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Genetic evaluation of production potential of Black Bangal goat using frozen semen under community based rearing system

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Abstract

The objective of this study was to investigate production potential of Black Bengal goat using frozen semen under community based-rearing system. Forty Black Bengal does were distributed to the goat keepers and inseminated with frozen semen of selected Black Bengal bucks. Statistical analyses of all parameters were done using SAS. Genetic parameters were also measured using VCE software. Means along with standard errors for productive performance were 0.96 ± 0.01, 4.25 ± 0.06, 7.04 ± 0.12 kg, 36.51 ± 0.64, 31.29 ± 0.98 g/d, and 247.80 ± 3.13 ml/d, respectively for birth weight, body weight at 3- and 6-month, average daily gain at 3- and 6-month and daily milk yield. Reproductive performances were 1.81 ± 0.107, 1.44 ± 0.097, 145.33 ± 0.649 days, 200.60±2.83 days, 7.69±1.97 kg, 40%, 19.65%, respectively for litter size, service per conception, gestation period, age and weight at first heat, conception rate and kid mortality. Effects of sex and litter size were significant ($p<0.01$) for birth and 3-month weight and season was significant ($p<0.05$) only for birth weight. Bucks showed significant effects ($p<0.05$) for birth and 3-month weight. Estimated heritability for birth, 3- and 6-month weight were 0.21±0.03, 0.36±0.07 and 0.12±0.05. Genetic correlations among body weights ranged from 0.35 to 0.65 and phenotypic correlations ranged from 0.44 to 0.52. Therefore, the AI program with frozen semen of Black Bengal buck would be beneficial to the farmers.

Key words: productive and reproductive performance, frozen semen, Black Bengal goat

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Introduction

In the livestock sector Black Bengal goat is the only recognized goat breed among the domestic species available in Bangladesh. The domestic goat (*Capra hircus*) is an important livestock species in Bangladesh and has about 25.734 million in number (BER, 2015). Black Bengal goat is famous for its high fertility, prolificacy, superior skin and meat quality, early sexual maturity, resistance against common diseases and short kidding interval (Devendra and Burun, 1983; Islam *et al*., 1991; Singh *et al*., 1991; Husain, 1993; Bathaei and Leroy 1996). More than 98% of Black Bengal goat is being reared in the traditional village system in Bangladesh (Husain *et al*., 1998). In this situation, community-based breeding program may play a vital role for the genetic improvement of Black Bengal goat. Goat raisers castrate almost all the male kids at an earlier age for economic and social reasons. Consequently, availability of breeding bucks becomes squeezed. Therefore, Artificial insemination (AI) has remained the main vehicle for rapid dispersal of desirable genes. AI has gained widespread acceptance in the dairy cattle throughout the world and now-a-days also become popular in Bangladesh. Globally more than 100 million AI in cattle, 40 million in pigs, 3.3 million in sheep and 0.5 million in goats are performed annually (Donovan and Hanrahan, 1999). But AI has not yet such universal acceptance in the goat breeding industries (Evans and Maxwell, 1987). The use of AI in small ruminants is very limited. However, the interest in goat AI is increasing day by day due to the lack of breeding bucks throughout the country. It is important to state that significant amount of work using frozen semen has been done under farming condition with satisfactory result. But information on performances of Black Bengal goat using frozen semen in Bangladesh is very limited. From that stand point the present study was designed to investigate the performances of Black Bengal goat using frozen semen under community based rearing production system in Bangladesh.

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Materials and Methods

Location of the experiment

The present experiment was conducted from July 2014 to October 2015 at Bhabkhali village of Mymensingh in Bangladesh.

Management of the experimental animal

Forty Black Bengal goats were distributed to the goat keeper as the experimental material. All the animals of this study were tagged to maintain the individual identity. The goat was reared under the community-based rearing system. The animals were dewormed by broad-spectrum anthelmintic (paraclear) twice in a year. Vaccination was done at regular basis against *Peste des Petits Ruminants* (PPR) disease.

