Genetic Variation and Correlation Studies of Some Carcass Traits in Goats

S. Das, S. S. Husain, M. A. Hoque* and M. R. Amin
Department of Animal Breeding & Genetics, Bangladesh Agricultural University, Mymensingh-2202, Bangladesh

ABSTRACT : Three groups of wethers viz. Jamunapari ♂×Black Bengal ♀ (JBB), Selected Black Bengal ♂×Selected Black Bengal ♀ (SBB) and Random Black Bengal ♂×Random Black Bengal ♀ (RBB) of 1 year old were evaluated for pre-slaughter traits and carcass characteristics. The correlations between pre-slaughter traits and carcass traits were computed. It was found that the pre-slaughter weights of JBB and SBB were almost similar in yielding hot and chilled carcass as well as dressing percentage (DP). RBB wethers were lighter ($p<0.05$) than JBB and SBB in pre- and post-slaughter weights and also inferior ($p<0.05$) in DP. SBB wethers were found to produce more visceral fat compared to JBB and RBB. Other variety meats appeared erratic in yield.1. Correlations were compared by Z statistic among three genetic groups and the value of Z did not differ ($p>0.05$) between groups.
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Key Words : Selection, Crossbreeding, Pre- and Post-Slaughter Traits, Correlations

INTRODUCTION

Meat producing potentiality of animals is reflected mainly by their rate of gain, weight at slaughter, dressing percentage and prolificacy. In Bangladesh, Black Bengal is the only recognized goat in Bangladesh breed and it showed a large degree of variation in the birth weight and subsequent live weights (Husain et al. 1996a). For genetic improvement of such traits Husain et al. (1996b) also suggested selective breeding among themselves or introduction of favorable exotic germplasm.

It has been noticed that some non-government organizations, private enterprises or farmers have been crossing Black Bengal goat with Jamunapari. Some reports are available in the literature where Jamunapari bucks are being exploited to upgrade local small type goat aiming at increasing the meat and milk production with the assumption that crossbreeding might increase the birth weight, adult size and weight, and carcass value (Peters and Horst, 1981; Mukherjee, 1991; Chopra, 1996). Now-a-days fat % has a specific value in determining the quality and price of carcass. The medical opinion now suggests that high level of fat content of meat causes high incidence of coronary heart disease (Wood, 1984). On the hand, a certain amount of fat is also necessary to make the meat taste tender, flavoury, juicy and delicious.

Bradford (1974) reported that crossbreeding decreased the fat % and increased lean meat in sheep. So, crossbreeding may be an efficient way of strengthening chevon (goat meat) production and producing commercial meat type goat. On the other hand, selective breeding was reported to favour body weight gain in Black Bengal goats (Husain et al., 1996b). Selection aimed at improving other traits may affect meat and meat related characters. It is, therefore, necessary to evaluate the correlated effects of selection on carcass and related characteristics. With this view the genotypic variation and some correlation studies on carcass traits of 12-month old castrated male goats (wether) belonging to three genetic group were undertaken with the following objectives:

i) to examine the variation in yield and quality of meat in different genetic groups
ii) to study the feasibility of producing a commercial terminal meat type goat, and
iii) to establish relationship between between pre-slaughter traits and carcass traits

MATERIALS AND METHODS

Experimental animals used in this study were maintained in the village goataries in the vicinity of Bangladesh Agricultural University (BAU), Mymensingh. Goats of this experiment belong to either of the three genetic groups viz. Jamunapari ♂×Black Bengal ♀ (JBB), selected Black Bengal ♂×selected Black Bengal ♀ (SBB) and Random Black Bengal ♂×Random Black Bengal ♀ (RBB). The experimental does were serviced the bucks maintained at BAU Artificial Insemination Center. Goats belonging to group JBB were first generation (F_1) crossbred wethers and those of group SBB were obtained from first generation selected line where both parents were selected on the basis of faster growth rate as described by Amin et al. (2000). Animals of group RBB were produced from the parents chosen randomly. Male kids were castrated at the age of 2 weeks by open (surgical) method and nursed by their dam up to weaning and later on kept under extensive management system. They fed on grass, herbs and tree leaves. The overall

* Corresponding Author: M. A. Hoque. Tel: +880-91-55695-7/2270, Fax: +880-91-55810, E-mail: azharul@royalten.net.
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management and feeding were almost identical for the three genetic groups under rural condition.

