Comparison of phenotypic characterization, productive and reproductive performance of pure black bengal and crossbred goat

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ABSTRACT

The study was conducted between Pure Black Bengal (PBB) and crossbred (CBB) goat to compare the phenotypic features, morphometry, production and reproduction performance. A total number of 87 goats from which 26 PBB goats from Government Goat Development Sub center, Jhenidah and 61 CBB goats from Alamdanga Upazila and Jhenidah Sadar Upazila were collected for this study from November 2019 to January 2020. Prominent coat color was black in both PBB and CBB but in case of 55.74% CBB has long hair in its hind quarter but it was totally absent in PBB. The average value of morphometric measurements was compared between sex and age. The result indicated that, the height of wither and rump, length of horn, ear, head and scrotum were higher (p<0.05) in CBB (77.57, 75.03, 12.17, 23.16, 22.33 and 12.98cm, respectively) than PBB buck (58.93, 61.47, 10.97, 13.00, 17.78 and 9.86cm, respectively). The measurement between the does indicated that the horn length was higher (P<0.001) in PBB doe but ear length was higher (p<0.01) in CBB than PBB. In case of kids, height of wither, heart girth and ear length was higher (p<0.01) in CBB (36.9, 31.39 and12.7cm, respectively) than PBB (30.48, 24.77 and 7.8cm, respectively). The average milk production of PBB (390.44 ml/day) was significantly (p<0.01) lower than CBB (1045.01 ml/day) but the litter size was significantly (p<0.05) higher in PBB (2.30) than CBB (1.77). The age of puberty, age of first kidding and kidding interval were better (P<0.01) in PBB (205.30, 355.5 and 200.30 days, respectively) than CBB (275.92, 401.5and 273.77 days, respectively). The study revealed that the morphologic and morphometric characteristics were higher in CBB and quiet altered from PBB due to indiscriminate cross breeding and the reproductive performance were better in PBB in comparison with CBB. These data may help in identifying current status of Black Bengal goat and contribute to in situ conservation of the breed.

INTRODUCTION

Bangladesh, an agricultural country, where agriculture plays a major role in the national economy with contribution of around 14.2% in GDP (DLS, 2019). Livestock is one of the major components of agriculture and it contributes about 1.47% of overall GDP (DLS, 2019). Total livestock population of Bangladesh is 402.56 million in which goat population is 26.24 million (DLS, 2019). Goat ranks second position in meat and skin production representing 38% and 28% respectively of the total livestock in Bangladesh (FAO, 2003). Total income from hides, skin and

leather was 19045 million taka (0.69% total export commodities) (Bangladesh Statistics, 2017).

The goats are to be popular for its high adaptability, higher disease resistance, fertility, prolificacy, early sexual maturity, larger litter size, delicious meat and superior skin quality (Saadullah, 1991; Husain et al., 1996, 1998). Goat has been described as a poor man's cow because of its immense contribution to the poor man's economy. Goat rearing is the most useful way of women earning those who are staying at home (Siddiky, 2017). Bangladesh has only one goat breed of its own, known as the Black Bengal. It is estimated that more than 90% of the goat

population in Bangladesh comprised the Black Bengal, the reminder being Jamunapari and their crosses (Husain, 1993). Black Bengal goat having some outstanding features like higher prolificacy, superior litter size, seasonality besides it produces excellent quality flavored, tender, delicious meat with low intramuscular fat and extraordinary skin quality for which there is a high demand all over the world (Husain, 1993; Islam et al., 1991). It plays a vital role in the economy of Bangladesh by contributing 1.66% of the GDP (DLS, 2017). Jamunapari goats are multi-purpose animals, producing meat, milk, skin and hair (Amin et al., 2001). The number of this breed in Bangladesh is unknown but it has been estimated that 8-9% goats are Jamunapari and are found in Chuadanga, Meherpur, Kushtia, Jhenidah and Jashore district (Faruque and Khandoker 2007, Siddiky, 2017).

