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Evaluation of Black Bengal breeding buck based on sexual urge, semen quality and non-return rate

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ABSTRACT

This study was carried out to evaluate the sexual urge, semen quality, and non-return rate (NRR) of Black Bengal breeding bucks to establish criteria for selecting superior bucks. Data were collected from five bucks aged between 17 and 19 months over a period of five months. The results showed that reaction time (RT) and erection status (ES) differed significantly among the bucks ($p<0.05$), whereas no significant ($p>0.05$) differences were observed for libido and fixing strength (FS). Moreover, significant differences ($p<0.05$) were also observed in semen volume and sperm concentration, whereas mass motility, progressive motility, live sperm, and normal sperm percentages were similar among the bucks. Furthermore, RT exhibited significantly ($p<0.05$) strong negative correlations with both libido and FS, whereas ES showed significantly ($p<0.05$) strong positive correlation with semen volume. In addition, strong and significant ($p<0.05$) positive correlations were observed among all key semen quality parameters. Finally, the bucks had an average NRR of 48.98 %, ranging from 33.33 % to 66.67 %. Buck 56 had the highest NRR and showed overall better performance in sexual urge, seminal parameters and fertility. These findings emphasize the importance of libido, semen quality, and NRR as reliable indicators for evaluating breeding soundness and improving reproductive efficiency in Black Bengal bucks.

Introduction

Goats have been reared in Bangladesh since the beginning of human settlement in this region and represent a vital element in the country's rural agricultural system. Bangladesh has only one native goat breed, the Black Bengal, which ranks second in the national livestock sector due to its significant contribution to meat yield and skin quality. The total goat population in Bangladesh is estimated at 27.29 million (DLS, 2025), of which over 90% are Black Bengal goats, with Jamunapari and their crossbreeds comprising the remainder (Husain, 1993; Amin et al., 2001). The Black Bengal goat is renowned worldwide for its adaptability, high fertility, and prolificacy, as well as for producing tender meat and superior-quality skin (Husain et al., 1996; Hasan et al., 2015).

To strengthen goat husbandry in Bangladesh, it is necessary to maximize the production potential of bucks. This can be achieved through systematic selection, planned crossbreeding, and the establishment of goat breeding and multiplication centers. Evaluation of buck

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represents the starting point in goat development program. Breeding bucks with superior genetic merit is essential to ensure the propagation of superior goat species. Unfortunately, there is a major shortage of stud bucks throughout the country, particularly in rural areas, where farmers raise more than 80% of the goats. Due to the scarcity of breeding bucks, the same bucks are used over successive generations, thereby increasing the risk of inbreeding, reducing reproductive performance, and promoting the spread of venereal and other infectious diseases (Husain, 2007). For economic and social reasons, goat keepers castrate nearly all male kids at a young age (Khandoker et al., 2007). Consequently, there was a marked reduction in the availability of breeding bucks. As a result, there is no reliable way to judge the fertility and overall breeding soundness of bucks (Husain, 2007). It is already well known that selecting high-quality bucks and making them widely available can boost goat production generally (Husain, 2007). Therefore, the selection of high-performing bucks based on precise and reproducible reproductive parameters is essential for achieving genetic progress and sustainable productivity.

Libido is an important component of breeding sound assessment (BSE) and has a significant impact on overall flock fertility (Matos and Thomas, 1991). Libido is commonly tested using reaction time, which is defined as the period between being exposed to stimuli and receiving the first service (Chenoweth, 1999). Semen quality is a primary criterion for selecting breeding bucks and has a major impact on male fertility and overall reproductive performance (Moussa, 1997). The ejaculate volume, sperm concentration, sperm motility, percentage of live spermatozoa, and morphological properties of spermatozoa define the quality of semen in relation to fertility. Accordingly, semen-quality assessment provides a practical framework for predicting and comparing the reproductive performance of breeding bucks (Sultana et al., 2013). In addition, the non-return rate (NRR) serves as an indirect yet widely recognized indicator of fertility, providing valuable insight into reproductive efficiency.

