

RELATIONSHIP OF BODY WEIGHT WITH LINEAR BODY MEASUREMENTS IN THREE COLOUR VARIETIES OF BENGAL GOATS



Animal Science

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N.K. TUDU	Research Scholar, Institute of Agricultural Sciences (Animal Science Section), Visva-Bharati, Sriniketan, Dist. Birbhum, West Bengal
S.K. PYNE	Professor, Institute of Agricultural Sciences (Animal Science Section), Visva-Bharati, Sriniketan, Dist. Birbhum, West Bengal
N. GHOSH	Associate professor & Head, Department of Animal Science, Bidhan Chandra Krishi Viswavidyalaya, P.O.-Mohanpur, Dist.-Nadia, West Bengal

ABSTRACT

The present research work was done in Nadia district of West Bengal during January, 2010 to December, 2013. Positive and significant correlation coefficients were observed between body weight and linear body measurements with the exception of a few cases in all the three colour varieties of Bengal goats. There was a high correlation between body weight and body length, height at withers and chest girth in all the three colour varieties of Bengal goats especially at the age group of 6, 9, and 12 months, indicating that body weight and these three traits tended to move together and measurements of any one of these three traits or in combinations may be used to estimate the body weight at a particular age. From the present study it can be concluded that body weight can be predicted using body measurements considering the correlation coefficients in three colour varieties of Bengal goats reared under village condition.

INTRODUCTION

Goats play a vital role in the economy of poor dwellers living in diverse climatic conditions of India. In rural areas goat keeping generates employment at the rate of 4.2% per annum (Dhara *et al.*, 2008). Goats are considered as the fixed deposits for the poorest of the poor supplying fund as and when necessary by virtue of their ready market demand (Sahoo *et al.*, 2004). The body weight of a goat is important for a number of reasons, related to breeding (selection), feeding and health care. However this fundamental knowledge is often unavailable to those working with goats in the small scaling farming sector, due to unavailability scales. Hence, farmers have to rely on questionable estimates of the body weight of their goats, leading to inaccuracies in decision-making and husbandry. Hence, the present investigation was designed to relate body weight with different body measurements of three colour varieties of Bengal goats under village condition.

MATERIALS AND METHODS

The present work was done in Nadia district of West Bengal during January, 2010 to December, 2013. Nadia district is located between 22°52'30" and 24°05'40" parallels of North latitudes and 22°08'10" and 88°48'15" meridians of East Longitudes. For biometrical characterization, a total of five hundred (500) Bengal goats of the three colour varieties (250 Black, 150 Brown and 100 White) were selected irrespective to sex from 200 families from 10 villages of the two Gram Panchayats. All the animals under study were neck tagged to maintain individual identity. The parameters were measured in five age groups of the three colour varieties of Bengal goats as at birth, 3, 6, 9 and 12 months. In order to characterize and evaluate the male and female goat morphometrically, the body weight, body length, height at wither, chest girth, ear type & length, horn type & length, tail length were measured. Birth weight of animal was recorded within 12 hours of kidding. Growth of individual kid was measured in terms of its body weight in the subsequent periods profiled viz., 30 day weight, 90 day weight, 180 day weight, 270 day weight and 365 day weight as included in the present investigation, both males and females being recorded to examine the sex effect. The body weight was taken in the morning hours when no feed was offered to kids/goats or before the kids/goats were allowed for grazing. The birth weight and subsequent body weight was taken with the help of Dial-type spring balance (Salter, 20 kg capacity with 200 g graduation) and expressed in kg. The oblique length between the shoulder point and pin bone constituted the body length. The distance between the ground and the

level of wither was taken as height at wither of the animal. The chest girth is measured surrounding the heart just behind the elbow. The ear length is measured from tip of the ear to base of ear. The horn length is measured from tip of the horn to base of horn. The tail length is measured from tip of the tail to base of tail. These were measured with the help of measuring tape and Scale in cm. The data collected for the study were compiled, tabulated and analyzed following the standard procedures (Snedecor and Cochran, 1967). All the data collected were analyzed statistically through SPSS computer software version 16.0 (SPSS, 2010) and MSTATC for regression (linear and non linear). Step-wise multiple regression analysis was performed to elaborate regression equations for prediction of body weight of three colour varieties of Bengal goats. Accuracy of prediction equation for morphometry was estimated through the coefficients of multiple determinations (R^2); linear relationship between body weight and other six body measurements using Pearson correlation coefficients (r_p) was also calculated. Best-fitted regression equation was developed to estimate body weight through different linear body measurements.