A total of fifteen castrated male goats of one-year age (wether) were taken from three genetic groups (5 from each) and slaughtered to evaluate the variabilities in the carcass traits. All the goats were kept on fasting for about 24 hours before slaughter. They were provided only with fresh drinking water. The wethers were weighed individually before keeping on fasting (pre-slaughter weight) and after 24 hours fasting (empty live weight) just before slaughter. Body length (from pole to rump), heart girth and body height were also recorded at the time of slaughter. Slaughtering was performed according to local method severing jugular veins, throat and trachea without stunning. The slaughtered animals were allowed to bleed to their end usually for 5 minutes and the head was then removed at its atlanto-occipital articulation followed by flaying, evisceration and disjoining of cannons. The weight of head and skins were recorded separately.

The entire gastro-intestinal tract was removed from the slaughtered goat individually and weighed with and without content. A hot carcass was prepared by removing head, skin, thoracic cavity contents, abdominal cavity contents, pleural cavity contents and canons from slaughtered animals. The hot carcass was weighed within one hour of slaughter. Liver, lungs, heart, kidneys, perinephric fat and caul fat were removed from the body cavity and weighed separately. The dressed carcasses were chilled at -20°C for 24 hours, which led to shrinkage in carcass. Chilled carcass weight was obtained before cutting the carcass into different prime cuts. The weight of chilled prime cuts (fore and hind limbs) were also recorded.

The chilled carcass was split between the 13th and 14th ribs. Five pairs of isolated tracing of the *muscle longissimus dorsi* or 'eye muscle' were made on a transparent acetate sheet to determine the cross section area of the muscle. Each acetate paper was xeroxed onto a plane white paper of known area and the weight. The demarcated areas on to a white paper for eye muscle were separated. From the area-weight relationship the eye muscle area was determined by simple arithmetic calculation.

The collected data were analyzed by 'Mixed Model Least Squares and Maximum Likelihood Computer Program PC-2 Version' (Harvey, 1990). The analysis of variances were made for all the traits studied to have the variabilities of those parameters among three different genetic groups. The general statistical model for carcass traits:

$Y_{ij} = \propto + G_i + e_{ij}$

where, Y_{ij} = individual yield

μ = general mean

G_i = effect of i-th genetic group (i = 1,2,3)

e_{ij} = residual error

Least Significant Difference (LSD) test was performed to separate means in group of significant difference among themselves according to the method described by Shil and Debnath (1995).

Correlation between pre-slaughter traits and carcass traits were calculated. Since the distribution of correlation coefficient (r) is not normal, a tranformation of r to z with the relation $z=\frac{1}{2}\log_e(1+r)/(1-r)$ was made. To test the significance of the difference between r_1 and r_2 the difference between $z_1$and z_2 was tested with standard error $\sqrt{1/(n_1-3)+1/(n_2-3)}$ (Pillai and Sinha, 1968).

