B-5145
[1-5]

SHORT COMMUNICATION Indian Journal of Animal Research

Changes in Testicular Biometry and Ejaculate Characters during Pubertal Age in Black Bengal Kids

Prince Clinton Rava[1], Mohan Mondal[1], Ajoy Mandal[1], Subrata Kumar Das[1], Saroj Rai[1], Champak Bhakat[1], Muthupalani Karunakaran[1]

10.18805/IJAR.B-5145

ABSTRACT

The interaction between body weight, testicular growth and sperm production, is the key factor influencing the onset of puberty and sexual maturity. The present experiment was carried out to study the changes in testicular biometry and seminal parameters during pre and post pubertal period in Black Bengal bucks. Black Bengal males (n=8) of four months age were used in the study. Body weight and scrotal biometry parameters increased significantly as age advances. First ejaculates were collected from kids aged 4.5 months which contained mostly immature sperm cells, but semen ejaculates containing adequate numbers of matured motile sperm cells could be collected from six months of age onward. Semen ejaculate characters were optimal at 11-12 months of age with almost stable body weight and scrotal biometry. Based on the above facts, it could be concluded that the Bengal bucks attained puberty at 5-6 months and sexual maturity at 11-12 months of age.

Key words: Bengal buck, Onset of puberty, Seminal parameters, Scrotal and testicular biometry.

Productive and reproductive performances of farm animals regulate the economic efficiency of the farming. It is crucial to select the animals for breeding at an earlier age so that they can be utilized effectively for a longer period. Testicular growth of buck is closely related to the live weight and age of buck (Souza *et al*., 2011). Scrotal circumference is an indirect indicator that gauges the size of the testicles. The onset of puberty is ascertained by the first presence of spermatozoa in seminiferous tubules, epididymis and ejaculates (Kridli *et al*., 2006). Bengal goats (*Capra hircus bengalensis*) are distributed in Eastern and North Eastern Hill states of India as well as in Bangladesh. Bengal goats are known for their superior quality meat and skin, adaptability, fertility and prolificacy. The present study aimed to determine the influence of age and body weight on testicular attributes as well as semen characteristics in growing Black Bengal bucks and to determine the onset of puberty in Bengal bucks.

The present study was carried out at ICAR-National Dairy Research Institute (NDRI), Eastern Regional Station, Kalyani, West Bengal, India, during the months of November, 2021 to June, 2022. A total of eight Black Bengal males aged four months were selected and maintained under standard managemental conditions. Body weight, scrotal circumference and testicular biometry of males were recorded at 15 days interval during the study period. Length (L), width (W) and thickness (T) of testis were measured with the help of the Vernier caliper. The volume of each testis was calculated using the Lambert formula:

$$V = L \times T \times W \times 0.71 \text{ cm}^3$$

Where,
L = length.
W = Width.
T = Thickness.

[1]ICAR-National Dairy Research Institute, Eastern Regional Station, Kalyani-741 235, West Bengal, India.

Corresponding Author: Muthupalani Karunakaran, ICAR-National Dairy Research Institute, Eastern Regional Station, Kalyani-741 235, West Bengal, India. Email: drmkarunakaran@gmail.com

How to cite this article: Rava, P.C., Mondal, M., Mandal, A., Das, S.K., Rai, S., Bhakat, C. and Karunakaran, M. (2023). Changes in Testicular Biometry and Ejaculate Characters during Pubertal Age in Black Bengal Kids. Indian Journal of Animal Research. DOI: 10.18805/IJAR.B-5145

Submitted: 10-05-2023 **Accepted:** 18-12-2023 **Online: 26-12-2023**

Semen collection was attempted from four months of age onward with an artificial vagina using an estrus female as a teaser, at weekly intervals. Presence of motile sperm cells in the ejaculate was considered as the onset of puberty in the male. The sperm concentration was estimated by an Accucell photometer (IMV Technologies, France), live sperm cell count was carried out with eosin-nigrosin stain, sperm abnormalities were screened with Rose Bengal staining and plasma membrane integrity of sperm cells was ascertained with hypo osmotic swelling test (HOST). The data of fresh semen were subjected to normality test and found showing a normal distribution. Subsequently, data were analyzed by one-way ANOVA followed by Duncan's multiple range test and considered as significantly different when $P<0.05$ or $P<0.01$. The analysis was carried out using SPSS software (version-26.0).