RESULTS AND DISCUSSION

Coefficient of correlation between body weight and linear body measurements

Coefficient of correlation between body weight and six linear body measurements of three colour varieties of Bengal goats at birth and at 3, 6, 9, and 12 months of age is presented in Table 1 and 2.

'Table 1 and 2 about here',

At birth

Body weight was significantly correlated with body length of Black Bengal goat (0.499), Brown Bengal goat (0.694), and White Bengal goat (0.859) at birth. Body weight was correlated with height at withers of Black Bengal goat (0.429), Brown Bengal goat (0.618), and White Bengal goat (0.665) at birth. Body weight was correlated with chest girth of Black Bengal goat (0.514), Brown Bengal goat (0.580) and White Bengal goat (0.377) at birth. Body weight was correlated with ear length of Black Bengal goat (0.785), Brown Bengal goat (0.814), and White Bengal goat (0.772) at birth. Body weight was correlated with tail length in of Black Bengal goat (0.389), Brown Bengal goat (0.792), and White Bengal goat (0.810) at birth.

At 3 months

Body weight was correlated with body length of Black Bengal goat (0.495), Brown Bengal goat (0.748) and White Bengal goat (0.945) at 3 months of age. Body weight was correlated with height at withers of Black Bengal goat (0.541), Brown Bengal goat (0.780), and White Bengal goat (0.944) at 3 months of age. Body weight was correlated with chest girth of Black Bengal goat (0.521), Brown Bengal goat (0.789), and White Bengal goat (0.940) at 3 months of age. Body weight was correlated with ear length of Black Bengal goat (0.088), Brown Bengal goat (0.069), and White Bengal goat (0.556) at 3 months of age. Body weight was correlated with horn length of Black Bengal goat (0.289), Brown Bengal goat (0.427), and White Bengal goat (0.824) at 3 months of age. Body weight was correlated with tail length of Black Bengal goat (0.092), Brown Bengal goat (0.387), and White Bengal goat (0.822) at 3 months of age.

At 6 months

Body weight was correlated with body length of Black Bengal goat (0.975), Brown Bengal goat (0.968), and White Bengal goat (0.975) at 6 months of age. Body weight was correlated with height at withers of Black Bengal goat (0.973), Brown Bengal goat (0.976), and White Bengal goat (0.981) at 6 months of age. Body weight was correlated with chest girth of Black Bengal goat (0.971), Brown Bengal goat (0.977), and White Bengal goat (0.989) at 6 months of age. Body weight was correlated with ear length of Black Bengal goat (0.623), Brown Bengal goat (0.573), and White Bengal goat (0.490) at 6 months of age. Body weight was correlated with horn length of Black Bengal goat (0.290), Brown Bengal goat (0.457), and of White Bengal goat (0.624) at 6 months of age. Body weight was correlated with tail length in of Black Bengal goat (0.975), Brown Bengal goat (0.967), and White Bengal goat (0.933) at 6 months of age.

At 9 months

Body weight was correlated with body length of Black Bengal goat (0.989), Brown Bengal goat (0.867), and White Bengal goat (0.988) at 9 months of age. Body weight was correlated with height at withers of Black Bengal goat (0.995), Brown Bengal goat (0.871), and of White Bengal goat (0.990) at 9 months of age. Body weight was correlated with chest girth of Black Bengal goat (0.993), Brown Bengal goat (0.878), and White Bengal goat (0.986) at 9 months of age. Body weight was correlated with ear length of Black Bengal goat (0.561), Brown Bengal goat (0.618), and White Bengal goat (0.230) at 9 months of age. Body weight was correlated with horn length of Black Bengal goat (0.513), Brown Bengal goat (0.511), and of White Bengal goat (0.634) at 9 months of age. Body weight was correlated with tail length of Black Bengal goat (0.944), Brown Bengal goat (0.766), and of White Bengal goat (0.932) at 9 months of age.

