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Full Length Research Paper

Impact of Body Weight on Testicular Dimensions and Semen Yield in Black Bengal Bucks: A Study from Bangladesh

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Biometrical study of testes were done in twelve black Bengal bucks (*Capra hircus*) of three different age groups, 0.5 to 1.0 years (group A), 1.5 to 2.0 years (group B) and 2.5 to 3.0 years (group C) to find out the age depended changes in the biometry of testes and their relationship with semen quality. Before slaughtering the bucks, the semen quality of the bucks of three different age groups was evaluated in terms of volume (ml), live sperm (%) and sperm concentration (billion/ml) for a period of 45 days. The semen volume and sperm concentration of age group C (0.68±0.04 ml and 3.04±0.10 billion/ml respectively) were significantly (p<0.05) higher than those of age group A (0.32±0.04 ml and 76.46±2.65 billion/ml respectively) but no significant difference was observed with that of age group B. Whereas, live sperm percentage of age group B (85.64±0.87) was higher than those of other age groups but the difference was not significant (p>0.05). Testicular measurements were increased with the advancement of age and body weight. The size and weight of left testis were higher than those of right testis at same age. Semen volume and sperm concentration were highly significant (p< 0.01) and positively correlated with almost all testicular measurements.

Key words: Biometry, black Bengal bucks, body weight and semen output.

INTRODUCTION

The Black Bengal goat is the second most economically important ruminant in Bangladesh after cattle. Unfortunately, there are severe shortfalls of the stud bucks all over the country (Husain, 2004). It is established that due to haphazard breeding system the genetic merit of Black Bengal goat is under threat. For the better propagation of the species of goat, superior buck selection seems to be very important and alternative approach to boast up the production potential. This has led to the development of methods for predicting potential sperm production and particularly for identifying bucks with high sperm output potential at an early age. To our knowledge, scant information exists on these aspects in the black Bengal buck (Rahman, 2009; Islam, 2001). It is established that due to haphazard breeding system the genetic merit of Black Bengal goat is under threat. In this regard, superior buck selection seems to be very important and alternative approach to boast up the production potential. Therefore, during selection of breeding buck special attention should be given on age, body weight, soundness of the sexual organ and quality of ejaculated semen.

Considering the aforementioned facts in mind the present study was undertaken to ascertain the relationship of age and body weight to testicular growth in black Bengal bucks and to examine the relationship between certain testicular measurements with semen

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production for the establishment of some norms for breeding soundness evaluation of black Bengal bucks.

MATERIALS AND METHODS

The experimental bucks were maintained in the nucleus breeding flock (NBF) of the research project entitled "Conservation of Black Bengal goat as the Potential Genetic Resource in Bangladesh" at AI centre, Bangladesh Agricultural University, Mymensingh-2202.

Animals used

Twelve black Bengal bucks aged between 6 to 36 months were selected on the basis of morphometric characterization and the potentiality to produce quality semen. The selected bucks were again divided into three different age groups as A (0.5 to 1.0 years), B (1.5 to 2.0 years) and C (2.5 to 3.0 years).

Feeding and other managemental procedures

The bucks were fed with Napier and/or German grass twice daily as per requirement. The feed was supplemented with commercial concentrate (crude protein content: l20 g/kg DM and energy content: 10.4 MJ ME/kg DM) in the morning and again in the afternoon at the rate of 100 gm/ buck of 20 kg live weight. The breeding bucks were also supplied with germinated gram (20 gm/buck/day). Clean and safe water was made available at all times. Throughout this study the nutrition of bucks remained uniform and constant. All bucks were vaccinated against Peste des Petits Ruminants (PPR) and dewormed routinely with Ivermectin® thrice a year. Individual pen was provided for each buck (10 sq ft) in the shed with the provision of sufficient access to fresh air and their movement freely and they were allowed to graze outside for one hour daily.

Semen collection

The bucks were trained to ejaculate in artificial vagina (AV). Semen was collected within 8.30 AM twice a week from each buck after cleaning the prepuce with antiseptic (savlon) solution. Collection of semen was done with artificial vagina maintaining optimum pressure and temperature about 41 to 43°C. The bucks received homosexual stimulation by being exposed to the teaser male. The semen was collected twice a week up to 45 days thus 12 records were made available for this study.

Evaluation of semen

Immediately after collection the volume of each ejaculates was measured directly from the reading of the graduated collection vial in millimeter. Then semen samples were prepared according to the method described by Herman and Madden (1963) and the concentration of spermatozoa per ml of semen was counted by haemocytometer method and expressed as billion per ml. The following formula was used for calculating total number of spermatozoa per ml of fresh semen.

