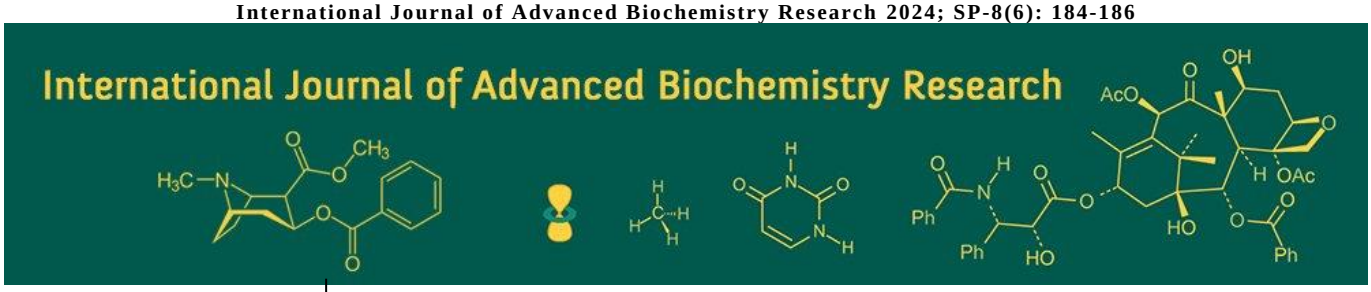

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Evaluation of Shaeffer's formula and regression methods for predicting the live body weight of Salem black goats

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Abstract
The objectives of the present study were to evaluate the fitness of Schaffer's formula for weight estimation in Salem black goats and determination of the best fitted regression equation. Data on body weight and body measurements were collected from Livestock Farm Complex (LFC) Veterinary College and Research Institute, Salem (35 numbers). Simple and multiple regression models were fitted with body weight as dependant variable and height at withers, chest girth and body length as independent variables. The coefficient of determination in case of simple linear regression was lowest using height at withers (0.0023) followed by chest girth (0.019) and then body length (0.0705). Inclusion of chest girth produced higher R^2 (0.7839) with significant correlation when combined with body length and height at withers. This suggests that the estimation of body weight with chest girth alone or in combination with other linear body measurements provides a better fit in Salem black goats.

Keywords: Body weight, correlation, Salem black goat, prediction and regression

Introduction
Livestock body weight is the most significant and essential economic factor for selection and production performance. Estimation of live body weight of small ruminants is important for a number of reasons, such as breeding, appropriate feeding and treatment of diseases (Slippers *et al*. 2000) [9]. It is also used for determining prices while selling animals. However, visual appreciation method is often used in rural and inaccessible areas to estimate body weight and monitor the performance of small ruminants where weighing scales are not easily available (Vanvanhossou, 2018) [15] and it would be difficult to know the correct weight of small ruminants (Mahmud *et al.* 2014) [7].

Predicting the live weight from body measurements is useful, faster, simpler and less expensive in the rural areas where accurate facilities are meagre for the breeders (Tsegaye *et al.*, 2013) [14]. Apart from taking live weight of meat animals, researchers also use other parameters such as body length, width of pelvis, height at withers and chest girths in order to adequately evaluate live animals (Atta *et al*., 2004) [1]. The relationship between body weight and linear body measurements in meat animals was examined in predicting body size and shape. Since the body weight and morphometry of the animals are highly correlated, it would be helpful in determining the extent of variation in body weight caused by biometry of the animal and thus helpful in formulation of a suitable selection criterion on the basis of body conformation of animals (Khan *et al.* 2003) [5]. Ultimately, when farmers and buyers of livestock are able to relate body measurement of animals to assess their LBW, optimum price and benefit will be given to owners.

Salem Black goats are distributed in north-western agro climatic zone of Tamil Nadu and are reared mainly for meat. The name "Salem Black" has been derived from its place of origin (Salem districts of Tamil Nadu) and Black coat colour. Salem Black goats are tall animals with lean body and the coat colour is completely black in colour. Salem Black goats have considerable production potential under semi-arid, tropical conditions of north-western agro-climatic zone of Tamil Nadu. The distinguishing features of this breed are early sexual maturity, better adaptability to harsh climatic condition and higher prolificacy. The present study was carried out to establish the relationship between body weight and linear body

measurements such as body length, height at withers and heart girth in Salem black adult female goats under field conditions.

Materials and Methods

A total of 35 adult Salem black goats (Picture 1) reared at Livestock Farm complex, Veterinary college and Research Institute, Salem were randomly selected.

Electronic weighing: Goats were weighed during early morning before the animals were left loose for browsing.

Morphometry: The linear body measurements were recorded using a measuring tape with graduation in centimeter.