RESULT AND DISCUSSION

Body weights and hot carcass weight

Means with standard errors for carcass traits of wethers belonging to three genetic groups are presented in table 1. Pre-slaughter (PSW) and empty live weight (ELW) were lower in RBB compared to JBB and SBB wethers. Table 1 indicated that hot carcass weight (HCW) varied from 4.72 kg in RBB to 7.07 kg in JBB. HCW of different genetic groups maintained following pattern JBB>SBB>RBB. HCW of JBB and SBB showed significant ($p<0.01$) difference from RBB group. This result are supported by the report of Kanaujia et al. (1985) who found significant ($p<0.01$) variation in HCW of different genotypes. They reported that HCW averaged 6.80, 5.83, 5.23 and 7.71kg for Beetal, Black Bengal, Black Bengal ♂×Beetal ♀, and Beetal ♂×Black Bengal ♀, respectively at the age of 6 months. The present findings are in line with the findings of Mukherjee (1991) who reported that F_1 crossbred of German fawn ♂×Local Kambing Katjang ♀ goat had higher slaughter weight and evisceration weight than Local Kambing Katjang ♂. Chopra (1996) from Indian experiment also reported that meat production of small size Black Bengal showed significant improvement by crossing with large-size Jamunapari breed for meat and milk production. Non-significant difference of HCW between JBB and SBB and significant difference between SBB and RBB revealed that F_1 progeny of JBB were almost close to the SBB.

Chilled carcass weight and dressing percentage

The chilled carcass weight (CCW) of crossbred JBB wether was highest followed by that of SBB and RBB. Differences between the groups were realistic considering the pre-slaughter weight (PSW) and HCW of respective groups. The analysis of variance revealed significant ($p<0.01$) difference between genetic groups for CCW (table 1). Weight loss of hot carcass caused by chilling was almost similar in the three genetic groups. The non-significant difference in CCW between JBB and SBB reflected similarly to the HCW

Table 1. Least-squares means with standard errors for pre-slaughter and different carcass traits

Genetic Group	PSW (kg)	ELW (kg)	HCW (kg)	CCW (kg)	EMA (cm^2)	Dressing Percentage
JBB	$17.04^{a}\pm0.67$	$16.56^{a}\pm0.65$	$7.07^{a}\pm0.27$	$6.95^{a}\pm0.26$	$8.05^{a}\pm0.18$	$41.54^{a}\pm0.54$
SBB	$16.10^{a}\pm0.80$	$15.70^{a}\pm0.78$	$6.53^{a}\pm0.43$	$6.43^{a}\pm0.43$	$6.67^{b}\pm0.19$	$40.48^{a}\pm1.33$
RBB	$12.40^{b}\pm0.33$	$12.02^{b}\pm0.34$	$4.72^{b}\pm0.29$	$4.63^{b}\pm0.29$	$5.70^{b}\pm0.26$	$37.93^{b}\pm1.85$

Means with different superscripts in the same column differ significantly (p<0.01). PSW=Pre-slaughter weight, ELW=Empty live weight, HCW=Hot carcass weight, CCW=Chilled carcass weight and EMA=Eye muscle area.

Table 2. Least-squares means with standard error for weight (g) of different edible body parts, meat offal and prime cuts

Genetic group	Skin	Head	Liver	Heart	Kid-neys	Lungs	Caul fat	PF	FGI	EGI	Fore limbs	Hind limbs
JBB	1256^{a}6	806^{a}6	354^{a}6	89^{a}6	68^{a}6	228^{a}6	166^{a}6	96^{ab}6	3770^{a}6	1546^{a}6	1398^{a}6	1626^{a}6
	±37.73	±41.75	±15.58	±6.96	±5.21	±20.82	±23.56	±19.27	±108.99	±116.47	±46.94	±62.54
SBB	1310^{a}6	818^{a}6	336^{a}6	61^{b}6	63^{ab}6	204^{a}6	310^{b}6	112^{a}6	3680^{a}6	1496^{a}6	1470^{a}6	1616^{a}6
	±32.81	±49.10	±43.52	±3.57	±3.89	±3.57	±32.04	±16.98	±159.77	±93.50	±68.58	±54.57
RBB	940^{b}6	606^{b}6	230^{b}6	53^{b}6	52^{b}6	196^{b}6	90^{a}6	35^{b}6	2790^{b}6	1045^{b}6	1022^{b}6	1150^{a}6
	±40.92	±6.68	±16.46	±1.79	±3.34	±14.56	±10.56	±6.31	±35.71	±28.59	±115.40	±113.82