Total number of spermatozoa per ml of semen = $[\{(C\times400)/S\}\times D]\times10^{-3}$

Where,
C = Number of sperm counted in given number of small squares.
S = Number of small squares counted.
D = Dilution ratio.

Eosin-nigrosin staining method has been used as a routine staining in order to evaluate sperm viability (World Health Organization, 1992) , briefly, after washing sperm samples in saline solution at 37°C, one drop of the suspension containing 35 x 10^6 sperm/ml was placed on a tempered glass slide, which was mixed with one drop of Eosin-nigrosin solution. The mixture was smeared on the glass slide and let air dried. The samples were observed under a light microscope. Eosin penetrated in non viable cells which appear red. Nigrosine offers a dark background facilitating the detection of viable, non stained cells. Four smears were performed from each ejaculate, in fresh samples. A total of 333 sperms were counted randomly from different field of the slide. Number of dead spermatozoa deducted from total number of spermatozoa gave the number of live spermatozoa and expressed in percentage.

Measurement of body weight

The body weight of each buck was recorded in kg in the morning before the animals were slaughtered. The weights were taken with a top loading balance.

Measurement of scrotal circumference

The scrotal circumference was measured as per method recommended by the Society of Theriogenology (Ball et al., 1983). The testes were first retracted into the lower part of the scrotum for measurement of scrotal circumference. To prevent separation of the two testes, the thumb and the fingers were placed on the sides rather than on the front or back of the scrotum. Then a flexible metal tape (Scrotal tape; Lane Manufacturing, Co., Denver, USA) was looped and placed around the greatest diameter of the scrotum and pulled snugly so that the tape was firmly in contact with the entire circumference. Repeated measurement was done and the mean of the measures was recorded to ensure the accuracy.

Slaughtering and biometrical study

Immediately after slaughter, both the left and right testes were collected from the bucks of three different age groups. Immediately after collection, the length and width of testes were measured by measuring tape and weights were measured in digital balance.

Statistical analysis

Simple ANOVA was performed considering the age of buck and to observe the significant differences among the mean values, Duncan's multiple range test (DMRT) was done. Lastly correlations among the traits were also performed. Analysis was performed with the help of statistical analysis system (SAS, 1998).

RESULTS AND DISCUSSION

Semen quality evaluation

Semen quality of the bucks of three different age groups were evaluated in terms of semen volume (ml), live sperm percentage and sperm concentration (billion/ml). The evaluation results are summarized in Table 1.

Table 1. Evaluation of semen of black Bengal bucks (Mean ± SE).

Age group (Year)	Volume (ml) (n = 48)	Sperm concentration (billion/ml; n = 48)	Live sperm (%) (n = 48)
Group-A (0.5 to 1.0)	0.32^{b}±0.04	2.07^{b}±0.12	76.46±2.65
Group-B (1.5 to 2.0)	0.55^{ab}±0.05	3.12^{a}±0.14	85.64±0.87
Group-C (2.5 to 3.0)	0.68^{a}±0.04	3.04^{a}±0.10	83.88±1.96

Means with different superscripts within the column differ significantly (p<0.05). SE = Standard error.

Semen volume

The semen volume of age group C was significantly (p<0.05) higher than that of age group A but statistically similar with that of age group B (Table 1) . Higher semen volume in age group C might be due to older age with higher scrotal circumferences of the animals. The semen volume obtained in the present study ranged from 0.32±0.04 to 0.68±0.04 ml (Table 1) which strongly supports the findings of other researchers (Karim, 2008; Vilar et al., 1993; Singh et al., 1985). Semen volume of buck may vary according to breed. Furstoss et al. (2009) reported 0.48±0.10 ml of semen produced from Alpine bucks at 7 months of age which was slightly higher than the result of the present study (0.32±0.04 ml at 0.5 to 1.0 year of age) . These might be due to breed and nutritional differences. Semen production largely depends on the factors like age, sexual maturity, nutritional status, general health condition, endocrine balance and soundness of the sex organs and season (Peters, 2002; Karagiannidis et al., 2000).

Das et al. (2006) reported that the volume ranges from 0.16 to 0.51 ml in black Bengal buck, which is lower than that of the value of this study. These differences might be due to the aforementioned reasons.