- The body length (BL) was measured from the point of pin bone to point of shoulder (Scapula).
- The wither height (WH) was measured as the distance from the ground level to the level of wither of the animal in standing position.
- The chest girth (CG) was measured by taking the measurement of circumference of the chest just behind the front leg.

Picture 1: Adult male (left) and female Salem black goat

Shaeffer's formula: The original equation used for calculating live weight was:

$W = (BL \times CG^2)/300$

where W, body weight in lbs;

BL, length of the animal from point of shoulder to pin bone in inches; and CG, chest girth of the animal in inches (Sastry *et al*. 1983, Khan *et al*. 2003) [8, 5]. The formula was reformatted to measure the body weight in kg.

Mean and standard error for the body weight and body measurements were calculated. The body measurement was fitted in the given formulae to determine the estimated weight and then was correlated with the actual bodyweights to determine the accuracy of these formulae. Step wise multiple regression procedure was used to find the combination of body measurements which can explain the maximum variation in the dependent variable, the body weight and regression equation was compared based on coefficient of determination as per Snedecor and Cochron (1989) [10].

Results and Discussion

The mean body weight and linear body measurements of Salem black goats are presented in Table 1. The mean body weight (kg) was 9.79±0.20and body length, height at withers and chest girth (in inches) were 18.48±0.32, 20.26±0.34 and 20.06±0.41, respectively.

Table 1: Mean (±S.E.) for body weight and linear body measurements

Sample no. (N)	Body weight (kg)	Body length (in)	Height at withers (in)	Chest girth (in)
35	9.79±0.20 (21.54±0.44 lbs)	18.48±0.32	20.26±0.34	20.06±0.41

Correlation between formula estimated and actual body weight of Salem black goat is given in Table 2. There was positive and non-significant correlation (p>0.05) between the actual body weight and calculated body weight indicating the less reliability of Shaffer's formula in Salem black goats. This is in accordance with Moaeen-ud-Din *et al.*, (2006) [6] for Beetal goat.

Table 2: Correlation between formula estimated andactual body weight

Sample no. (N)	Actual body weight (lbs)	Body weight as per Shaffer's formula (lbs)	Correlation between Shaffer's and actual body weight
35	21.39±0.50	25.03±0.99	0.0040^{NS}

The regression equation for predicting the dependent variable body weight based on linear body measurements Viz. body length, chest girth and height at withers and coefficient of determination are presented in Table 3. The coefficient of determination in case of simple linear regression was lowest using height at withers (0.0023)

followed by chest girth (0.019) and then body length m (0.0705).

It is clear that maximum value of R^2 was obtained by combination of more than one estimate of body measurements so this indicated that weight can be estimated more accurately by combination of two or more than two factors than only one. The studies reported by Das and Sharma, (1994) [3]; Topal *et al*., (2003) [13, 14] and Topal and Macit (2004) [11, 12] also supported these results.

Table 3: Regression of body weight on body measurements

Prediction equation	Intercept (Y)	Regression co-efficient			R^2
		B1	B2	B3	
$Y = a + b_1X_1$	12.90	-0.1680 (0.1232)	-	-	0.0705^{NS}
$Y = a + b_2X_2$	8.40	-	0.0697 (0.4185)	-	0.0199^{NS}
$Y = a + b_3X_3$	9.20			0.0295 (0.7825)	0.0023^{NS}
$Y = a + b_1X_1 + b_2X_2$	6.33	0.3421 (0.1481)	0.9469 (0.0000)	-	0.7839^{**}
$Y = a + b_1X_1 + b_3X_3$	11.02	0.3421 (0.1481)	-	-0.2883 (0.2068)	0.0623^{NS}
$Y = a + b_2X_2 + b_3X_3$	12.42	-	0.9469 (0.0000)	-0.2883 (0.2068)	0.7839^{**}
$Y = a + b_1X_1 + b_2X_2 + b_3X_3$	9.92	0.9469 (0.1481)	-0.2883 (0.0000)	0.3421 (0.2068)	0.7839^{**}

X_1-Body Length, X_2-Chest Girth, X_3-Height at withers, Y-Body weight

Conclusion

In a multiple regression analysis the important thing to be considered was which independent variables were most considered in determining the dependent variable. As a criterion, the value of R^2always increased as more independent variables were added to the regression. Inclusion of chest girth produced higher R^2 (0.7839) with significant correlation when combined with body length and height at withers whereas the regression equation with body weight as dependent variable and body length and height at withers as independent variable produced lowest R^2 (0.0623) value in Salem black goats. This is in accordance with the results of Chitra *et al.*, 2012 [2]. Hence the estimation of body weight with chest girth alone or in combination with other linear body measurements produces a better fit in Salem black goats.

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