Despite the recognized importance of these parameters, limited information is available on the relationship between sexual urge, semen quality, and fertility of Black Bengal bucks. Therefore, this study aimed to evaluate these attributes to identify reliable indicators of reproductive performance for use in breeding programs.

Materials and methods

Experimental location

The experiment was carried out at the Artificial Insemination (AI) Center, Department of Animal Breeding and Genetics, Bangladesh Agricultural University, Mymensingh, Bangladesh, from October 2021 to February 2022.

Experimental animal and facilities

Five adult bucks were chosen for this experiment and were ear tagged as 51, 53, 54, 55, and 56. All the bucks were observed on a regular basis to identify any reproductive problems. The bucks were managed under a semi-intensive system, comprising stall feeding with an open foreyard for exercise. The individual space for each buck in the shed was 19.5 square feet. The bucks were provided with 300 g of commercial feed in mash form and 40 g of germinated gram each morning, and green fodder was given ad libitum. Clean drinking water was also provided ad libitum, and the bucks were routinely dewormed and vaccinated against PPR and anthrax.

Sexual urge parameters

Sexual urge parameters of the bucks were evaluated through four key indicators: libido, reaction time, fixing strength, and erection status. Libido assessment followed the scoring system of Vince et al. (2017), ranging from 1 to 5, where 1 represented no interest in estrous does and 5 indicated immediate mounting following visual contact. Reaction time (RT), defined as the interval between the first contact with the teaser doe and the first false mount with penile erection, was measured according to Hoflack et al. (2006). Fixing strength (FS) was recorded based on the buck's ability to grasp the hindquarters of the teaser doe during semen collection, following Suyadi (2012), using a three-point scale (1 = weak or no fixation, 2 = moderate fixation, 3 = strong fixation). Erection status (ES) was evaluated following Kumar et al. (2016), with scores of 1 to 3 representing the degree of penile exposure and coloration (1 = no protrusion from prepuce, 2 = pink to pale red, 3 = bright red with or without seminal plasma secretion).

Collection, handling, and evaluation of semen

The bucks were trained to mount estrous and non-estrous goats, as well as a male teaser, one month prior to starting the semen collection process (Silvestre et al., 2004). Semen was collected using a standard artificial vagina (AV) designed for bucks, as described by Herman and

Madden (1963), and ejaculated semen was immediately placed in a graduated collection tube. The sample was subsequently placed in a 37°C water bath for further evaluation. Semen quality was assessed according to the protocol of Herman and Madden (1963). The volume per ejaculation was recorded using a graduated collection vial. Sperm concentration was measured using the hemocytometer method, where spermatozoa were counted in five small squares at 40x magnification, and the concentration was calculated using the formula:

Mass motility was scored based on a 0-5 scale, where 0 indicated no motility and 5 represented excellent motility, with more than 80 % of sperm in vigorous motion. Progressive motility was assessed by mixing a small drop of semen with a sodium citrate buffer on a slide and examining it under a microscope at 40x magnification. The percentage of live sperm was determined using the eosin-nigrosine stain method, where unstained sperm were considered live, and dead sperm were stained. The percentage of normal sperm was determined by counting a total of 333 spermatozoa, assessing any malformations, and calculating the percentage of normal sperm by subtracting the number of abnormal sperm from the total count (Silvestre et al., 2004).

Artificial Insemination

The Black Bengal does (n = 49) were inseminated with liquid semen at the BAU AI Center by trained AI personnel. The does selected for insemination had normal estrous cycles, and farmers detected estrus on the basis of behavioral signs. Inseminations were performed 12 to 24 h following the onset of estrus (Murtaza et al., 2019). For the procedure, the vulva area of the estrus doe was wiped with tissue paper during AI. Holding her hind leg aloft, the doe was restrained. The exterior opening of the cervix was then viewed using a lubricated vaginal speculum, and semen was placed into the AI pistol and deposited into the os of the cervix slowly.

Non-return rate (NRR)

The NRR was used as an indicator of pregnancy rate. Pregnancy status was confirmed by contacting doe owners by telephone 42 d after insemination, and does that did not return to estrus within this period were considered pregnant (Karim et al., 2018).