AI with frozen semen

Heated does were inseminated with the frozen semen of selected Black Bengal bucks maintained at BAU, AI Centre. At first the does were restrained before insemination. After the doe is restrained, the semen is thawed and the insemination gun is prepared. The frozen straw removed from the liquid nitrogen tank and place it in a dish filled with warm water at 95 ºF for 10 to 15 seconds and then loaded in the AI gun. The speculum was inserted approximately 1.3 to 1.5 inches at an upward angle to prevent vaginal irritation. Then insemination gun was removed slowly.

Management of the research activities

Data of this study were recorded regularly in the data sheet. Separate data sheet for each animal was maintained for data recording. Individual ID of the farmer and goat are maintained. Goats were kept under regular supervision especially to record the birth weight of the kids within 24 hours of birth. New born kids were enrolled in the data sheet just after kidding. The birth weight of the kid were measured within 24 hours of birth with the help of digital weighing balance and recorded in the data sheet. Body weight at 3-month and 6-month age of the kids was measured in the morning before the animals were fed with the help of spring balance. Weight gain was calculated by subtracting the initial live weight from the final live weight of each goat. Each nanny goat was hand milked at every two week. Kids were kept separated from their mother over night before the milking was performed. It was measured in ml with the help of measuring cup. Milking was done at 10.00 AM.

Statistical analysis

The data generated from this experiment were entered in Microsoft Excel Worksheet, organized and processed for further analysis. Statistical analyses of all the parameters were analyzed using Statistical Analysis System (SAS) software (SAS Institute Inc., 2009) version 9.1.3 according to the following linear model. Phenotypic correlation was also measured by using SAS Software.To see the significant differences among the mean values, Duncan's multiple range test (DMRT) was performed.

Statistical model for growth

$Y_{ijk} = \mu + S_i + B_j + A_k + e_{ijk}$

Where,

Y_{ijk}=is a dependent variable (individual animal record for the trait)

μ= is the overall mean.

S_i = is the effect of sex of the kid

B_j= is the effect of birth type.

A_k= is the effect of season where [1= Winter (from November to February);
2= Summer (from March to June); 3= Rainy (from July to October)] as
described by (Husain, 1993).

e_{ijk}= is the residual error.

Statistical model for milk production

$Y_i = \mu + L_i + e_i$

Where,

Y_i=is a dependent variable (individual animal record for the animal).

μ = is the overall mean.

L_i = is the effect of the litter size of the kid.

e_i=is the residual error.

Statistical model for reproductive traits

$Y_{ijk} = \mu + S_i + B_j + A_k + e_{ijk}$

Where,

Y_{ijk}=is a dependent variable (individual animal records for the animal).

μ= is the overall mean.

S_i = is the effect of sex of the kid

B_j= is the effect of birth type.

A_k= is the effect of season

e_{ijk}=is the residual error.

The heritability and genetic correlations among the body weight at different age of kids were also analyzed using Variance Component Estimation (VCE) software version 4.2.5 (Groeneveld, 1998). The models used to estimate genetic parameters included random effects and all fixed effects that were found significant in the least-squares analysis. The genetic correlations between traits were estimated by using intra-class correlation method.The model was fitted for genetic correlations as follows:

Y= Xb + Za + e

Where,

Y= vector of observations;

B= vector of fixed effects;

a= vector of random animal effects (direct genetic);

X= incidence matrix for fixed effects;

Z= incidence matrix for random effects and

e= vector of random residual effects.

It was assumed that all effects in the models are independent and normally distributed.