The mean body weight (BW) of male kids at 4 months was 6.86±0.54 kg which significantly ($P<0.01$) increased with advancing age till 9 months. Mean scrotal circumference (SC) varied from 14.04±0.37 to 18.63±0.31 cm; the testicular length from 4.84±0.15 to 5.59±0.1 cm and 4.91±0.14 to

5.63±0.11 cm in the right and left testis respectively, during the observation period (Table 1). The mean testicular width (RTW) varied from 3.4±0.13 to 3.91±0.11 cm in the right testis and 3.41±0.09 to 3.85±0.11 cm for the left testis. The thickness of the testis ranged from 2.8±0.15 to 3.4±0.09 cm and 2.99±0.13 to 3.52±0.08 cm for the right and left testis, respectively (Table 2). The mean testicular volume ranged from 34.22±2.45 to 54.02±3.05 cm^3 at the 4^{th} and 12^{th} months of age, respectively. The mean scrotal skinfold thickness (SST) varied between 0.1±0.01 and 0.33±0.02 cm. Body weight and scrotal/testicular biometry measurements of Bengal kids had increased gradually over the period during the 4^{th} to 12^{th} months of age and differed significantly (P<0.01). The increase in testicular measurements with advancement of age was in accordance with the earlier reports in different goat breeds (Gogoi *et al*., 2005; Akpa *et al*., 2013 and Kumbhar *et al*., 2019). Chaudhari *et al*. (2018) reported that all the testicular parameters were significantly affected by body condition /growth rate while Akpa *et al*. (2013) suggested that bucks with higher body size might possess larger testicular size which might invariably result into a good reproductive capability, better semen quality and thus improve the fertility of the animal.

Very few immature sperm cells in the ejaculate were first recorded at 4.5 months of age in three kids and presence of matured, motile cells with more than 500 x 10^6/ml sperm concentration was recorded in all the kids from 6 months of age onwards. Ejaculate characters of 76 semen samples collected from the bucks aged between 6 to 12 months are presented in Table 3. Volume of semen ejaculate at 6 months of age was 0.32±0.02 ml, which increased significantly (P<0.01) during 11 to 12 months. Volume of semen ejaculates in the present study were similar to the reports of Furstoss *et al*. (2009); Sultana *et al*. (2013) and Kumbhar *et al*. (2019) in goats, but slightly lower than the observation by Chaudhari *et al.* (2018) in Surti bucks (0.7 ml) at 12 months of age. The lowest spermatozoa concentration in the semen ejaculates was observed at 6 months of age and the sperm cell concentration increased significantly (P<0.01) over the period and reached to 3176.14±66.4 × 10^6/ml at 12 months of age. Sperm cell concentration recorded in the present study was in close agreement with Chaudhari *et al*. (2018), who found 991±20.48 × 10^6/ml sperm concentration in Surti bucks at 7 months of age. However, the values were higher than those reported by Thakur *et al.* (2005) in Chegu Pashmina bucks (1759±79.79 × 10^6/ml), Gogoi *et al.* (2008) in Beetal × Assam local (2751±102.40 × 10^6/ml). Kabiraj *et al.* (2011) opined that older bucks have more spermatogenic activity due to larger testicular size. Environmental factors like nutrition, seasonal changes, semen collection method and collection frequency can influence the activity of accessory sex glands and subsequently semen quality and quantity. According to Aguiar *et al.* (2006), such increase in the spermatogenic activity results from the significant development of the seminiferous tubules and Sertoli cell differentiation.

Table 1: Body weight and testicular biometry measurements of 4 to 12 months of aged in Black Bengal bucks.