At 12 months

Body weight was correlated with body length of Black Bengal goat (0.984), Brown Bengal goat (0.560) and White Bengal goat (0.981) at 12 months of age. Body weight was correlated with height at withers of Black Bengal goat (0.541), Brown Bengal goat (0.576), and White Bengal goat (0.981) at 12 months of age. Body weight was correlated with chest girth of Black Bengal goat (0.670), Brown Bengal goat (0.578), and White Bengal goat (0.981) at 12 months of age. Body weight was correlated with ear length of Black Bengal goat (0.213), Brown Bengal goat (0.231), and White Bengal goat (0.325) at 12 months of age. Body weight was correlated with horn length of Black Bengal goat (0.611), Brown Bengal goat (0.411), and White Bengal goat (0.874) at 12 months of age. Body weight was correlated with tail length of Black Bengal goat (0.944), Brown Bengal goat (0.555), and White Bengal goat (0.978) at 12 months of age.

Positive and significant correlation coefficients were observed between body weight and linear body measurements with the exception of a few cases in all the three colour varieties of Bengal

goats. There was a high correlation between body weight and body length, height at withers and chest girth. All the three colour varieties of Bengal goats especially at the age group of 6, 9, and 12 months, indicating that these body weight and the three traits tended to move together and measurements of any one of these three traits or in combinations may be used to estimate the body weight at a particular age. These results are in agreement with the earlier work of Iqbal *et al.* (2013), Fasae *et al.* (2005) and Bassano *et al.* (2003).

Multiple Linear Regression Model and body weight estimation using stepwise multiple regression analysis

The multiple linear equations for estimating live body weight from body measurements of three colour varieties of Bengal goats at birth and at 3, 6, 9 and 12 months of age are presented in Table 3 to 7. "Table 3 to 7 about here"

All six body measurements (ear length, tail length, body length, chest girth, height at withers and horn length) were included in the model. Through stepwise elimination procedure, two of the body measurements *viz.*, chest girth and horn length were found to be unfit in the model at birth. Likewise, height at withers and horn length were found unfit at 3 months of age; horn length was unfit at 6 months of age; tail length was unfit at 9 months of age; and ear length and chest girth were unfit at 12 months of age. The best fitted measurements at birth were ear length ($R^2=0.616$) and tail length ($R^2=0.609$) as single trait or in combinations with other traits. In case of 3 months of age, the best fitted traits were chest girth as single trait ($R^2=0.622$), or tail length and body length jointly ($R^2=0.919$) or along with other two traits (ear length and chest girth, $R^2=0.653$) in combination. The best fitted body measurements at 6 months of age were chest girth ($R^2=0.777$) or tail length ($R^2=0.573$) as single measurement or chest girth and height at withers in combination ($R^2=0.984$). The best fitted traits at 9 months of age were height at withers ($R^2=0.989$) or horn length ($R^2=0.739$) as a single trait and ear length, body length and chest girth in combination ($R^2=0.870$). The important traits at 12 months of age were height at withers ($R^2=0.963$) and horn length ($R^2=0.528$) as single measurement or tail length, body length, height at withers and horn length in combination ($R^2=0.986$).

The coefficient of determination (R^2) for combined tail length, body length and height at withers (86.1%) was higher than other body measurements in multiple traits evaluation for body weight in male and female White Bengal goats at birth, whereas body length was the poor estimator of body weight of female White Bengal goats with coefficient of determination (R^2) as 43.1% at birth. The coefficient of determination (R^2) for combined tail length and body length (91.9%) was higher than other body measurements in multiple traits evaluation for body weight in male and female White Bengal goats at 3 months of age, whereas height at withers was the poor estimator of body weight of male and female Black Bengal goats with coefficient of determination (R^2) as 29.3% at 3 months of age. The coefficient of determination (R^2) for height at withers and chest girth in combination (98.4%) was higher than other body measurements in multiple traits evaluation for overall body weight of three colour varieties of Bengal goats (Black, Brown and White) at 6 months of age, whereas tail length was the poor estimator of body weight of female Black Bengal goats with coefficient of determination (R^2) as 57.3% at 6 months of age. The coefficient of determination (R^2) for height at withers (98.9%) was higher than other body measurements in multiple traits evaluation for body weight of male and female Black Bengal goats at 9 months of age, whereas chest girth was the poor estimator of body weight of male Black Bengal goats with coefficient of determination (R^2) as 47.3% at 9 months of age. The coefficient of determination (R^2) for combined tail length, body length, height at withers and horn length (98.6%) was higher than other body measurements