In Bangladesh most of the farmers used natural mating system to serve their does. The majority of goat keepers (70.7%) used village buck to inseminate their does and most of the farmers (73.2%) paid service charge to the buck keepers while most of the farmer (80.5%) did not keep bucks for breeding (Hossain et al., 2015). Bangladesh Livestock Research Institute (BLRI) trying to improve the performance of Black Bengal goat through selective breeding and open nucleus breeding system (ONBS). In spite of, some cross breeding observed in Bangladesh. The parents are mainly Black Bengal and Jamunapari (Siddiky, 2017). Currently some other crosses are also found in the country. Bucks of some other exotic breeds are being imported (mainly illegal trade) from India and used for cross breeding especially south-western region of Bangladesh (Siddiky, 2017). Although, National Livestock Development Policy, 2007 is not support any cross breeding with Black Bengal goat.

One of the difficulties in conserving a genetic resource is the lack of its characterization and knowledge of the best production system for raising it (Chacan et al., 2011) Black Bengal is an important genetic resource of Bangladesh that it eroding rapidly due to indiscriminate cross breeding. The situation is arising as a result of lack of commodity awareness, lack of technical expertise, poor marketing system, and limited support services. Cross breeds are randomly observed now a days in markets but due to scarcity of reporting we don't know about the current status. Phenotypic characterization is therefore an important step in conservation program for breed identification and classification in ways that farming communities could be related (Dossa et al., 2007; Mwacharo et al., 2006). According to FAO (2008), phenotypic characterization of AnGR is the process of identifying distinct breed populations describing their external and production characteristics in a given environment and under given management, taking into account the social and economic factors affecting them. That is why this study was undertaken to study the morphological characteristics, productive and reproductive performance of pure Black Bengal goat (PBB).

MATERIALS AND METHODS

Location of the experiment

The study was conducted at the selected area of Alamdanga upazila, Jhenidah sadar upazila and Jhenidah Government Goat Farm in the period of November 2019 to January 2020.

Selection of experimental goat

Sixty-one (61) crossbred Black Bengal (CBB) goats of both sex from different farm and household of the upazila of Alamdanga and Jhenidah sadar upazila and twenty-six (26) pure Black Bengal (PBB) goats of both sexes from Government Goat Development Sub center, Jhenidah were randomly selected for this study. The goat's selection was done on the basis of 5 categories (doe, buck, wither, kids before and after weaning).

Trait analyzed

A questionnaire was developed according to FAO (2012) animal health and production guideline. The qualitative, productive and reproductive data was collected by personal interaction with the owner of goat and goat farm attendant.

Qualitative and quantitative variables

Sex, coat color pattern, hair type, ear orientation, and presence of horn and long hair in hind quarter.

The body part measurement was described by FAO descriptor tool (2008).

Trait	Description
Body length	Measured as the distance between the anterior point of the shoulder to the posterior extremity of the pin bone.
Heart girth	Circumferential measure taken around the chest just behind the front legs and withers.
Height at wither	Measured from the highest point of the withers vertically to the ground with the animal standing with its feet placed squarely on the level of ground.
Rump height	Distance from the surface of a platform to the rump.
Ear length	Distance from the point of attachment to the tip of ear.
Tail length	Measured from the base of the tail to the end of the coccygeal vertebra.
Horn length	Measured from the temple of the head to the tip of the horn.
Neck circumference	Measured as the circumference of the neck at the midpoint.
Head length	Measured from the base of the tail to the end of the coccygeal vertebra.
Scrotal circumference	Recorded by pulling the testes firmly down into the lower part of the scrotum and placing the measuring tape around the widest point.
Scrotal length	Measured from the base of scrotum to the tip.

The height measurement (inch) was performed using a graduated measuring rule while length measurement (inch) was taken using a measuring tape. All measurements were carried out by same person in order to avoid between individual variations.

Body weight measurement:

$$\frac{Bodylength \times (Heartgirth)2}{660} = kg$$

Productive and reproductive traits

The following traits were used to measure the productive and reproductive performance of PBB and CBB goats- birth weight of kids, litter size, gestation period, kidding interval, age of puberty, milk production and age of first kidding.

Statistical Analysis

The obtained data were cleaned, loaded and stored on the Excel spread sheet 2007. Then the data of quantitative variables was arranged and transferred to the software SAS (Statistical Analysis Software) to calculate the Mean and Standard Error (SE) of both genotypes and paired T-test was performed to know significance level between genotypes for different traits. Duncan's Multiple Range Test was used to determine the significant differences between means.