The NRR was calculated as follows:

$$\text{NRR (\%)} : \frac{\text{No.of served does not requested further service for a given conception}}{\text{Total no.of does served}} 100$$

Statistical analysis

All experimental records were transferred to a Microsoft Excel spreadsheet, organized in spreadsheet and then processed for further analysis. Descriptive statistics were performed to calculate mean, standard errors and percentage. Data were analyzed using a one-way ANOVA in a completely randomized design (CRD) with buck as the fixed effect and each individual observation/ejaculate as the experimental unit. The statistical model used was $Y_{ij} = \mu + B_i + e_{ij}$. Where Y_{ij} is the j-th observation from the i-th buck, μ is the overall mean, B_i is the fixed effect of the i-th buck ($i = 1…5$), and e_{ij} is the random residual error term, assumed to be independently and normally distributed with mean 0 and variance σ^2. Each ejaculation/observation was treated as an experimental unit and was randomly allocated across bucks within the CRD framework. Analyses were performed in SPSS following the principles of CRD (Steel and Torrie, 1980). The significance of the differences in the mean values was also determined using Duncan's multiple range test (Snedecor and Cochran, 1980). Correlation analyses were performed in R (version 4.3.1), and graphical outputs were generated using GraphPad Prism (version 9.3.0).

Results

Sexual urge of breeding bucks

The sexual urge parameters of different breeding bucks are presented in Figure 1. In the present study, no significant ($p>0.05$) differences were observed for libido among the individuals. However, buck 56 exhibited the highest libido (4.6 ± 0.24), followed by bucks 54 (3.86 ± 0.26), 51 (3.67 ± 0.33), 55 (3.67 ± 0.33), and 53 (3.60 ± 0.24) (Figure 1A). The mean RT among the bucks differed significantly ($p<0.05$). A significant difference ($p<0.05$) was observed in RT, where buck 56 (11.26 ± 2.20 s) demonstrated a significantly faster RT than bucks 51 (36.05 ± 7.44 s) and 53 (28.80 ± 2.65 s). However, no significant differences ($p>0.05$) were observed among bucks 51, 53, 54, and 55. Bucks 54 and 55 displayed intermediate RT values that were not significantly different from the other groups (Figure 1B). For FS, no significant differences ($p>0.05$) were found among the bucks. Buck 56 displayed the highest FS (2.60 ± 0.24), while buck 51 had the lowest (1.67 ± 0.34) (Figure 1C). In terms of ES, buck 56 had the highest mean value (2.60 ± 0.24), while buck 53 had the lowest (1.80 ± 0.20). Significant differences ($p<0.05$) were found between buck 56 and the other bucks. However,

no significant differences (p>0.05) were found between bucks 56, 51 (2.50 ± 0.22), and 54 (2.14 ± 0.14). Additionally, buck 53 did not differ significantly (p>0.05) from the other bucks (Figure 1D).