Means with different superscripts in the same column differ significantly (p<0.01).
PF=Perinephric Fat; FGI=Filled Gestro-intestinal Tract; EGI=Empty Gestro-intestinal Tract.

in the three genetic groups. Hesler (1961) reported that chilling at -20° to -30°C for 7 days caused 2% weight loss of the dressed carcass of lamb. In the present experiment 1.3% to 1.6% weight loss of hot carcass was observed due to chilling at -20°C for a period of 24 hours only. JBB was as good as SBB in terms of dressing percentage (DP) and both were superior to RBB (p<0.05). DP in Black Bengal wethers at 1 year of age in this experiment appeared to be lower in comparison to that (44.6%) cited by Acharya (1988).

Eye muscle area

Mean areas of eye muscle for three genetic groups are presented in table 1. From the table it was found that eye muscle area (EMA) was greatest in JBB, least in RBB and intermediate in SBB. LSD test indicated that JBB had significantly (p<0.01) greater EMA than the other two groups and non-significant (p>0.05) difference in EMA was found between SBB and RBB. This is in line with the results of Wolf et al. (1980) who observed that crossbred lambs produced the leanest carcass with a high lean/ bone ratio and EMA. In the present experiment a significantly greater EMA was observed with significantly (p<0.01) higher pre-slaughter weight (PSW) in JBB. The influence of genetic groups on PSW and HCW was reflected in the area of eye muscle. This was in accordance with the reports of Singh et al (1990) who reported a significant increase in carcass measurement and *longissimus dorsi* muscles area due to weight at slaughter. According to the reports of Wolf et al. (1980), a greater EMA is associated with a higher production of lean in the carcass and lean/ bone ratio. So the significantly higher EMA in JBB may result in an increase of lean meat in crossbred goat.

Edible body parts, meat offals and prime cuts

Mean weight of skin, head, liver, heart, kidneys, lungs, caul fat and perinephric fat (PF) are shown in table 2. JBB and SBB produced significantly (p<0.01) higher weight for skin, head and heart than RBB but the difference in those between JBB and SBB was not statistically significant. JBB produce more kidneys and lungs weights than SBB and RBB and the effects of genetic groups on both kidneys and lungs weights were statistically significant (p<0.01). SBB had significantly (p<0.01) higher caul fat and PF weight than the other two genetic groups and the effect of genetic groups was highly significant (p<0.001) on those traits. The results were in line with those of Pal et al. (1997) who reported that variety meats (heart, liver and kidneys) and cavity fat weight (PF, caul fat, mesenteric and inguinal fats) varied significantly (p<0.01) between breeds. The significantly lower weight of caul fat and non-significant of PF in JBB indicated that fat deposition in abdomen and in the carcass may be lower in crossbreds and they may produce more lean meat. The genetic groups ranked in order as JBB=SBB>RBB for empty gastro-intestinal tract (EGI) weight (table 2). Least squares analysis of variance indicated RBB produce lower (p<0.01) weight of EGI than the other two groups. These results are somewhat similar to those of Owen and Norman (1977). Mean weight of cannon free fore and hind limbs were significantly (p<0.01) higher in JBB and SBB than in RBB but differences between JBB and SBB were not significant. The overall weights of edible body parts were higher in JBB followed by SBB due to the effect of crossbreeding and selection.