RESULT

Morphological characteristics

The frequency of different morphological features of CBB and PBB goat are summarized in Table 1. Coat color was found black, black and white, white, brown, brown and white but black color was most prominent in both CBB (59.01%) and PBB (96.15%) goat. The hair type was found glossy, smooth, straight long hair, curly rough hair and dull hair type was mostly found in both CBB (39.34%) and PBB (50%).

Table 1: Morphological characteristics of CBB and PBB goat

Traits	Characteristics features	No. of observation		Frequency (%)	
		CBB (N=61)	PBB (N=26)	CBB (%)	PBB(%)
Coat color	Black	36	25	59.01	96.15
	Black & White	9	1	14.75	3.84
	White	0	0	0	0
	Brown	2	0	3.27	0
	Brown &White	14	0	22.95	0
Hair type	Glossy	23	8	37.70	30.77
	Smooth	11	5	18.03	19.23
	Straight long	2	0	3.27	0
	Curly rough	1	0	1.64	0
	Dull	24	13	39.34	50.00
Horn presence	Present	56	24	91.80	92.31
	Absent	5	2	8.20	7.69
Ear orientation	Erect	4	24	6.56	92.30
	Semi pendulous	3	2	4.91	7.69
	Pendulous	54	0	88.52	0
Presence of long hair in hind quarter	Present	27	0	44.26	0
	Absent	34	26	55.74	100.0

CBB - Crossbred Black Bengal, PBB - Pure Black Bengal

More than 91% goats had horn of both genotypes. But ear orientation was mostly found pendulous (88.52%) in CBB and erect (92.30%) in PBB goat. Long hair in hind quarter is absent in PBB but present in CBB (55.74%) goat.

Morphometric characteristics of doe

Morphometric characteristics of CBB and PBB doe are presented in Table 2. In this study, the average horn length, ear length of CBB and PBB were found to be 4.85, 17.48cm, respectively and 9.83, 13.26cm, respectively. Horn length was significantly higher (p<0.001) in PBB while the ear length was found higher (p<0.01) in CBB does. On the other hand, other traits did not differ significantly between the genotypes.

Table 2: Measurement of different body parts of CBB and PBB does at the age of 1-3.5 years

Trait	Mean ± SE		Significance level
	CBB (N=13)	PBB (N=10)	
Body weight (kg)	22.00±1.40	21.29±2.15	NS
Body length (inch)/(cm)	21.77±.0.58/(55.30)	21.90±0.83/(55.63)	NS
Height of wither (inch) /(cm)	23.73±0.49/(60.27)	22.90±0.83/(58.17)	NS
Heart girth (inch) /(cm)	25.38±0.55/(64.47)	24.80±0.83/(62.0)	NS
Horn length (inch) /(cm)	1.91[b]±0..28/(4.85)	3.87[a]±0.45/(9.83)	***
Ear length (inch) /(cm)	6.88[a]±0.41/(17.48)	5.22[b]±0.07/(13.26)	**
Rump height (inch) /(cm)	23.35±0.36/(59.31)	22.50±0.72/(57.15)	NS
Head length (inch) /(cm)	7.5±0.18/(19.05)	7.09±0.14/(18.01)	NS
Tail length (inch) /(cm)	4.69±0.18/(11.91)	4.25±0.30/(10.80)	NS
Neck circumference (inch) /(cm)	12.04±0.42/(30.58)	12.70±.56/(32.26)	NS

CBB - Crossbred Black Bengal, PBB- Pure Black Bengal, SE-Standard Error, Row wise different superscript letters denote significant level at **p<0.01, ***p<0.001, NS – Non significant

Productive and reproductive performances of doe

Different reproductive performances of CBB and PBB are illustrated in Table 3. Average milk production, age of puberty and kidding interval were significantly higher (p<0.01) in CBB than PBB does. Similarly, age of first kidding was significantly higher (p<0.05) in CBB than those of PBB does. Whereas, the litter size was found to be higher (p<0.05) in PBB than CBB does. However, gestation length and birth weight of kids did not differ significantly between the genotypes.