Age (months)	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12
BW (kg) ± SE	6.86^{a}	7.46^{ab}	7.88^{abc}	8.31^{abcd}	8.85^{bcde}	9.42^{cdef}	9.81^{defg}	10.26^{efgh}	10.73^{fghi}	11.15^{ghij}	11.55^{ghijk}	11.86^{hijk}	12.16^{ijk}	12.46^{ijk}	12.81^{ijk}	13.12^{k}	13.35^{k}
	±0.54	±0.60	±0.42	±0.42	±0.38	±0.37	±0.37	±0.39	±0.39	±0.39	±0.38	±0.40	±0.39	±0.40	±0.39	±0.35	±0.33
SC (cm) ± SE	14.04^{a}	14.25^{a}	14.49^{ab}	14.85^{ab}	15.69^{ab}	16.14^{bc}	6.71^{cd}	17^{cdef}	17.31^{cdef}	17.63^{def}	17.81^{def}	18.04^{ef}	18.27^{ef}	18.39^{ef}	18.51^{ef}	18.59^{f}	18.63^{f}
	±0.37	±0.45	±0.34	±0.39	±0.38	±0.4	±0.42	±0.39	±0.35	±0.33	±0.41	±0.36	±0.38	±0.32	±0.38	±0.35	± 0.31
RTL (cm) ± SE	4.84^{a}	4.88^{ab}	4.94^{abc}	5^{abcd}	5.09^{abcde}	5.15^{abcde}	5.21^{abcde}	5.27^{abcde}	5.32^{abcde}	5.37^{abcde}	5.42^{bcde}	5.46^{cde}	5.51^{de}	5.53^{de}	5.55^{de}	5.57^{e}	5.59^{e}
	±0.15	±0.15	±0.13	±0.12	±0.11	±0.11	±0.11	±0.11	±0.11	±0.11	±0.11	±0.11	±0.11	±0.11	±0.11	±0.1	±0.1
LTL (cm) ± SE	4.91^{a}	4.95^{a}	5^{ab}	5.09^{abc}	5.17^{abcd}	5.22^{abcd}	5.25^{abcd}	5.3^{abcd}	5.37^{abcd}	5.42^{abcd}	5.47^{bcd}	5.51^{bcd}	5.56^{cd}	5.59^{cd}	5.61^{cd}	5.64^{d}	5.63^{d}
	±0.14	±0.13	±0.12	±0.09	±0.1	±0.1	±0.1	±0.1	±0.11	±0.1	±0.1	±0.1	±0.1	±0.1	±0.1	±0.1	±0.11

Rows with different superscripts (a, b, c,.... k) differed significantly (P<0.01).

BW- Body weight; SC- Scrotal circumference; RTL- Right testicular length; LTL- Left testicular length; SE- Standard error.

Table 2: Testicular biometry measurements of 4 to 12 months of aged in Black Bengal bucks.

Age (months)	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12
RTW (cm) ± SE	3.4± 0.13	3.43± 0.14	3.46± 0.1	3.52± 0.1	3.57± 0.11	3.63± 0.11	3.66± 0.11	3.7± 0.11	3.72± 0.11	3.75± 0.11	3.78± 0.11	3.81± 0.11	3.83± 0.11	3.86± 0.11	3.88± 0.11	3.9± 0.11	3.91± 0.11
LTW (cm) ± SE	3.41± 0.09	3.45± 0.08	3.42± 0.1	3.48± 0.12	3.51± 0.1	3.58± 0.11	3.62± 0.11	3.65± 0.11	3.68± 0.11	3.7± 0.11	3.74± 0.11	3.75± 0.11	3.78± 0.11	3.8± 0.11	3.82± 0.11	3.83± 0.11	3.85± 0.11
RTT(cm) ± SE	2.8^{a} ±0.15	2.83^{ab} ±0.15	2.87^{abc} ±0.1	2.93^{abcd} ±0.1	2.98^{abcd} ±0.09	3.01^{abcd} ±0.09	3.05^{abcd} ±0.09	3.09^{abcd} ±0.09	3.14^{abcd} ±0.09	3.19^{abcd} ±0.09	3.23^{abcd} ±0.09	3.28^{bcd} ±0.09	3.31^{cd} ±0.09	3.34^{cd} ±0.09	3.36^{d} ±0.09	3.38^{d} ±0.09	3.4^{d} ±0.09
LTT(cm) ± SE	2.99^{a} ±0.13	3.02^{ab} ±0.13	3.06^{abc} ±0.1	3.08^{abcd} ±0.11	3.09^{abcd} ±0.08	3.12^{abcd} ±0.08	3.16^{abcd} ±0.08	3.2^{abcd} ±0.08	3.25^{abcd} ±0.08	3.3^{abcd} ±0.08	3.34^{abcd} ±0.08	3.39^{bcd} ±0.08	3.43^{cd} ±0.08	3.45^{cd} ±0.08	3.47^{cd} ±0.08	3.5^{cd} ±0.08	3.52^{d} ±0.08
TV (avg) (cm^3) ± SE	34.22 ±2.45	35.33^{ab} ±2.49	35.6^{ab} ±1.7	37.48^{abc} ±1.93	39.48^{abcd} ±2.38	41.22^{abcde} ±2.47	42.46^{abcde} ±2.54	43.76^{abcde} ±2.58	45.31^{abcde} ±2.66	46.75^{abcde} ±2.71	48.28^{bcde} ±2.79	49.59^{cde} ±2.84	50.85^{de} ±2.93	51.86^{de} ±3	52.61^{de} ±3	53.41^{e} ±3.01	54.02^{e} ±3.05
SST (cm) ± SE	0.1^{a} ±0.01	0.11^{ab} ±0.05	0.14^{abc} ±0.02	0.15^{abc} ±0.02	0.15^{abc} ±0.01	0.16^{bcd} ±0.01	0.18^{cde} ±0.01	0.2^{cdef} ±0.01	0.22^{defg} ±0.01	0.23^{efgh} ±0.01	0.25^{fghi} ±0.01	0.27^{ghij} ±0.02	0.29^{hijk} ±0.01	0.31^{ijk} ±0.01	0.31^{ijk} ±0.02	0.32^{jk} ±0.02	0.33^{k} ±0.02