Results

The data generated from this experiment were used for this study. The results are obtained by analyzing the data of the study are given below:

Table 1. Productive performance of Black Bengal goat ignoring other effects

Parameter	Mean ± SE (Total number of observation)
Birth weight (kg)	0.96 ± 0.01 (49)
3-month body weight (kg)	4.25 ± 0.06 (35)
6-month body weight (kg)	7.04 ± 0.12 (35)
Average daily gain at 3-month (g)	36.51 ± 0.64 (35)
Average daily gain at 6-month (g)	31.29 ± 0.98 (35)
Average daily milk yield up to 2-month (ml)	247.80 ± 3.13 (10)

The Table 2 shows the effect of different factors of sex of kids, birth type, and season on the birth weight, 3- and 6-month body weight of the Black Bengal goat. The effect of the sex of the kids on birth weight was significant ($p<0.01$). The male kids were significantly heavier than female kids. The effect of birth type was significant ($p<0.01$) on the body weight at birth. Single and twin kids were significantly heavier than triplet kids.

Table 2. Effect of different factors on the birth, 3-and 6-month weight of the goats

Factor	Birth weight	3-month weight	6-month weight
Sex of kid	**	**	NS
Male	$0.99^{a} \pm 0.01$	$4.35^{a} \pm 0.05$	$7.00^{a} \pm 0.26$
Female	$0.8^{b} \pm 0.01$	$3.90^{b} \pm 0.12$	$6.98^{a} \pm 0.14$
Litter size	**	**	NS
Single	$1.09^{a} \pm 0.02$	$4.64^{a} \pm 0.17$	$7.66^{a} \pm 0.36$
Twin	$0.95^{b} \pm 0.01$	$4.36^{ab} \pm 0.10$	$7.36^{a} \pm 2.0$
Triplet	$0.90^{c} \pm 0.00$	$4.15^{b} \pm 0.09$	$6.87^{a} \pm 0.19$
Season	**	NS	NS
Winter	$1.10^{a} \pm 0.04$	$4.33^{a} \pm 0.11$	$7.10^{a} \pm 0.21$
Summer	$0.94^{b} \pm 0.01$	$4.17^{a} \pm 0.08$	$6.95^{a} \pm 0.15$
Rainy	$0.96^{b} \pm 0.02$	$4.55^{a} \pm 0.05$	$7.21^{a} \pm 0.10$

Different symbols indicate *, significant ($p<0.05$), **, significant ($p<0.01$), NS, Non-significant ($p>0.05$). Means with different superscripts within each column differed significantly ($p<0.01$).

On the other hand, season of birth had significant ($p<0.01$) effect on the body weight at birth. The kids born in the winter season were significantly heavier than other seasons. The effect of sex of the kids at 3-month weight was significant ($p<0.05$). The male kid at the same stage was also significantly heavier than female kid. The effect of birth type was significant ($p<0.05$)

Table 3. Effect of sire on different growth traits of Black Bengal goat

Buck ID	Body weight (kg)		
	Birth weight	3-month weight	6-month weight
68	$0.94^{b} \pm 0.02$	$4.05^{b} \pm 4.05$	$7.11^{a} \pm 0.24$
69	$1.02^{a} \pm 0.02$	$4.50^{a} \pm 0.12$	$7.03^{a} \pm 0.35$
73	$0.93^{b} \pm 0.01$	$4.16^{b} \pm 0.10$	$7.08^{a} \pm 0.22$
81	$0.95^{b} \pm 0.02$	$4.27^{ab} \pm 0.11$	$6.99^{a} \pm 0.21$
Significance level	*	*	NS

Different symbols indicate *, significant ($p<0.05$), **, significant ($p<0.01$), NS, Non-significant ($p>0.05$). Means with different superscripts within each column differed significantly ($p<0.01$).

Considering the body weight at 3-month, single and twin kids were significantly heavier than triplet kids. On the other hand, season of birth had no significant effect on the body weight at the 3-month of age. The effect of birth type,

season of birth and the sex of the kids had no significant effect on the body weight at the 6-month of age. The variations in the body weight of progeny of different bucks were found significant ($p<0.05$) at birth and 3-month of age. At birth and 3-month of age, the highest birth weight (1.02 ± 0.02 kg) and body weight (4.50 ± 0.12 kg) was found of the progeny for the buck bearing ID 69. The effect of buck had no significant effect on the 6-month body weight.