Table 3: Reproductive and productive performance of CBB and PBB at the age of 1-3.5 years

Parameter	Mean ± SE		Significance level
	CBB (N=13)	PBB (N=10)	
Gestation length (days)	146.38±0.78	146±.70	NS
Milk production (ml/day)	1045.01[a]±66.96	390.44[b]±9.67	**
Birth weight of kids (gm)	854.25±161.33	850.00±4.14	NS
Age of puberty (days)	275.92[a]±20.56	205.30[b]±5.00	**
Age of first kidding (days)	401.5[a]±15.5	355.5[b]±9.8	*
Kidding interval (days)	273.77[a]±21.66	200.30[b]±5.00	**
Litter size (no.)	1.77[a]±0.20	2.30[b]±.015	*

CBB - Crossbred Black Bengal, PBB - Pure Black Bengal, SE-Standard Error, Row wise different superscript letters denote significant level at**p<0.01, *p<0.05, NS – Non significant

Table 4: Measurement of different body parts of CBB and PBB buck at the age of 1-3.5 years

Trait	Mean ± SE		Significance level
	CBB (N=12)	PBB(N=5)	
Body weight (kg)	40.06±5.30	31.52±2.73	NS
Body length (inch)/(cm)	26.29±1.19/(66.78)	24.00±.70/(60.96)	NS
Height of wither (inch) /(cm)	30.54[a]±1.47/(77.57)	23.20[b]±1.28/(58.93)	**
Heart girth (inch) /(cm)	30.83±1.37/(78.31)	29.30±0.85/(74.42)	NS
Horn length (inch) /(cm)	4.79±0.48/(12.17)	4.32±.09/(10.97)	NS
Ear length (inch) /(cm)	9.12[a]±0.88/(23.16)	5.12[b]±0.19/(13.00)	*
Rump height (inch) /(cm)	29.54[a]±1.28/(75.03)	24.20[b]±1.28/(61.47)	*
Head length (inch) /(cm)	8.79[a]±0.27/(22.33)	7.00[b]±0.65/(17.78)	**
Tail length (inch) /(cm)	5.01±0.22/(12.73)	5.58±0.16/(14.17)	NS
Neck circumference (inch) /(cm)	16.83±0.63/(42.75)	16±0.50/(40.64)	NS
Scrotal circumference (inch) /(cm)	8.22±0.29/(20.88)	8.28±0.10/(21.03)	NS
Scrotal length (inch) /(cm)	5.11[a]±0.24/(12.98)	3.88[b]±0.12/(9.86)	**

CBB - Crossbred Black Bengal, PBB - Pure Black Bengal, SE - Standard Error, Row wise different superscript letters denote significant level at**p<0.01, *p<0.05, NS – Non significant

Morphometric parameters of buck

The morphometric parameters of CBB and PBB buck are shown in table 4. Average height of wither, head and scrotal length of CBB and PBB were77.57, 22.33, 12.98cm, respectively and 58.93, 17.78, 9.86cm,respectively. These parameters were higher (p<0.01) in CBB than PBB buck. Similarly, ear length and rump height were higher (p<0.05) in CBB than those of PBB buck. However, some parameters like body weight, neck circumference did not differ significantly between the genotypes.

Morphometric parameters of kids (before weaning)

The morphometric parameters of kids (before weaning) are reflected in Table 5. The average body weight, birth weight, ear length, heart girth, and wither height of CBB and PBB were found to be 2.76kg, 1086.36 gm, 12.7, 31.39, 36.93cm, respectively and 1.99 kg, 883.33 gm, 7.82, 24.77, 30.48cm,respectively.Remarkable

difference was found in ear length, where it was significantly higher (p<0.001) in CBB than PBB kids. Similarly, height of wither and heart girth were significantly higher (p<0.01) in CBB than

PBB kids. Though, body weight and birth weight shows difference apparently but those traits did not differ significantly between the genotypes.