Rows with different superscripts (a, b, c,…. k) differed significantly (P<0.01).

RTW- Right testicular width; LTW- Left testicular width; RTT- Right testicular thickness; LTT- Left testicular thickness; TV- Testicular volume; SST- Scrotal skinfold thickness; SE- Standard error.

Table 3: *In vitro* sperm characters of semen ejaculates in Black Bengal bucks aged 6 to 12 months (Mean±SE).

Parameters	Age (months)						
	6	7	8	9	10	11	12
Volume (mL) ± SE	0.32^{a}±0.02	0.42^{bc}±0.02	0.46^{bc}±0.02	0.5^{bc}±0.03	0.53^{c}±0.04	0.73^{d}±0.03	0.67^{d}±0.04
Conc. (million/ml) ± SE	844.57^{a}±23.12	984.27^{a}±35.14	1408^{b}±34.94	2280.33^{c}±113.42	2654^{d}±97.53	2969.13^{e}±67.17	3176.14^{e}±66.4
Mass motility (0-5) ± SE	2.64^{a}±0.13	2.87^{ab}±0.13	3.13^{abc}±0.09	3.33^{bc}±0.17	3.57^{c}±0.2	3.63^{c}±0.18	3.71^{c}±0.18
Individual motility (%) ± SE	56.79^{a}±1.24	60.67^{b}±0.96	64.06^{b}±0.5	68.89^{c}±0.73	72.86^{d}±1.01	76.88^{e}±0.91	80.71^{f}±1.3
Live sperm (%) ± SE	61.36^{a}±1.11	64.53^{ab}±0.83	67.56^{bc}±0.86	71.33^{c}±1.39	77.43^{d}±1.29	81.25^{de}±1.13	83.14^{e}±1.12
HOST (%) ± SE	59.21^{a}±1.73	61.93^{a}±0.85	59.69^{a}±1.55	67.56^{b}±2.55	74.14^{c}±1.52	78.5^{c}±1.3	80.71^{c}±1.52
Intact acrosome (%) ± SE	57.57^{a}±1.21	63.07^{b}±1.02	64.13^{b}±1.46	74.33^{c}±1.42	77.29^{c}±1.36	80^{c}±1.13	87.57^{d}±1.34
Abnormal spermatozoa (%) ± SE	19^{c}±0.86	14.73^{b}±0.52	12.75^{b}±0.78	9.22^{a}±0.4	8.86^{a}±0.74	8.38^{a}±0.5	7.29^{a}±0.68

Means with different superscripts differ significantly (p<0.01) within rows.

