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Heritability and Genetic Evaluation of Black Bengal Goats for Growth Traits

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Abstract

Estimation of heritability (h^2) and its use in predicting animals' breeding are keys to selection and breeding programs aiming to livestock improvement. In this study, heritability of birth weight (BWT), weaning weight at 3-month (WWT), 6-months body weight (SMWT), and growth rates from birth to weaning (GR 1), birth to 6-month (GR 2) and weaning to 6-month (GR 3) were estimated using data collected from 607 pedigree recorded growing Black Bengal goats during 2017–2020 of Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka, Bangladesh. After basic statistical analyses, variance components and heritability were estimated using an animal model fitted in Variance Component Estimation (VCE) 4.2.5 software and then obtained heritability values were used to predict breeding values of animals for each trait with Prediction and Estimation (PEST) software. The least squares means of BWT, WWT, SMWT were 1.16±0.10, 5.55±0.05, 8.76±0.10 kg and of GR 1, of GR 2 and of GR 3 were 48.73±0.63, 41.89±0.59 and 34.57±0.91 g/day, respectively. Parity of dam, type of birth, season of birth and year of birth and some interactions among them had significant effect on growth at different stages. Parity of dam significantly affected ($p < 0.01$) birth weight only and birth weight increased with the progress of parity. Season of birth significantly influenced ($p < 0.01$) all the growth traits except BWT and similarly, type of birth had significant effect ($p < 0.01$) on all growth traits except GR 3. Year of birth had significant influence on BWT ($p < 0.001$), SMWT ($p < 0.01$) and post-weaning growth rate whereas sex had no significant effect on any of the growth traits. The heritability ± standard errors were 0.46±0.02, 0.42±0.05, 0.47±0.03, 0.43±0.04, 0.48±0.02 and 0.49±0.02 for BWT, WWT, SMWT, GR 1, GR 2 and GR 3, respectively. Estimated higher heritability's indicates that selection would be effective if based on them. The mean of predicted breeding values were 0 .0010 for BWT, 0.0013 for WWT, 0.0027 for SMWT, -0.0033 for GR 1, 0.0127 for GR 2 and -0.0011 for GR 3, respectively. The predicted breeding values of the traits on each animal could well be used in selecting candidates in the on-going Black Bengal goat improvement program.

Keywords: Black Bengal goat, growth traits, heritability, breeding value

Introduction

Goats are among the earliest domesticated animals and distributed widely to diversified climatic conditions associated with smallholder farmers all over the world. In developing countries, goat farming is working as a tool to alleviate poverty and hunger. Bangladesh is among the world's top countries for goat production and approximately two-third of the households' rear goat as primary or secondary occupation. Despite of it, per capita meat consumption is below standard requirements. Success of any meat enterprise depends largely on birth weight and pre-weaning

growth as they are strongly associated with mature weights. Growth traits are influenced by both genetic and environmental factors. Environmental influences are major determinants of growth in semi-intensive and extensive rearing system. Before implementation of any selection program, knowledge on genetic parameters and mechanism of genetic principles is required Zhang et al., 2009). Knowledge of the magnitude of the heritability and (co)variance components for traits of economic importance is critical for the genetic evaluation of animals and the development of sound breeding programs (Willham, 1980). Moreover, estimates of the additive genetic and environmental components of (co)variances are useful in designing multi-trait selection indices and accurate genetic evaluation (Mandal et al., 2008). Estimation of predicted breeding values facilitates selection of superior bucks.

Black Bengal goats are indigenous dwarf type goat breed of Bangladesh having distinct qualities of better prolificacy, high fertility, prompt sexual maturity, better resistance against common diseases, low kidding interval, delicious meat and superior skin quality. In spite of having above qualities, they are inferior in some economic traits such as birth weight, growth rates, milk yield, and kid survivability (Hossain, 2021). Researchers in different times argued that existing substantial genetic variations among individuals in the production traits of Black Bengal goats show prospects of increasing productivity through breeding approaches. One of the major approaches could be through selective breeding in the prevailing management system. The objective of this study is therefore to find the factors affecting body weights and growth rates in Black Bengal goats as well as estimates of genetic components.

Material and Methods

Animal Management and feeding

All the experimental animals were reared semi-intensively at Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka, Bangladesh. The animals were grazed for six hours per day throughout the year except inclement weather in the native and cultivated pastures. Additionally, concentrate mixture (17% CP, 11MJ/kg DM) was supplied twice daily (morning and evening) at the rate of 300g per head per day. The birth weight (kg) was recorded for all kids born alive within 24 hours of their birth with a top loading balance. Subsequent live weights of the kids were recorded with an interval of 15 days.

Statistical model and data analysis

Data on body weights were obtained from a total number of 607 kids (393 males and 394 females) resulting from 26 sires and 153 dams during the time period of 2017 to 2020. Traits recorded were birth weight (BWT), weaning weight (WWT), body weight at 6-month (SMWT), growth rate from birth to weaning (GR 1), growth rate from birth to 6-month (GR 2), growth rate from weaning to 6-month (GR 3). Fixed factors were classified as generation (1,2,3,4,5,6 and 7); parity of dam (1,2,3,4 and ≥5); season of birth (winter in Nov. to Feb., rainy in Mar. to Jun. and summer in Jul. to Oct.); sex (male and female); type of birth (single, twin, triplets and quadruplet); year of birth (2017, 2018, 2019 and 2020). Fixed factors as well as their interactions were analyzed using GLM procedure (SPSS 23.0).