Table 3. Correlation coefficients (r) and test of equality of the relationship of some trait–pairs in different genetic groups

Pairs of traits	Genetic groups					
	JBB		SBB		RBB	
	r	z	r	z	r	z
PSW:HCW	0.95**	1.83**[a]	0.87*	1.33[a]	0.87*	1.33[a]
ELW:HCW	0.95**	1.83**[a]	089*	1.42*[a]	0.86*	1.29[a]
Heart girth:HCW	0.93**	1.66*[a]	0.88*	1.38[a]	0.95**	1.83*[a]
Body length :HCW	0.31	0.32[a]	0.66	0.79[a]	0.21	0.21[a]
Body height:HCW	0.85*	1.25[a]	0.86*	1.29[a]	0.76*	1.00[a]
HCW:EMA	0.68	0.83[a]	0.92**	1.58*[a]	0.84*	1.22[a]
HCW:Hind limbs wt.	0.87*	1.33[a]	0.98**	2.30**[a]	0.99**	2.65*8[a]
HCW:Forelimbs wt.	0.89*	1.42*[a]	0.89*	1.42*[a]	0.98**	2.30**[a]
EMA:PF wt.	0.63	0.79[a]	0.68	0.83[a]	0.59	0.68[a]
Caulfat wt:PF wt.	0.87*	1.33[a]	0.95**	1.78**[a]	0.32	0.33[a]
PSW:PF wt.	0.92*	1.58*[a]	0.80*	1.09[a]	0.57	0.64[a]
PSW:Caulfat wt.	0.84*	1.22[a]	0.81*	1.13[a]	0.95**	1.83**[a]
PSW:Liver wt.	0.89*	1.42*[a]	0.97*	2.09**[a]	0.19	0.19

* p<0.05; ** p<0.005. The values of z with same superscripts in the same row are not significantly different (p>0.05). PSW=Pre-slaughter weight. ELW=Empty live weight. HCW=Hot carcass weight. CCW=Chilled carcass weight and EMA=Eye muscle area. PF=Perinephric Fat.

Correlations

Simple phenotypic correlation coefficients of pre-slaughter traits viz. PSW, ELW, heart girth, body length and body height of wether with HCW are given in table 3. The correlation of PSW and ELW with HCW was positive and significant (p<0.01, p<0.05) for all the three genetic groups but the correlation coefficients were not significantly different among the three groups. The present findings are in good conformity with those of Stanley *et al* (1963), Chawla and Nath (1979) and Singh et al. (1991). They reported that phenotypic correlation of PSW and ELW with HCW were positive and significant (p<0.01). It further revealed that body weight (PSW and ELW) which has high association with carcass traits, is a good predictor of carcass trait. Table 3 also revealed that the correlations of body measurements like heart girth and body height with HCW were positive and significant (p<0.01, p<0.05) irrespective of genetic groups. The phenotypic correlation between body length and HCW was positive but not significant. These results were partially in agreement with those of Singh et al. (1994) who explained that phenotypic correlation of the pre-slaughter measurements like body weight, height at wether and chest girth with HCW was positive and significant (p<0.01). These results are to a degree similar to those of Stanley et al (1963), Yacob et al. (1985) and and Singh et al. (1991). Phenotypic association of pre-slaughter traits of body weight, body length, height and heart girth with live weight and HCW indicated that selection within breed on the basis of body frame-work and size may be considered as an effective tool for improving HCW. It has been shown that EMA is positively and moderately related with HCW for all the three genetic groups. The genetic groups did not differ from one another in respect of correlation coefficient between these two carcass traits (table 3). The results are indirectly in accordance with Raghavan (1988) who reported the EMA increased with increased body weight and was accompanied by a decrease in bone content. In this study the influence of genetic group on PSW and HCW was reflected in the shape of the eye muscle area. Menfredini et al. (1988) found that a higher body weight at slaughter was associated with greater *longissimus dorsi* area and PSW.

CONCLUSION

Of the three genetic groups examined, crossbreds were more or less similar in performance to selected Black Bengal goats at one year of age. Selected Black Bengal goats performed better than random breds, signifying that selective breeding within Black Bengal goat may be advocated for commercial chevon production instead of crossbreeding. No definite trend was found to predict hot carcass weight from pre- and post-slaughter measurements between genetic groups.

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