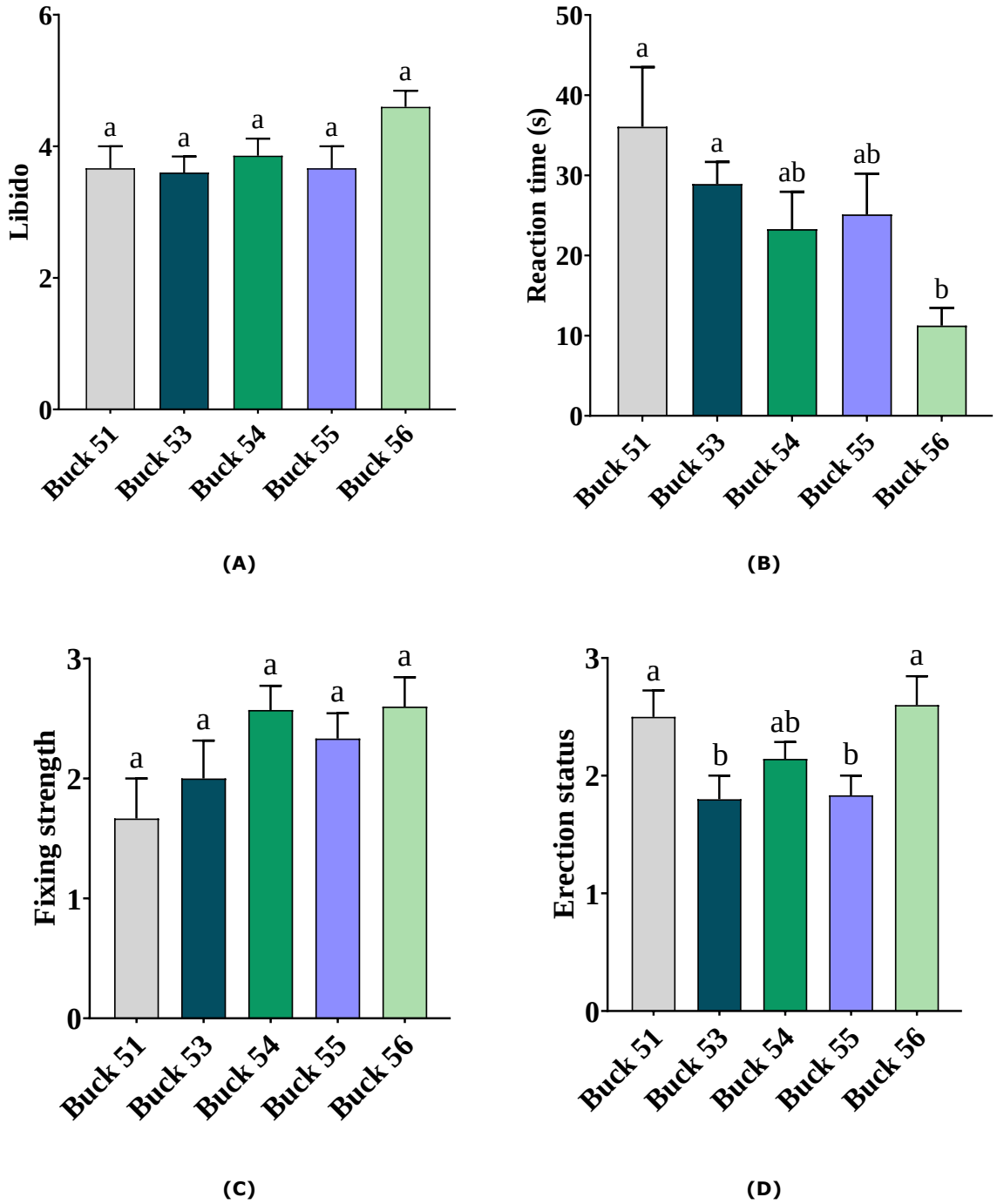

Figure 1: Sexual urge of different breeding buck. Each value represents the mean percentage (± SEM). Bars with different superscripts (a, b) at the same column differ significantly (p <0.05). (A) Libido; (B) Reaction time (s); (C) Fixing Strength; (D) Erection status; n = 5.

Table 1: Characteristics of fresh semen of Black Bengal bucks

Buck No.	Volume(mL)	Conc. (10^6/mL)	Mass motility (%)	Progressive motility (%)	Live Sperm (%)	Normal Sperm (%)
51(5)	$0.80^{a} \pm 0.05$	$2461^{b} \pm 78.01^{b}$	77.80 ± 2.20	70.62 ± 2.62	83.53 ± 1.85	89.26 ± 2.92
53 (5)	$0.52^{c} \pm 0.06$	$2806^{a} \pm 107.68$	81.00 ± 1.00	71.29 ± 3.00	85.59 ± 2.43	89.83 ± 0.95
54 (7)	$0.61^{bc} \pm 0.04$	$2476.43^{b} \pm 58.72$	80.30 ± 1.38	71.69 ± 1.26	86.10 ± 1.10	89.75 ± 0.56
55 (6)	$0.52^{c} \pm 0.08$	$2798.33^{a} \pm 56.59$	74.17 ± 3.74	66.84 ± 3.92	79.00 ± 3.54	88.65 ± 1.39
56 (5)	$0.72^{ab} \pm 0.05$	$2560^{b} \pm 85.15$	83.00 ± 0.93	74.68 ± 0.94	87.68 ± 0.78	90.63 ± 0.73

Each value represents the mean percentage (± SEM). Values with different superscripts (a, b, c) at the same column differ significantly (p<0.05). Parenthesis indicates the number of observations.