Mass motility of neat semen ranged from 2.64±0.13 at 6 months of age to 3.71±0.18 at 12 months. There was a gradual increase in the mass motility from 9 months onwards and a significant (P<0.01) difference in mass motility has been observed between the ejaculates harvested during 6 to 7 months and 10 to 12 months. The results of the study are in agreement with Kumbhar *et al.* (2019) who observed mass motility of 3.78±0.10, the highest value at 9.5 months of age. However, the value of the present study was lower (4.0±0.16) than the observations of Kerketta *et al.* (2014) in goats found in the Rohilkhand region. Sperm motility is also affected by collection interval as because prolonged collection interval, spermatozoa in the epididymis degenerate resulting inferior quality semen. The individual motility (%) in fresh semen samples was lowest at 6 months of age (56.79±1.24) which increased significantly over the period and reached to 80.71±1.30% at 12 months of age. The present values were in agreement with the findings of Akpa *et al.* (2013) who reported 80.00±2.42% initial motility in 11 to 13 months old Red Sokoto bucks, while Gimenez, (2007) reported individual motility of buck semen ranged between 70 and 90%. The percentage of non-eosinophilic live sperm cells in the ejaculates of Bengal bucks varied between 61.36±1.11% and 83.14±1.12% at 6 and 12 months of age, respectively. There was a significant (P<0.01) increase in viable sperm count from 9 months to 11 months of age. A higher percentage of live sperm than the present study was reported in indigenous bucks at 12 months of age by Kumbhar *et al.* (2019), while the lowest values were reported in crossbred bucks Surti bucks (Jadav *et al*., 2008) and Boer bucks (Suyadi *et al.*, 2012). Factors like age, feeding and breed had an impact on the sperm quality (Abah *et al*., 2023).

The percentage of HOST positive spermatozoa in the ejaculates were in the range of 59.21±1.73 to 80.71±1.52 during 6 to 12 months of age in Bengal bucks. The population of HOST-positive sperm cells increased significantly (P<0.01) in the ejaculates collected during 10 to 12 months of age than those of 6 to 8 months. The values of HOST-positive sperm count in the study were in accordance with that of Chaudhari *et al.* (2018) in Surti bucks at 7 to 12 months of age. However, lower values were reported by Kale and Tomar (2000) in crossbred bucks and Deori *et al.* (2016) in Assam Hill goats. Intact acrosome percentage was 57.57±1.21 at 6 months of age, which increased significantly (p<0.01) to 87.57±1.34 at 12 months of age. Dorado *et al.* (2009); Ahmad *et al.* (2014) and Deori *et al.* (2016) reported a higher percentage of intact acrosome than the present study. The abnormal sperm count (%) showed a reverse trend with a significantly (P<0.01) lower value of 9.22±0.4 from 9 months of age onwards. The values of the study were similar to Mahal *et al.* (2013) who recorded a normal sperm percentage of 87.20±0.66 in 7 to 9 months and 89.20±0.44 in the bucks aged 9 to 12 months. The percentage of abnormal sperm is negatively correlated with age in the present study similar to that of Zamiri and Heidari (2006). Nutritional status, seasonal changes, false mounting, methods of semen collection and collection frequency may influence semen quality in terms of volume, sperm cell concentration and motility parameters.

CONCLUSION

Based on the findings, such as presence sperm cells in the ejaculate and the *in vitro* sperm characters at different months of age, it can be concluded that Black Bengal bucks attain puberty and sexual maturity at least by 6 and 12 months of age, respectively and the testicular biometrical measurements increased significantly with advancement of age and body weight.

Conflict of interest

All authors declare that there is no conflict of interest.

REFERENCES

Abah, K.O., Fontbonne, A., Partyka, A., Nizanski, W. (2023). Effect of male age on semen quality in domestic animals: Potential for advanced functional and translational research? Veterinary Research Communications. 47: 1125-1137. https://doi.org/10.1007/s11259-023-10159-1.

Aguiar, G.V., Araújo, A.A., Moura, A.D.A.A. (2006). Desenvolvimento testicular, espermatogênese e concentrações hormonais em touros Angus. Revista Brasileira de Zootecnia. 35(4): 1629-1638.

Ahmad, M., Nasrullah, R., Riaz, H., Sattar, A., Ahmad, N. (2014). Changes in motility, morphology, plasma membrane and acrosome integrity during stages of cryopreservation of buck sperm. Journal of the South African Veterinary Association. 85(1): 1-4.

Akpa, G.N., Ambali, A.L., Suleiman, I.O. (2013). Body conformation, testicular and semen characteristics as influenced by age, hair type and body condition of Red Sokoto goat. New York Science Journal. 6(7): 44-58.

Chaudhari, D.V., Dhami, A.J., Patel, J.A., Parmar, C.P., Hadiya, K.K., Belsare, V.P. (2018). Testicular biometry, sexual behavior and semen quality during the period of growth and adolescence in surti goats. Journal of Animal Research. 8(6): 1109-1115.

Deori, S., Deka, B.C., Arangasamy, A., Biswas, R.K., Selvaraju, S., Bhuyan, D., Nahardeka, N., Somashekar, L., Parthipan, S., Kalita, D.J., Borah, R.S., Phookan, A. (2016). Electrophoretic profile of sperm membrane proteins and correlation with fresh semen characteristics in Assam Hill goat. Indian Journal of Animal Sciences. 86: 1269-73.