Table 4. Effect of litter size on the average milk yield of the does

Factor	Daily milk yield (ml)
Litter size	*
Single	241.00^{a}±4.0
Twin	261.33^{b}±3.8

Different symbols indicate *, significant ($p<0.05$), **, significant ($p<0.01$), NS, Non-significant ($p>0.05$). Means with different superscripts within each column differed significantly ($p<0.01$).

Table 4 shows the effect of birth type on the milk production of the Black Bengal goat. Birth type had significant ($p<0.05$) effect on the daily milk yield of the does. Single kidded dams were inferior in milk yield compared to twin kidded dams.

Table 5. Reproductive performance of Black Bengal goat

Parameter	Mean ± SE (Total number of observation)
Litter size	1.81 ± 0.10 (27)
Service per conception	1.44 ± 0.097 (35)
Gestation period (days)	145.33 ± 6.49 (27)
Kid mortality (%)	19.65 (61)
Conception rate (%)	40.0 (70)
Age at first heat (days)	200.60 ± 2.83 (15)
Weight at first heat (kg)	7.69 ± 1.97 (15)

Table 6. Effect of season on the average litter size of the does

Factor	Litter size
Season	**
Winter	2.01^{a} ±0.10
Summer	2.07^{a} ± 0.08
Rainy	1.00^{b} ± 0.21

Different symbols indicate *, significant ($p<0.05$), **, significant ($p<0.01$), NS, Non-significant ($p>0.05$). Means with different superscripts within each column differed significantly ($p<0.01$).

Table 6 shows the effect of season on the average litter size of the Black Bengal goat. The effect of the season on the average litter size of the Black Bengal goat was significant ($p<0.01$). The highest average litter size was found in the summer followed by winter and rainy season.

Table 7. Effect of different factors on the average gestation period

Factor	Gestation period (days)
Sex of kid	Non significant ($p>0.05$)
Male	145.08^{a} ± 0.59
Female	145.69^{a} ± 0.55
Litter size	Non significant ($p>0.05$)
Single	145.14^{a} ± 1.69
Twin	145.88^{a} ± 0.72
Triplet	142.5^{a} ± 1.5
Season	Non significant ($p>0.05$)
Winter	145.00^{a} ±1.05
Summer	145.66^{a} ± 0.92
Rainy	144.50^{a} ± 2.50

Table 7 shows the effect of different factors of sex, litter size, season on the average gestation period of the Black Bengal goat. The effect of the sex, birth type and season on the average gestation period was not significant. The average conception rate using frozen semen of the Black Bengal bucks in the selected area was found 40%. The highest conception rate was found 43.75% for the buck bearing ID 69 followed by 73, 68, and 81buck ID.

Table 8. Conception rate using frozen semen of the Black Bengal goat

Buck No	Number of does inseminated	Number of does conceived	Conception rate (%)
68	15	6	40.00
81	17	6	35.29
73	22	9	40.90
69	16	7	43.75
Level of significance			(P>0.05)

Moreover, heritability values were estimated for the traits of birth weight, 3-month and 6-month weight and the valued were (0.21 ± 0.03), (0.36 ± 0.07), and (0.12 ± 0.05) for the birth weight, 3-month and 6-month weight, respectively. The estimate heritability for live weight ranged from 0.12 to 0.21 except that for three month (0.36). The values for birth weight and 3-month weight were moderate.

Table 9. Genetic (above the diagonal) and phenotypic correlations (below the diagonal) among the birth weight, 3- and 6-month body weight

Parameter	Birth weight	3-month weight	6-month weight
Birth weight		0.65	0.45
3-month weight	0.52		0.35
6-month weight	0.44	0.49	

The estimated genetic correlations for live weight ranged from 0.35 to 0.65 and phenotypic correlations for live weight ranged from 0.44 to 0.52 (Table 9).