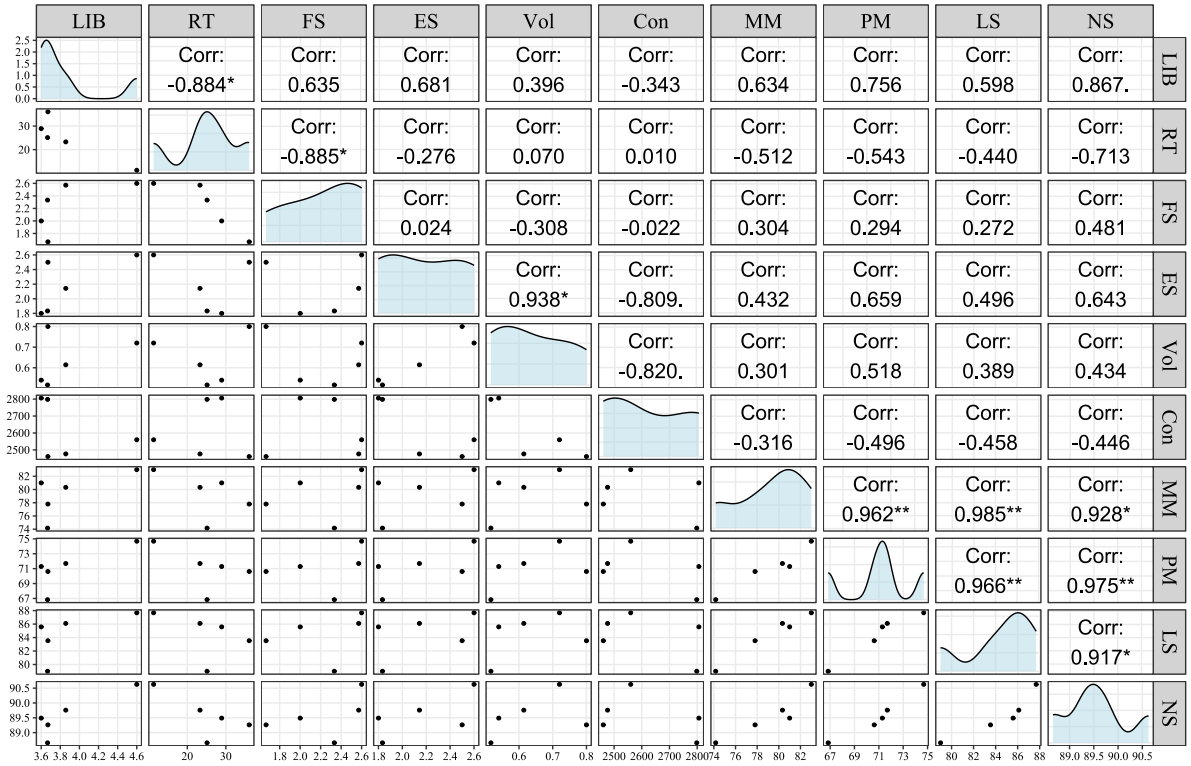

Figure 2: Pearson correlation coefficients between different sexual urge and seminal parameters of Black Bengal buck. The diagonal shows parameter distributions, the lower triangle contains scatterplots, and the upper triangle presents correlation coefficients (r) with significance levels (*p<0.05, **p<0.01).