Dorado, J., Hidalgo, M., Muñoz, A., Rodríguez, I. (2009). Assessment of goat semen freezability according to the spermatozoa characteristics from fresh and frozen samples. Animal Reproduction Science. 112(1-2): 150-157.

Furstoss, V., David, I., Leboeuf, B., Guillouet, P., Boué, P., Bodin, L. (2009). Genetic and non-genetic parameters of several characteristics of production and semen quality in young bucks. Animal Reproduction Science. 110(1-2): 25-36.

Gimenez, D. (2007). Reproductive management of goats and sheep. Alabama cooperative extension system. Bulletin ANR-1316.

Gogoi, C., Deka, B.C., Biswas, R.K., Sarma, B.C., Nath, K.C., Baruah, P.M. (2008). Semen characteristics and scrotal and testicular dimensions of crossbred bucks. Indian Veterinary Journal. 85(4): 454-455.

Gogoi, C., Deka, B.C., Biswas, R.K., Nath, K.C., Baruah, P.M., Sarmah, B.C. (2005). Testicular biometry in Beetal x Assam bucks during adolescence. Indian Journal of Small Ruminants. 11(1): 24-27.

Jadav, P.V., Shah, R.G., Sarvaiya, N.P., Patel, D.M. (2008). Studies on physical characteristics of semen of surti bucks. Indian Journal Field Veterinarians. 4(2): 20-24.

Kabiraj, S.K., Hoque, S.M., Khandoker, M.A.M., Husain, S.S. (2011). Testicular biometry and its relationship with body weight and semen output of black Bengal bucks in Bangladesh. Journal of Cell and Animal Biology. 5(2): 27-32.

Kale, M.M.and Tomer, O.S. (2000). Enzymatic constituents in crossbred buck semen. Indian Journal of Animal Sciences. 70(1): 30-32.

Kerketta, S., Singh, M., Patel, B.H.M., Verma, M., Prasad, J.K., Upadhyay, D., Bhushan, B. (2014). Study on buck's mating behaviour, libido score and semen biology in local goat of Rohilkhand region, India. Indian Journal of Animal Research. 48(5): 491-495. doi: 10.5958/0976-0555.2014.00017.X.

Kridli, R.T, Yousef Abdullah, A., Mohamed Momani, S., Al-Momani, A.Q. (2006). Age at puberty and some biological parameters of Awassi and its first crosses with charollais and romanov rams. Italian Journal of Animal Science. 5(2): 193-202.

Kumbhar, U.B., Gulavane, S.U., Gaikwad, S.M., Shelar, R.R., Deshpande, V.P., Rebeiro, R., Yadav, K. (2019). Correlation of testicular ultrasonography, testicular biometry, serum testosterone levels and seminal attributes in pre and post-pubertal age for breeding soundness evaluation in Osmanabadi bucks. Tropical Animal Health and Production. 51(6): 1467-1480.

Mahal, Z., Khandoker, M.A.M.Y., Haque, M.N. (2013). Effect of non-genetic factors on productive traits of Black Bengal goats. Journal of the Bangladesh Agricultural University. 11(1): 79-86.

Souza, L.E.B.D., Cruz, J.F.D., Teixeira Neto, M.R., Nunes, R.D.C.S., Cruz, M.H.C. (2011). Puberty and sexual maturity in Anglo-Nubian male goats raised in semi-intensive system. Revista Brasileira de Zootecnia. 40: 1533-1539.

Sultana, F., Husain, S.S., Khatun, A., Apu, A.S., Khandoker, M.A.M.Y. (2013). Study on buck evaluation based on semen quality and fertility. Bangladesh Journal of Animal Science. 42(2): 101-108.

Suyadi, S. (2012). Sexual behaviour and semen characteristics of young male Boer goats in tropical condition: A case in Indonesia. International Journal of Animal and Veterinary Sciences. 6(6): 388-391.

Thakur, Y.P., Singh, M., Jaisial, S. (2005). Semen production and freezability attributes of Chegu Pashmina bucks. Indian Journal of Animal Sciences. 75(10):1165-1167.

Zamiri, M.J. and Heidari, A.H. (2006). Reproductive characteristics of Rayini male goats of Kerman province in Iran. Animal Reproduction Science. 96(1-2): 176-185.