The variance components and heritability were estimated by using Restricted Maximum Likelihood procedure fitting an Individual Animal Model (VCE 4.2.5). Breeding values of each animal for various growth traits were estimated using Prediction and Estimation (PEST) program following Best Linear Unbiased Prediction (BLUP) procedure. Factors that were found to be significant on growth traits were fitted in the model to estimate genetic parameters.

Results and Discussion

Parity of dam had significant effect on birth weight and birth weight increased with progress of parity. Usually, dams have a strong relationship with their kids up to weaning and better

mothering ability in increased parities accelerates kid's growth. Seasonal influence on growth was strong; winter born kids got better environment and nutrition due to availability of green grasses compared to others. Single kids nourished better during gestation period as a result grew faster than twins and triplets. But, after weaning effect of birth type was declined. Varying management and climatic conditions might have attributed changes at body weights in different years. These findings are in accordance with Mia et al. (2013) and Mahal et al. (2013) in the same genotype. The effect of various fixed factors on growth traits is depicted in Table 1.

Tab 1: Test of significance of various factors on body weight and growth traits of Black Bengal goats

Factor	BWT (kg)	WWT (kg)	SMWT (kg)	GR 1 (g/day)	GR 2 (g/day)	GR 3 (g/day)
Generation	**NS**	NS	NS	NS	NS	NS
Parity of dam	**	NS	NS	NS	NS	NS
Season of birth	NS	**	**	**	**	**
Sex	NS	NS	NS	NS	NS	NS
Type of birth	**	**	**	**	**	NS
Year of birth	***	NS	**	NS	**NS**	***

NS: P>0.05; *: P<0.05; **: P<0.01; ***: P<.001

Variance components and heritability

The variance components and heritability estimates of body weights at different ages and growth rates in Black Bengal goats are illustrated in Table 2, which shows medium heritability estimates ranging from 0.42 to 0.49. Mia et al. (2013), Hossain et al. (2020), Akhter et al. (2021) reported medium ranged heritability in Black Bengal goats which strengthens the reliability of present finding. Moderate heritability estimates indicated that the additive genetic variance existed which can be exploited by mass selection for improving the traits relatively quickly at birth or later at 3, 6-month of age. The relatively higher estimates could be result of ignoring maternal genetic effects in this study.

Tab 2: Estimates of additive genetic variance (σ^2_a), common environmental variance (σ^2_e), total phenotypic variance (σ^2p) and heritability (h^2±SE) of growth traits at different ages of Black Bengal kids

Growth trait	No. of record	Sire	Dam	Variance component			h^2(±SE)
				σ^2_a	σ^2_e	σ^2_p	
BWT	549	30	158	0.330	0.005	0.069	0.46±0.02
WWT	366	30	108	0.697	0.228	1.478	0.42±0.05
SMWT	275	28	96	1.767	0.170	3.718	0.47±0.03
GR 1	366	30	108	80.131	23.897	163.455	0.43±0.04
GR 2	275	28	96	53.402	4.555	108.983	0.48±0.02
GR 3	275	28	96	113.833	3.688	237.152	0.49±0.02

Where, a = additive genetic variance, e = common environmental variance and p = phenotypic variance

Estimation of predicted breeding values

The mean of predicted breeding values (PBVs) ranged from -0.0033 to + 0.0127 with maximum PBV at 6-months weight. PBVs of body weights with maximum and minimum values are presented in Figure 1. Akhter *et al*. (2006) found maximum predicted breeding values of Black Bengal goat for the 6 months body weight and Mahal *et al*. (2012) estimated breeding values of bucks for birth weight ranged from -0.0423 to +0.0278.

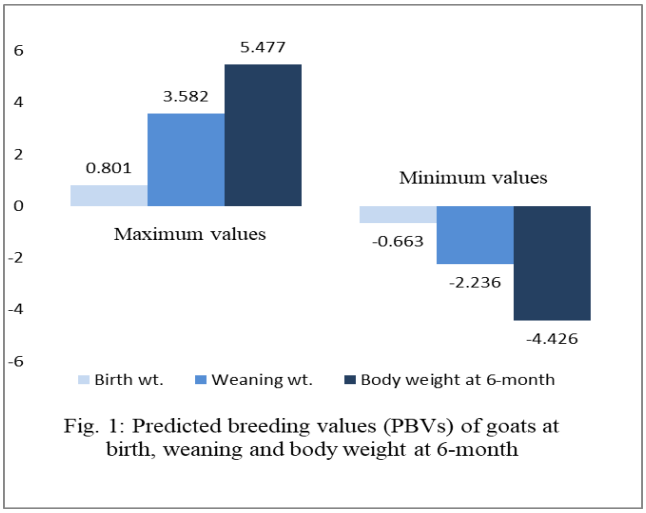

Fig. 1: Predicted breeding values (PBVs) of goats at birth, weaning and body weight at 6-month

Conclusions and Outlook

Parity, season, type and year of birth and some interactions among them were the major determinants of growth traits in Black Bengal goats and should be fitted in the model for genetic parameter estimation as well as genetic evaluation process. Type of birth significantly affected pre-weaning growth, which should be given emphasis while optimizing their management. The strong effect of season of birth of kids suggests that planning of kidding season would improve further growth. The medium range estimates of heritability from this study suggest the existence of substantial additive genetic variation in the population that can be utilized for replacement animal selection while implementing genetic improvement program of growth traits in Black Bengal goats. The heritability estimates and highest predicted breeding values of goats at 6-month of age indicated that selection of future bucks and does for weight and weight gain should be done on the basis of PBVs.

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