Characteristics of fresh semen

Fresh semen characteristics of the experimental bucks with their mean values and SEM are presented in Table 1. Significant differences (p<0.05) were observed in semen volume and sperm concentration. Semen volume per ejaculate ranged from 0.52 ± 0.06 ml to 0.80 ± 0.05 ml, with the highest volume recorded in buck 51 (0.80 ± 0.05 ml) which was significantly higher than that of bucks 53 and 55 (0.52 ± 0.06 and 0.52 ± 0.08 ml, respectively). However, buck 51 and buck 56, as well as buck 56 and

buck 54, did not differ significantly ($p>0.05$). In terms of concentration, bucks 53 and 55 exhibited the highest sperm concentrations (2806 ± 107.68 and 2798.33 ± 56.59 × 10^6/mL, respectively), which were significantly greater than those of bucks 51, 54, and 56. No significant differences ($p>0.05$) were detected among bucks for mass motility, progressive motility, live sperm, and normal sperm percentages. However, buck 56 consistently displayed the highest numerical values for mass motility (83.00 ± 0.93 %), progressive motility (74.68 ± 0.94 %), live sperm (87.68 ± 0.78 %), and normal sperm (90.63 ± 0.73 %). In contrast, buck 55 showed the lowest numerical values for all these motility and viability parameters.

Correlation between sexual urge and seminal parameters

Figure 2 presents the correlation coefficients between various sexual urge and seminal parameters. Notably, libido exhibited a strong negative correlation with RT ($r = -0.884$, $p<0.05$). However, no significant correlations were observed between libido and other seminal parameters. Furthermore, a significant negative correlation was observed between RT and FS ($r = -0.885$, $p<0.05$) and no significant correlation was found between RT with ES, semen volume, concentration, motility of sperm, viability and morphological characteristics of sperm. FS did not exhibit significant correlations with seminal parameters. A significant positive correlation was observed between ES and semen volume (vol) ($r = 0.938$, $p<0.05$) and no significant correlation was found between erection status with other seminal parameters. Among the seminal parameters, mass motility was highly and significantly correlated with progressive motility ($r = 0.962$, $p<0.01$), live sperm ($r = 0.985$, $p<0.01$), and normal sperm ($r = 0.962$, $p<0.01$). Similarly, progressive motility was strongly correlated with both live sperm ($r = 0.966$, $p<0.01$) and normal sperm ($r = 0.975$, $p<0.01$), and a significant correlation existed between live sperm and normal sperm percentages ($r = 0.917$, $p<0.05$).

Non-return rate (NRR)

The average NRR to first insemination is presented in Table 2. The average NRR of buck was 48.98 % and ranged from 33.33 % to 66.67 %. The highest NRR was 66.67 % in buck 56 followed by 57.14 % in buck 51, 33.33 % in both buck 53 and 54 and 36.36 % in buck 55. On the other hand, Figure 3 illustrates the NRR of different bucks. Buck 56 demonstrated the highest fertility with an NRR of 66.67 %. In contrast, bucks 53 and 54 yielded the lowest rate at 33.33 %.

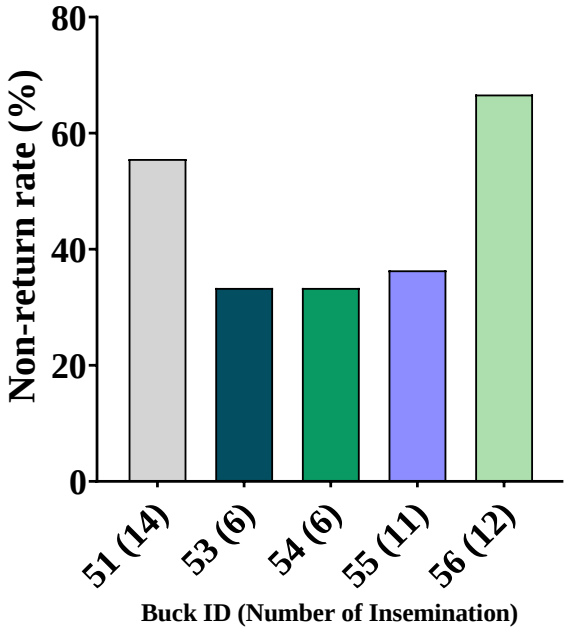

Figure 3: Non-return rate of different buck

Table 2: NRR of Black Bengal goat

No of does inseminated	No. of does not returned to estrus (42 d)	NRR (%)
49	24	48.98