in multiple traits evaluation for body weight of male and female Black Bengal goats at 12 months of age, whereas chest girth was the poor estimator of body weight of male and female Brown Bengal goats with coefficient of determination (R^2) as 33.4% at 12 months of age. Since in various age groups the highest coefficient of determination (R^2) was obtained when considering single body measurement, or two or more body measurements in combination, the specific body measurement(s) was/were included in the regression equations for estimation live body

weight more accurately at respective age. These results are also supported by Topal *et al.* (2003) and Topal and Macit (2004).

CONCLUSION

From the present study it can be concluded that body weight can be predicted using body measurements considering the correlation coefficients in three colour varieties of Bengal goats reared under village condition.

Table 1: Coefficient of correlation between body weight and linear body measurements (body length, height at withers and chest girth) of three colour varieties of Bengal goats at birth and at 3, 6, 9 and 12 months of ages

Body weight		At birth			3 month			6 month			9 month			12 month		
Colour varieties	Black	Body length	Height of wither	Chest girth	Body length	Height of wither	Chest girth	Body length	Height of wither	Chest girth	Body length	Height of wither	Chest girth	Body length	Height of wither	Chest girth
		Black	0.499*	0.429	0.514*	0.495*	0.541*	0.521*	0.975**	0.973**	0.971**	0.989**	0.995**	0.993**	0.984**	0.541*
Brown	0.694**	0.618**	0.580**	0.748**	0.780**	0.789**	0.968**	0.976**	0.977**	0.867**	0.871**	0.878**	0.560*	0.576**	0.578**	
White	0.859**	0.665**	0.377	0.945**	0.944**	0.940**	0.975**	0.981**	0.989**	0.988**	0.990**	0.986**	0.981**	0.981**	0.981**	

**Correlation is significant at $p \leq 0.01$, *Correlation is significant at $p \leq 0.05$.

Table 2: Coefficient of correlation between body weight and linear body measurements (ear length, horn length and tail length) of three colour varieties of Bengal goats at birth and at 3, 6, 9 and 12 months of ages

Body weight		At birth		3 month			6 month			9 month			12 month		
Colour varieties	Black	Ear length	Tail length	Ear length	Horn length	Tail length	Ear length	Horn length	Tail length	Ear length	Horn length	Tail length	Ear length	Horn length	Tail length
		Black	0.785**	0.389	0.088	0.289	0.092	0.623**	0.290	0.975**	0.561*	0.513*	0.944**	0.213	0.611**
Brown	0.814**	0.792**	0.069	0.427	0.387	0.573**	0.457*	0.967**	0.618**	0.511*	0.766**	0.231	0.411	0.555*	
White	0.772**	0.810**	0.556*	0.824**	0.822**	0.490*	0.624**	0.933**	0.230	0.634**	0.932**	0.325	0.874**	0.978**	

**Correlation is significant at $p \leq 0.01$, *Correlation is significant at $p \leq 0.05$.

Table 3: Step-wise multiple regression analysis of body weight vs ear length, tail length, body length, chest girth, height at withers and horn length of three colour varieties of Bengal goats at birth

Multiple (stepwise) regression	Prediction equations							R ²
	β_0	β_1	β_2	β_3	β_4	β_5	β_6	
	Intercept	Ear length	Tail length	Body length	Chest girth	Height at withers	Horn length	
Body weight (Brown)	0.085	0.154	-	-	-	-	-	0.616
Body weight (Black)	-1.944	0.475	-	-	-	-	-	0.662
Body weight (Male White)	0.423	-	0.176	-	-	-	-	0.609
Body weight (Female White)	-2.793	-	-	0.205	-	-	-	0.431
Body weight (White)	-4.353	-	0.141	0.137	-	0.106	-	0.861
Overall (Black + Brown + White)	-1.123	0.134	0.158	-	-	0.033	-	0.734