DISCUSSION

Productive traits

Birth weight

The average birth weight of the kids was 0.96±0.01 kg and the result is in agreement with the findings of Husain *et al.* (1996) who reported that the birth weight of Black Bengal kids in Mymensingh, Trisal, Tangail was 1.01 kg. Bhowmik*et al.* (2014) and Mia (2011) reported the similar birth weight of the Black Bengal kids as 0.89±0.09 and 1.01 kg, respectively. Haque(2014) showed that the average birth weight of Black Bengal kids at BAU, Modhupur, and Dimla were 1.08±0.09, 1.21±0.07 and 0.98±0.02 kg, respectively.

Body weight at 3- and 6-month

The average body weight at 3-month of age was 4.25±0.06 kg which is almost similar with the results of Alam (2006), Fayjul (2014) and Rahman (2007) who reported 4.17, 4.67±0.15 and 4.26±0.25 kg, respectively. Alam (2006) and Dhara*et al.* (2011) reported that the average body weight at 6-month of age was 6.78 and 7.27 kg, respectively which is similar with the result of 7.04 kg in this present study.

Average daily gain

In this present study, the average daily gain were found 36.51±0.64 and 31.29±0.98 (g/d) from birth to 3-month and 3- to 6-month, respectively which is quite similar with the result of 43.29±1.82 and 39.50±1.91 (g/d) reported by Husain *et al.* (1996). Nazim*et al.* (2014) worked on five categories of Black Bengal goat and found that the average daily gains of Black Bengal goats were 39.00, 35.24, 42.21, 37.13 and 38.95 (g/d), respectively which was almost identical with the results of the present study.

Effect of the fixed factors

Sex

The male kids were heavier than the female kids from birth to3-month of age and the difference between two sex were significant ($p<0.01$). The result was in agreement with the findings of Husain *et al.* (1996) and Islam *et al.* (2009). The higher body weight of males compared to females at all the stage might be due to feeding and suckling ability of the male kids and male sex hormone which has an anabolic effect (Hafez, 1993). The heavier body weight of male than female kids may also be due to the difference in their endocrine system.

Type of birth

The effect of type of birth was significant on the body weight ($p<0.01$) at birth and 3-month of age. Single and twin kids were heavier than triplet at birth and these results are similar with Hyder*et al.* (2002) and Roy *et al.* (2007). Single born kids maintained their highest weight followed by twin and triplet for all the periods from birth to 3-month and 3-month to 6-month of age. These results are also agreed with the results of Neru*et al.* (2002), Akter*et al.* (2000) and Husain *et al.* (1996). Probably the birth weight of the kids may differ due to intra uterine environment where single kids get higher nutrient and space. The uterine space and the nutrient availability shared by more than one kids may be responsible for the reduction of the birth weight with increasing litter size which reflect also in the subsequent body weight of kids.

Birth season

The effect of season on birth weight was significant ($p<0.01$). The kids was born in the winter season were significantly ($p<0.01$) heavier than other seasons which is quite similar with the findings of Hyder*et al.* (2002) who reported that the birth weight vary due to the year and season. The winter born kids were heavier (1.46±0.06 kg) than summer born kids (1.42±0.06 kg). Season of birth plays an important role in the growth performance of the kids indirectly through

the influence of the dam nutrition that means the availability of green grass and hence the availability of milk.

Daily milk yield

In the present study, the average daily milk yield was found 247.80±3.13 (ml/d) which is comparable to the results of Husain (1993), Bhowmik*et al.* (2014), Haque (2014), Alam(2006) and Islam *et al.* (2009) whose values were 221, 158.82±40.45, 275.75±25.22, 214.44, and 162±0.003 (ml/d), respectively. In this study, single kidded dams were inferior in milk yield compared to twin kidded dams which is quite similar with the result of Zinat (2012). Constantinou*et al.* (1985) stated that it is the stimulus provided by the suckling kids that increase milk production to some extent.