Discussion

Libido assessment is a useful measure of reproductive efficiency in bucks. In the present study, no significant differences in libido were observed among bucks, as they were from the same breed. The mean value observed were ranged from 3.60 ± 0.24 to 4.6 ± 0.24. The mean libido intensity values found by Vince et al. (2017) between the MG (4.60; 4.17–4.91) and the CG bucks (4.34; 3.88–4.66) are consistent with the current study, whereas Ahmad and Noakes (1995) reported libido index 8.4, which is inconsistent with the current study and could be due to the different scale used. However, libido has a significant ($p<0.05$) and negative association with RT, indicating that the higher the libido, the shorter the RT. Different bucks' RT differ significantly ($p<0.05$) from one another. Buck 51 (36.05 ± 7.44 s) had the longest RT, while 56 (11.26 ± 2.20 s) had the shortest. Kumar et al. (2016) found that Jakhrana bucks have a mean RT of 41.56 ± 0.94 s in intensive system and 43.25 ± 0.88 s in semi intensive system, which is in contrast to the current study. It could be due to differences in breed and size

among the bucks. However, Moghaddam et al. (2014) observed mean RT of 24.45 ± 7.51 s and 11.76 ± 7.02 s in ArkharMerino×Ghezel rams and Ghezel×Baluchi rams, respectively, which are consistent with the current study. Again, there was no significant correlation between libido and seminal parameters which collaborates with Moghaddam et al. (2014).

When a male is introduced to a female, its ES indicates the strength of the penis and the extent of blood inflow to the penile vasculature, which can be used to assess his libido (Kumar et al. 2016). In the present study, ES ranged from 1.80 ± 0.20 to 2.60 ± 0.24 and differed significantly among bucks ($p<0.05$). Kumar et al. (2016) reported that the mean ES of Jakhrana bucks was 2.67 ± 0.04 in the intensive system and 2.63 ± 0.04 in the semi-intensive system, which supports the findings of this study. The current findings were marginally lower than those of Suyadi (2012), who observed ES 2.82 ± 0.12, 2.81 ± 0.15, and 2.12 ± 0.64 in different age groups of Boer bucks.

FS expresses a male's alignment in order to fix a female. The current study found a significant ($p<0.05$) but strong and negative relationship between FS and RT, indicating that the longer the RT, the worse the fixation to female. The highest observed FS was 2.60 ± 0.24 in buck 56 and lowest was 1.67 ± 0.34 in buck 51. Kumar et al. (2016) found mean FS of Jakhrana bucks to be 2.73 ± 0.03 in intensive system and 2.61 ± 0.04 in semi intensive system, which supports the current study. The findings of this study confirm those of Suyadi (2012), who discovered FS of 2.80 ± 0.13, 2.66 ± 0.32, and 2.10 ± 0.00 in various age groups of Boer bucks. However, no significant correlation was found between RT with ES, semen volume, concentration, motility of sperm, viability and morphological characteristics of sperm. This study supports the findings of Kumar et al. (2016) who stated that there was no significant association between RT and any of the seminal characteristics.

Semen volume per ejaculate in this study ranged from 0.52 ± 0.06 to 0.80 ± 0.05 mL and differed significantly among bucks ($p<0.05$). Apu et al. (2008) reported a mean ejaculate volume of 0.58 ± 0.03 mL in bucks, consistent with our observations. Afroz (2005) reported mean ejaculate volumes of 0.43 ± 0.03 to 0.45 ± 0.22 mL for Black Bengal bucks, and Pandey et al. (1985) reported 0.46 mL, both lower than the values observed in the present study. However, our findings align with earlier reports (Mittal, 1982; Vilar et al., 1993; Das et al., 2006; Farjana, 2009).

Apu et al. (2008) reported a mean mass motility of 77.82 ± 0.61 % for fresh Black Bengal semen, which is slightly lower than the current findings (74.17 ± 3.74 % to 83.00 ± 0.93 %). The differences observed in mass motility were not significant, this might be due to the small number of population and as well as observation studied in the present research. These findings agree with Afroz (2005), who reported 76.00 ± 1.45% to 78.00 ± 1.11% motility of spermatozoa in fresh semen, and are also consistent with previous observations by Karatzas et al. (1997); Shamsuddin and Chanda (1998); Das et al. (2006) and Islam et al. (2008).