Y_i = Body weight

β_0 = intercept of the best fit straight line

R²= Coefficients of determination

Table 4: Step-wise multiple regression analysis of body weight vs ear length, tail length, body length, chest girth, height at withers and horn length of three colour varieties of Bengal goats at 3 months of age

Multiple (stepwise) regression	Prediction equations							R ²
	β_0	β_1	β_2	β_3	β_4	β_5	β_6	
	Intercept	Ear length	Tail length	Body length	Chest girth	Height at withers	Horn length	
Body weight (Brown)	2.415	-	-	-	0.034	-	-	0.622
Body weight (Black)	1.992	-	-	-	-	0.040	-	0.293
Body weight (Male White)	1.970	-	0.270	-	-	-	-	0.568
Body weight (Female Brown)	-14.821	-	-	-	0.529	-	-	0.496
Body weight (Male Brown)	-8.702	-	-	0.409	-	-	-	0.425
Body weight (White)	-2.517	-	0.199	0.163	-	-	-	0.919
Overall (Black + Brown + White)	-13.919	.297	0.447	0.558	-0.140	-	-	0.653

Y_i = Body weight

β_0 = intercept of the best fit straight line

R²= Coefficients of determination

Table 5: Step-wise multiple regression analysis of body weight vs ear length, tail length, body length, chest girth, height at withers and horn length of three colour varieties of Bengal goats at 6 months of age

Multiple (stepwise) regression	Prediction equations							R ²
	β_0	β_1	β_2	β_3	β_4	β_5	β_6	
	Intercept	Ear length	Tail length	Body length	Chest girth	Height at withers	Horn length	
Body weight (Black)	3.374	-	0.128	0.027	-	-	-	0.962
Body weight (Black Female)	3.904	-	0.179	-	-	-	-	0.573
Body weight (Male White)	-3.718	-	--	-	0.210	-	-	0.632
Body weight (Female White)	-8.392	-	-	-	0.325	-	-	0.777
Overall (Black + Brown + White)	0.510	-	-	-	0.187	-0.077	-	0.984

Y_i = Body weight

β_0 = intercept of the best fit straight line

R²= Coefficients of determination

Table 6: Step-wise multiple regression analysis of body weight vs ear length, tail length, body length, chest girth, height at withers and horn length of three colour varieties of Bengal goats at 9 months of age

Multiple (stepwise) regression	Prediction equations							R ²
	β_0	β_1	β_2	β_3	β_4	β_5	β_6	
	Intercept	Ear length	Tail length	Body length	Chest girth	Height at withers	Horn length	
Body weight (Brown)	7.439	0.134	-	-.217	0.197	-	-	0.870
Body weight (Black)	5.747	-	-	-	-	0.092	-	0.989
Body weight (Black Male)	3.096	-	-	-	-	0.154	-	0.529
Body weight (Black Male)	2.910	-	-	-	0.134	-	-	0.473
Body weight (White)	7.105	-	-	-	-	0.081	-	0.981
Overall (Black + Brown + White)	3.439	-	-	-	-	-	1.834	0.739

Y_i = Body weight

β_0 = intercept of the best fit straight line

R²= Coefficients of determination

Table 7: Step-wise multiple regression analysis of body weight vs ear length, tail length, body length, chest girth, height at withers and horn length of three colour varieties of Bengal goats at 12 months of age

Multiple regression (stepwise)	Prediction equations							R ²
	β_0	β_1	β_2	β_3	β_4	β_5	β_6	
	Intercept	Ear length	Tail length	Body length	Chest girth	Height at withers	Horn length	
Body weight (Brown)	10.453	-	-	-	0.056	-	-	0.334
Body weight (Black)	8.913	-	0.107	0.061	-	-.014	0.142	0.986
Body weight (Black Female)	13.055	-	-	-	-	-.017	-	0.404
Body weight (White)	6.823	-	-	-	-	0.150	-	0.963
Overall (Black + Brown + White)	6.011	-	-	-	-	-	1.703	0.528

Y_i = Body weight

β_0 = intercept of the best fit straight line

R²= Coefficients of determination

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