Reproductive traits

Litter size

In this study it was found that, the average litter size of Black Bengal goats was 1.81±0.1 which is almost similar with the results of Haque (2014), Mia (2011) and Amin *et al.* (2000) whose values were 1.6, 1.5, and 1.86, respectively.

Gestation length

The average gestation period in the present study was 145.33±6.49 days which are almost similar with the result of Husain (1993), Verma *et al.* (1991), Bhowmik*et al.* (2014), Chowdhury*et al.* (2002), Dhara*et al.* (2011), Haque (2014), Khan *et al.* (2013) and Mia (2011). Sex, birth type and season had no significant effect on the gestation period which is also similar with the result of Faruque*et al.* (2010) who reported that the parity, generation, rearing system, season, had no significant ($p>0.05$) effect on gestation length.

Service per conception

Ahmed (2006), Chowdhury*et al.* (2002) and Alam (2006) reported that the average number of service required for conception were 1.59±0.69, 1.45±0.3 and 1.57±0.14, respectively which are almost relevant with the result of the present finding as 1.44±.09 in Black Bengal goat.

Age at first heat

The average age at first heat of the kids was 200.60±2.83 days which are in agreement with the findings of Khan *et al.* (2013) and Bhowmik*et al.* (2014).

Body weight at first heat

The average weight at first heat of the kids was found 7.69±1.97 kg that is significantly lower from the finding of Faruque*et al.* (2010) who showed that the body weight (kg) at first heat in Black Bengal goat was 9.62±0.76 and 9.34±0.62 kg, respectively under intensive and semi-intensive rearing system.

Kid mortality

The kid mortality rate of Black Bengal goat up to 3-month of age was 19.65% that was almost comparable with the findings of Husain, (1999), Islam *et al.* (2009), Hasan*et al.* (2014), Khan *et al.* (2013) and Tsedeke (2007) who found that the kid mortality of Black Bengal goat were 17, 14.28, 15.0±0.50, 26.06 and 12.2%, respectively under scavenging system.

Conception rate

The average conception rate of Black Bengal goats using frozen semen was 40%. Apu (2007), Gacitua and Arav (2005), Donovan *et al.* (2004), Stefanov*et al.* (2006),Arrebola*et al.* (2012) and Mehmood*et al.* (2011) observed that the average conception rates of goats using frozen semen were 39.64%, 42.1%, 42.86 to 53.33%, 48.7% and 44.4%, respectively which support the finding of the present study.

Estimate of heritability

The heritability estimate for the birth weight, 3-month and 6-month weight obtained in this study was comparable with the results of Akter*et al.* (2006), Amin (2000), and Singh *et al.* (1991) whose values were 0.26±0.09, 0.30±0.16 and 0.16±0.12, respectively. The estimate of heritability for 3-month weight was also comparable with the results of Mia, (2011) whose value was 0.47±0.05. The estimate heritability for 6-month weight was similar with the findings of Singh *et al.* (1991) which was 0.13±0.07. The large variation among heritability estimates may be due to different breeds and ages of animals regarded, but also the different models used for parameter estimation and size of data structure (Gredler*et al.,* 2007).

Genetic and phenotypic correlations among the body weight

The estimate of genetic and phenotypic correlations among the body weight between birth to 3-month weight, birth to 6-month weight, 3-month weight to 6-month weight were 0.65, 0.45, 0.35 and 0.52, 0.44, 0.49, respectively which is comparable with the findings of Haque, (2014) and Mia (2011). Strong phenotypic correlations were found between birth to 3-month weight (0.52) and genetic correlations were found between births to 3-month weight (0.65). The positive and high genetic and phenotypic correlations between 3-month and 6-month weight indicate that the selection of kids at 3-month weight would increase body weight at later stage of life.

Conclusion

It is revealed from the study that the productive and reproductive performance of Black Bengal goat was satisfactory using frozen semen at the community level.It will be possible to improve the performance of Black Bengal goat and frozen semen could be the effective alternative source against the acute shortage of bucks in the community-based rearing system.However, further study on this regard is suggested for authentic conclusion.

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