Sperm concentration

The concentration of spermatozoa of age group C was almost similar with that of age group B but significantly (p<0.05) higher than that of age group A. These could be due to higher testicular size with higher spermatogeic activity in the animals of age group C. The finding of the present study strongly agrees with the finding of Karim (2008) who reported the average sperm concentration ranged from 2.75±0.28 to 3.24±0.37 billion/ml in black Bengal buck. According to Apu (2007) and Afroz (2005), the averages of sperm concentrations of buck semen were 2678.33±30.59 to 2913.33±46.23 and 2434.00±52.81 to 2853.00±90.12 million/ml respectively which are almost similar to the present study. The present study also collaborates with the studies of other researchers (Das et al., 2006; Mittal, 1982). On the other hand, Khan (1999) reported the average sperm concentration of 3777.93±142.76 million/ml which is higher than the result of the present study.

Leon et al. (1991) and Sharma et al. (1991) reported that sperm concentration might vary according to variation in age, breed, collection frequency, feeding regime and climatic condition. This difference in sperm concentration might be due to the aforementioned reasons.

Sperm viability

In the present study, the variation in live sperm percentage did not differ significantly (p>0.05) among the three different age groups (Table 1). The highest percentage of live sperm was found in age group B than that of other two age groups although there was no significant difference (p>0.05) among the age groups. Highest percentage of live spermatozoa of the animals of age group B might be attributed to their higher physiological fitness. The present observation of the percentage of live spermatozoa strongly agrees with the findings of Kamal et al. (2005) who reported 84.50% live spermatozoa in buck semen. On the other hand, Karagiannidis et al. (2000) who reported 89.50 to 95.27% live spermatozoa in buck semen which was higher than that of the present study. A variety of factors affect the viability of sperm such as variations in age, breed, feeding regime (Leon et al., 1991; Graves, 1978), pH and osmolarity of semen (Makler et al., 1981), season and ambient temperature (Lincoln and Short, 1980).

The difference in live sperm percentage might be due to these reasons. However, the values obtained in this study were to some extent similar with those of many other investigators (Karim, 2008; Ahmed et al., 1997).

Biometrical study

The results of the biometrical studies were summarized in Table 2.

Body weight

Among the three different age groups, it was observed that body weight of age group C was significantly (p<0.05) higher than that of age group A, but no significant

Table 2. Comparative measurements of different parameters in left and right testes of buck with regard to age, body weight and scrotal circumference (n = 4), Mean ± SE.

Age group (Year)	Body weight (kg)	Scrotal circumference (cm)	Testicular parameter					
			Weight (gm)		Length (cm)		Breadth (cm)	
			Left	Right	Left	Right	Left	Right
Group-A (0.5 to 1.0)	12.41^{b}±1.80	17.50^{b}±0.65	39.06^{b}±3.39	38.11^{b}±3.20	6.10^{b}±0.13	5.85^{b}±0.13	3.88±0.24	3.75±0.10
Group-B (1.5 to 2.0)	23.95^{a}±1.66	21.38^{a}±0.43	63.85^{ab}±5.19	62.73^{ab}±5.22	7.20^{ab}±0.31	6.90^{ab}±0.33	4.63±0.31	4.38±0.24
Group-C (2.5 to 3.0)	27.81^{a}±0.46	22.88^{a}±0.66	66.37^{a}±3.78	65.16^{a}±3.90	7.85^{a}±0.22	7.35^{a}±0.18	4.85±0.12	4.68±0.12

Means with different superscripts within the column differ significantly ($p<0.05$). SE = standard error.

difference ($p>0.05$) was observed with that of age group B (Table 2) . These might be due to higher age with higher body lengths and heights in the animals of age group C. Rahman (2007) obtained the body weight of black Bengal buck at 11.5 to 12.0, 14.0 to 16.0 and 17.5 to 19.0 months of age as 16.62±0.12, 17.62±0.22 and 20.86±0.25 kg respectively which support the results of the present study. The results of the present study also collaborate with the results of Alam (2006) and Herbert et al. (2003). On the other hand, the body weight of black Bengal buck at 2.5 to 3.0 years of age is more than the findings of Fajemilehin and Salako (2008) who reported the average body weight of West African dwarf (WAD) goats, was 14.59 kg at the similar age.

In another study, Mittal and Ghosh (1985) reported the average body weight of Parbatsar breeds of goats at adult age was 48.80±2.45 kg which is much higher than the result of the present study. This might be due to breed and/or sex difference, physical condition of the selected animals, agro-climatic condition, nutritional level, housing, disease prevalence and other managemental procedure.