Table 5: Measurements of different body parts of CBB and PBB upto 60 days of age

Trait	Mean ± SE		Significance level
	CBB (N=11)	PBB (N=6)	
Body weight (kg)	2.76±0.30	1.99±0.42	NS
Body length (inch) /(cm)	11.63±0.62/(29.54)	13.13±0.56/(33.35)	NS
Height of wither (inch) /(cm)	14.54[a]±0.67/(36.93)	12.00[a]±0.28/(30.48)	**
Heart girth (inch) /(cm)	12.36[a]±0.53/(31.39)	9.75[b]±0.70/(24.77)	**
Ear length (inch) /(cm)	5.00[a]±0.29/(12.7)	3.08[c]±0.90/(7.82)	***
Rump height (inch) /(cm)	13.76±o.75/(34.95)	12.33±0.42/(31.32)	NS
Head length (inch) /(cm)	3.95±0.22/(10.03)	3.60±0.10/(9.14)	NS
Tail length (inch) /(cm)	2.82±0.22/(7.16)	2.26±0.13/(5.74)	NS
Neck circumference (inch) /(cm)	6.50±0.38/(16.51)	7.71±0.58/(16.51)	NS
Birth weight (gm)	1086.36±153.16	883.33±61.46	NS

CBB - Crossbred Black Bengal, PBB - Pure Black Bengal, SE - Standard Error, Row wise different superscript letters denote significant level at**p<0.01, ***p<0.001, NS – Non significant

Morphometric parameters of kids (after weaning)

The body parameters of kids (after weaning) are given in table 6. The mean value of body weight, ear length, heart girth, rump height, head length, tail length, neck circumference of CBB were 10.09 kg, 17.63, 49.66, 43.59, 13.56, 8.41, 21.31cm, respectively and in PBB were 10.56 kg, 13.16, 50.44, 43.82,14.07, 8.64, 22.76cm, respectively. The only statistically significant (p<0.05) parameter was ear length that was higher in CBB than PBB. After all, the trends of all parameters were similar to the parameters of kids before weaning.

Table 6: Measurement of different body parts of CBB and PBB kids (after weaning) at the age of 2-6 month

Trait	Mean ± SE		Significance level
	CBB (N=09)	PBB (N=05)	
Body weight (kg)	10.09±2.14	10.56±2.02	NS
Body length (inch) /(cm)	15.33±1.36/(38.94)	16.88±1.44/(42.88)	NS
Height of wither (inch) /(cm)	16.88±1.17/(42.88)	16.60±1.50/(42.16)	NS
Heart girth (inch) /(cm)	19.55±1.19/(49.66)	19.86±1.05/(50.44)	NS
Ear length (inch) /(cm)	6.94[a]±0.36/(17.63)	5.18[b]±0.37/(13.16)	*
Rump height (inch) /(cm)	17.16±1.6/(43.59)	17.25±1.5/(43.82)	NS
Head length (inch) /(cm)	5.34±0.28 /(13.56)	5.54±.25/(14.07)	NS
Tail length (inch) /(cm)	3.31±.19/(8.41)	3.40±0.36/(8.64)	NS
Neckcircumference(inch) /(cm)	8.39±0.46 /(21.31)	8.96±0.64/(22.76)	NS

CBB - Crossbred Black Bengal, PBB - Pure Black Bengal, SE - Standard Error, Row wise different superscript letters denote significant level at*p<0.05, NS – Non significant

Body parameters of CBB wither (Castrated goat)

The body parameters of CBB wither are presented in table 7. The average value of body weight, body length, height of wither, heart girth, horn length, ear length, rump height, head length, tail length, neck circumference were25.45 kg57.40, 66.55, 68.33, 5.97, 18.29, 67.13, 19.10, 11.30, 68.33cm, respectively.

Table 7: Measurement of different body parts of CBB wither (castrated goat) at the age of 9-40 months

Trait	Mean ± SE
Body weight(kg)	25.45±2.01
Body length(inch)/(cm)	22.6±0.08/(57.40)
Height of wither(inch)/(cm)	26.2±0.54/(66.55)
Heart girth(inch)/(cm)	26.9±0.67/(68.33)
Horn length(inch)/(cm)	2.35±0.18/(5.97)
Ear length(inch)/(cm)	7.2±0.17/(18.29)
Rump height(inch)/(cm)	26.43±0.68/(67.13)
Head length(inch)/(cm)	7.52±0.17/(19.1)
Tail length(inch)/(cm)	4.45±0.28/(11.30)
Neck circumference(inch)/(cm)	26.9±0.48/(68.33)