Mass motility showed strong and significant ($p<0.01$) correlation with progressive motility, viability and sperm biology which indicates that mass activity plays a strong role with these semen parameters. On the other hand, progressive motility significantly ($p<0.01$) correlated with both sperm viability and normal sperm morphology, and the percentage of live sperm also showed a significant association with the percentage of normal sperm. This study supports Sharma and Sood's (2021) findings, who reported a significant and positive correlation between progressive motility and viability.

Viable spermatozoa in fresh semen ranged from 79.00 ± 3.54% to 87.68 ± 0.78%, which is consistent with previously reported values of 84.99 ± 0.38% to 85.62 ± 0.57% in Black Bengal bucks (Husain, 2007). The present findings are consistent with earlier reports on semen quality traits in Black Bengal bucks (Mittal, 1982; Pandey et al., 1985). Similarly, Apu et al. (2008) observed 84.33 ± 0.88 % to 89.58 ± 0.98 % live sperm, with significant between-buck variation. The proportion of normal spermatozoa observed in this study is consistent with previous reports. Normal spermatozoa percentages of 91.07% and 89.72 ± 0.35% to 91.16 ± 0.36% have been documented in the semen of Black Bengal bucks (Singh et al., 1985; Afroz, 2005). Apu et al. (2008) reported a mean of 91.39 ± 0.24 %, marginally higher than our estimates. Our findings are further supported by earlier studies (Bakshi et al., 1987; Khan, 1999; Das et al., 2006).

One of the most important factors to consider when evaluating a breeding buck is fertility. Buck fertility varies, revealing the individual potential of each buck. The average NRR of buck found in this study was 48.98 % and ranged from 33.33 % to 66.67 %. The findings of this study were

consistent with those of Dorado et al. (2007). By contrast, Karim (2008) reported a 55.90 % conception rate with frozen semen, and higher conception rates were noted by Chauhan and Anand (1990) and Paulenez et al. (2003). This variation can be indicative of the fact of less data of insemination. However, the number of spermatozoa per dosage, overall semen quality, method of AI, site and depth of semen deposition, and optimal timing of insemination all affect the NRR or conception rate. These could also be contributing factors to NRR variation.

Conclusions

This study was carried out to observe the quality of bucks in the context of sexual urge, seminal attributes and NRR of Black Bengal breeding buck. Bucks with higher libido showed very aggressive reaction and good acquisition to the does which was an indicative of breeding soundness of the buck. Seminal attributes also showed the potentiality of a fertile bucks which was observed in the non-return rate percentage. Though no significant correlation found between libido and seminal attributes of the breeding bucks but in overall condition the bucks which had a higher libido show expected semen quality and also perform well in terms of fertilization. So, the results of present study give an important criterion for buck evaluation on the basis of sexual urge, semen quality and NRR. From this point of view, using selected buck on the basis of these criteria, we can improve NRR of buck through AI which results in rapid genetic improvement and overall production potential of Black Bengal buck.

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Authors contribution

Mahmud Hasan Maruf: Writing – review and editing, conceptualization, methodology, investigation. Md. Abul Bashar: Writing – original draft, review and editing, visualization, formal analysis, data curation. Tasmina Akter: Writing – review and editing, investigation, supervision. Mst. Mahomudha Akhtar: Writing – review and editing, investigation, supervision. Md. Rafikul Islam: Writing – review and editing, investigation, supervision. Md. Younus Ali: Writing – review & editing, investigation, supervision. M. A. M. Yahia Khandoker: Writing – review and editing, conceptualization, project administration, funding acquisition, supervision, resources.

Data availability

The research data that support the findings of this study are available from the corresponding author upon reasonable request.

Conflict of interest

The authors declare that they have no conflicts of interest.

Consent to Participate

All authors provided informed consent to participate in this study.

Consent for publication

All authors have read and approved the final manuscript and consent to its publication in the Bangladesh Journal of Animal Science.

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