence of unilateral cryptorchidism on the growth performance and fertility potentials of WAD goats. At the end of the study, the results obtained show that unilateral cryptorchidism does not influence the body weight, biometry of the testis and the length of the epididymis of bucks but reduces the count of reserved spermatozoa of unilateral cryptorchid bucks. These observations indicate that normal buck possesses better fertility index than unilateral cryptorchid buck. Also, similar growth performance was observed among normal and unilateral cryptorchid bucks. Therefore, farmers should abolish this belief to halt the increasing rate of infertility and other complications associated to cryptorchidism in goat production, in the nearest future. However, other complications of unilateral cryptorchidism in WAD goats are open for further research.

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