CBB - Crossbred Black Bengal, PBB - Pure Black Bengal, SE - Standard Error

DISCUSSION

Morphometric measurements of buck

The average wither height of pure Black Bengal goat was 51.21cm reported by Rahman et al. (2008) supports the findings of this study. But, wither height was found higher in CBB buck which is not in agreement with the finding of Boer and Boer cross buck (Peter el al., 2015). This may occur due to breed variation, sample size. The cross breeds were more varied due to disorganized crossing (Chacon et al., 2011). Rahman et al. (2008) found that the average length of ear of PBB was 13cm, which is very close to the findings of current study. The ear length was higher in CBB than PBB which is supported by the finding of Chacon et al.(2011) who found similar difference in Cuban Creole goat and its cross breed. Rump height and head length of PBB of current study strongly support the results described by Paul et al. (2011) and Rahman et al. (2008). The length of head and rump height in CBB were higher than PBB in the current study is similar to the finding of Chacon et al., (2011).

Morphometric measurements of doe

The horn length of PBB doe was 9.6 cm in this study which is in agreement with the reports of Paul et al. (2011) who studied that the horn length of PBB varied from 3.6 to 13.2 cm. The horn length of CBB was lower than PBB in the current study which is not in agreement with the reports

by Peter et al. (2015) who found higher horn length in crossbred Boer than pure breed goat. That may be for breed variation and indiscriminate crossing. The ear length of PBB doe was found 11cm by Paul et al. (2011) that is slightly lower than the present study. This variation may be due to sample size, age variation in groups.

Production and reproduction potentialities of doe

The study revealed that, average age at first sign of heat appears earlier in PBB than CBB does. Early maturity was observed in Pure Black Bengal goat than crossbred goat is reported by Banerjee (2004). These findings are very close to the findings of present study. However, Miah et al. (2016) found that the maturity was 197.35 and 328.44 days in pure and crossbred Black Bengal goats, respectively. This variation occurs due to various causes like presence of buck in the herd, nutrition, availability of forages and temperature (Islam et al., 2007). The average kidding interval in CBB was higher than PBB doe in current study. Kidding interval of Black Bengal goat was lower indicating better reproductive performance in Black Bengal goat than the crossbred goat. This result is in agreement with the study of Shill et al. (2003) and Islam et al.(2007), Bhowmik et al. (2014) who studied that the kidding interval in Black Bengal and crossbred goat were 181.76 and 199.17 days, respectively. On the other hand, average birth weight of CBB and PBB were854.25 and 850.00 gm, respectively which differ from the finding of Banerjee (2004). He reported that, the birth weight of pure and crossbred were 1.5 kg and 2.0 kg, respectively under traditional farming condition of sub-continent. These variations might be due to poor nutritional status of doe during pregnancy. The average age at first kidding was 401.50 and 355.5 days in CBB and PBB does, respectively. This result agrees with the finding of Islam et al. (2007) and Bhowmik et al. *(*2014) who reported that the variation of kidding interval depends on photoperiod, kidding season and nutritional status. Average Litter size was higher in PBB (1.96) than that of CBB (1.25) found by Islam et al. (2007) which is in agreement with this study. Bhowmik et al. (2014) reported that milk yield of Black Bengal and crossbred were 158.82 and 933.33ml/day, respectively which were in

agreement with the current study. Islam et al. (2007) and Banerjee (2004) also found that the milk production was poor in Black Bengal than in crossbred does. Due to genetic factor, the milk yield of Black Bengal goats is poor (Payne, 2000).

Morphometric measurements of kids (before weaning)

The wither height, heart girth and ear length of PBB kids are partially supported by of Paul et al. (2011) who found the traits were 31.75, 35.9and 9.42cm respectively at 3 month of age. This variation may be due to age variation, sample size and nutritional status of goats in the study area. These parameters were found to be higher in CBB than PBB which do not support the findings of Peter et al. (2015) who found these parameters higher in Boer goat than its crossbred kids. The variation in the results might be due to the region of breed characteristics, crossing pattern, age variation etc.

CONCLUSION

Comparison between Pure Black Bengal and their cross in the term of phenotypic characters, productive and reproductive performance were established through the present investigation. The study revealed not only the noticeable changes in black Bengal goat due to cross breeding but also highlighted the excellent reproductive performance of black Bengal goat. However, this study gives some basic information about Black Bengal and its crossbred goats which could be utilized to characterize the pure Black Bengal and helps to prevent the national resource from eroding.

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