Scrotal circumference

From Table 2, it was observed that the scrotal circumference of age group C was significantly ($p<0.05$) higher than that of age group A but there had no significant difference ($p>0.05$) with that of age group B. This might be due to difference in age and body weight of bucks, dam's age at first breeding, pregnancy rate and days to rebreeding after kidding. Shamsuddin et al. (2000) reported that the mean scrotal circumference of black Bengal buck at puberty ranged from 14.0 to 16.0 cm which supports the results of the present study. The present study also collaborates with the studies of other researchers (Rahman, 2007; Igboeli, 1974). On the other hand, the finding of the present study was somewhat lower than that of the findings of Keith et al. (2009) and Mekasha et al. (2008). This may be due to breed difference, post-weaning feed level, contemporary group/feed level, age of dam, and covariates age, weight and height of bucks (Bourdon and Brinks, 1986).

Shape and size of testes

In the present study the testes of buck were found ovoid in shape. The testes represented two surfaces, medial and lateral; two borders free (ventral) and attached (dorsal) and two extremities, head extremity and tail extremity. This is very much usual. The size of the testes varied in different age groups and even in between left and right testes of same age group in the present study. In the present study, the average length of the testes of age group C was significantly ($p<0.05$) higher than that of age group A, but the average length in age group B, did not differ significantly ($p>0.05$) with that of other two age groups (Table 2). On the other hand, the average breadth of the testes of age group C was higher than that of other two age groups but there exists no significant difference ($p>0.05$) among the age groups (Table 2). This study indicated that length and breadth of testes were increased with the advancement of age of animals which made a similar agreement with the findings of Gofur et al. (2007) and Islam (2001).

Testes weight

The weight of the testes were varied in different age groups and even in between left and right testes of same age group in the present study. In the present study, the average weight of the testes of age group C was significantly ($p<0.05$) higher than that of age group A but the average weight in age group B did not differ significantly ($p>0.05$) than that of other two age groups. Higher testes weight in age group C might be due to their higher body weight and size (Table 2). This finding made a strong agreement with the results of Islam (2001). On the other hand, Raji et al. (2008) reported the average testicular weight at 1.0, 2.0, and 3.0 years of age were 55.00±2.87, 77.28±1.88 and 103.01±2.23 gm respectively in red Sokoto goats, which was much higher than the present result. This might be due to breed and/or sex difference, physical condition of the selected animals, agro-climatic condition, nutritional level, housing, disease control and other managemental procedure.

The results of the present study also collaborate with the results of Gofur et al. (2007).

Table 3. Correlation coefficients (r) between age, body weight, testes weight, testes length, semen volume and sperm concentration in black Bengal buck.

Parameter	Age	Body weight	Testicular weight	Testicular length	Semen volume
Body weight	0.898 (**)				
Testicular weight	0.778 (**)	0.936 (**)			
Testicular length	0.848 (**)	0.787 (**)	0.668(*)		
Semen volume	0.886 (**)	0.924 (**)	0.867 (**)	0.793 (**)	
Sperm concentration	0.754 (**)	0.855 (**)	0.840 (**)	0.600 (*)	0.769 (**)

**Correlation is significant at the 0.01 level. *Correlation is significant at the 0.05 level.

Correlation coefficients (r) between age, body weight, testicular weight, testicular length, semen volume and sperm concentration in black Bengal buck

The correlation coefficients (r) between age, body weight, testicular weight, testicular length, semen volume and sperm concentration in black Bengal buck are presented in Table 3. It was observed that age had strong correlation coefficient (p<0.01) with body weight, testicular weight, testicular length, semen volume and sperm concentration (Table 3). All the parameters studied in this experiment found to be highly (p<0.01) correlated with each other (Table 3). The result of the present study agrees with the findings of Raji et al. (2008) who reported
a significant correlation coefficient (p<0.01; r = 0.78) between testicular weight and body weight in indigenous goats of Nigeria. He also reported a linear relationship between age, body weight and the entire testicular dimension in this goat of Nigeria. In the present study, testicular measurements were significantly correlated with semen volume and sperm concentration which were to some extent similar with other published works (Pant et al., 2003; Vasquez et al., 2003).

Conclusion

The final observation of this study was that testicular biometry and semen parameters were increased with the advancement of age and body weight. The size and weight of left testis were higher than right testis of the same individual of different groups. Semen quality, scrotal circumference and testicular biometry were highly (p< 0.01) correlated with each other. However, further study is recommended to further clarification. This study might be helpful in selection of breeding buck.

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