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Some body measurements as a management tool for Shami goats raised in subtropical areas in Egypt

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Abstract

Background: This filed work was conducted to describe the morphological features of Shami goats in subtropical areas in Egypt. The study covered Southern Sinai and Noubaria districts in Egypt. Data were collected from 30 goats of different age groups. Fifteen were males and 15 were females.

Results: Results show that male was heavier and longer than female. The mean live body weight (LBW) of the male group was 35.40 kg, while that of female group was 33.46 kg. However, these differences were not significant ($P > 0.05$). The body length (BL) of male recorded 77.80 cm, while that of the female was 74.73 cm. Similarly, the heart girth (HG), as well as withers height (WH), was also higher ($P < 0.05$) in male than those of the female. Both HG ($r = 0.98$) and neck circumference (NC) ($r = 0.96$) presented the highest correlations with LBW of males, while the measurements of BL and head length (HEL) presented the highest correlations ($r = 0.95$–0.86) with LBW of females. Live body weight of the male was accurately and significantly ($P < 0.01$) predicted by the measurements of HG and NC with $R^2 = 0.98$. While BL and paunch girth (PG) were significantly ($P < 0.01$) used to predict LBW of the female with $R^2 = 0.92$. Stepwise regression analysis determined that BL and HG were the major significant contributors to the LBW prediction equation of total (male and female). Body length was the first independent variable to enter the model followed by HG, NC, and PG entered the best-fitted regression models. Thus, they were the variables entered to obtain the optimal regression models. The high correlation values between predicted and actual live body weight measurements give credence to the validity of using these models for predicting live weights of Shami goats.

Conclusions: From this data, it could be concluded that the live weight can be predicted with high accuracy from some body measurements which can be exploited by goat producers for management, selection, and genetic improvement of Shami goats and could be used successfully in new breeding programs in Egypt.

Keywords: Body measurements, Management, Regression, Shami goats, Egypt

Introduction

Phenotypic characterization of animal genetic resources (AnGR) is the process of identifying distinct breeds by describing their external and production characteristics in a given environment and under given management, taking into account the social and economic factors. The information generated by phenotypic characterization studies is essential for planning the management of AnGR at local, national, regional, and global levels (FAO, 2012). The global plan of action for AnGR recognizes that a good understanding of breed characteristics is necessary to guide decision-making in livestock development and breeding programs (FAO, 2007).

In the last few years, there has been a growing interest in breeding schemes. Quite recently, considerable attention has been paid to breeding programs of goats. Breeding programs of goats are widely carried out in many countries of the world and have led to the development of several specialized breeds (Abd-Allah, 2014; Abd-Allah et al., 2015 and 2016; Dubeuf et al., 2004; Morand-Fehr and Lebbie, 2004). Phenotypic characterization is essential in mapping out an inventory of characteristics peculiar to a group of animals and sustainable use of its animal genetic resources. Lack of information on characterization of the genetic

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resource may lead to underutilization of that resource, its replacement, and dilution through crossbreeding despite their local adaptation to prevailing environmental constraints (Manzi et al., 2011). Several breeding programs were applied on Shami goats in Syria, Cyprus, and Lebanon. However, in a review on goat breeding comparing the performance of many of the world breeds, there was a little reference to the Shami (Damascus) goat (Shrestha and Fahmy, 2007a and b). Shami goats obtained importance in recent years, as it is a specialized breed that could increase the productivity of Egyptian goat and reduce kid production costs. Although, weight is an important objective in a selection, the potential for genetic improvement largely depend on the genetic and phenotypic parameters of this trait upon which selection may be applied (Mavrogenis et al., 1984 and Das et al., 1996). Moreover, environmental influences can be controlled and corrected to permit more accurate identification of genetic differences between individual goats (Hermiz, 1998). During selection of goat, attention should be given to the age, growth rate, LBW, HG, BL, and WH. The prediction of BW and its relationships to other morphological measurements produces appreciable knowledge for breeding investigation with regard to meat production per animal (Janssens and Vandepitte, 2004; Yilmaz et al., 2013 and Iqbal et al., 2013). The net result of dependence on estimated live body weights is inefficiencies in both the management of animals and inconsistencies in prices of goats which all work against the farmer. Availability of a weight band and farmer training on how to use it would assist resource-poor farmers in implementing good animal husbandry practices. The present experimental work, therefore, was undertaken to characterize some body characteristics of Shami goat and has been used to determine the best-fitted regression model for prediction of live body weight in subtropical districts such as South Sinai and Noubaria in an effort to develop local goat breeding strategy in Egypt.

Materials and methods
Description of the study area
During the period between 2015 and 2016, sampling was carried out in two selected governorats in subtropical areas in Egypt, namely Southern Sinai and Noubaria region, respectively. A total of 30 Shami goats (15 females and 15 males) located in two selected states. Experimental area has an arid climate with hot dry summer and cool winter prevailing in this area.

Experimental procedure
Sampling procedure
All procedures and experimental protocols were conducted in accordance with the Guide for the Care and Use of Agricultural Animals in Research and Teaching, Federation of Animal Science Societies (FASS, 2010). Two groups which contain 30 of bucks and does of Shami goats. The first group (southern Sinai region) involved 16 heads (10 males and 6 females), aging 1.5–3.5 years, while the second group (Noubaria region) was formed by 14 heads (5 males and 9 females) aging 1.4 years.

According to the environmental conditions at the two sites under study, all goats were kept under equal management and the ration was offered daily in two parts at 9 am and 4 pm, approximately. Fresh water and salt blocks were available continuously during the experimental period. All animals were fed on concentrate feed mixture (CFM), consisted of 17% wheat bran, 15% cotton seed meal, 50% yellow corn, 15% sunflower meal, 2% limestone, and 1% salt, according to their live body weight (NRC,1981), plus free available green Acacia and Atriplex or bean straw, where *Acacia saligna* and *Atriplex halimus* were collected daily from the experimental farm in El-Tor city, South Sinai.

Data collection

Assessment of live body weight (LBW) Goats were weighed individually by using a pallet balance of 500 kg capacity, where this body weight was recorded in the morning before the animals were fed.

Assessment of body linear measurements The linear dimensions measured included the following eight linear body measurements: heart girth (HG), wither height (WH), body length (BL), chest depth (CD), head length (HEL), paunch girth (PG), shank circumference (SC), and neck circumference (NC).

The height measurement (cm) was done using a graduated measuring stick. The measurements were taken in the morning, with the animals standing on a flat surface with head held up and held by three field assistants. The length and circumference measurements (cm) were effected using a tape rule. All measurements were carried out by the same person in order to avoid individual variations.

The measurements were taken as follows:

1. Heart girth (HG) was measured as a circumferential measure taken around the chest just behind the front legs and withers.
2. Wither height (WH) was measured as the distance from the surface of a platform to the withers.
3. Body length (BL) was the distance from the base of the ear to the base of the tail (where it joins the body).
4. Chest depth (CD) was measured as vertical distance from sternum to withers.

5. Head length (HEL) was the distance measured from nodule of the horn to the upper lip of the animal.
6. Paunch girth (PG) was measured as the circumference of the body immediately after the abdomen just before the hind legs.
7. Shank circumference (SC) was measured from the left mid metacarpus.
8. Neck circumference (NC) was measured as the circumference of the neck at the midpoint.

Data analysis

The program SPSS (2008) statistical package designed for windows was used for the statistical analyses. Means were separated using the two-tailed, two-sample t test. Differences were considered to be significant at $P < 0.05$. Relationships between the several body measurements were calculated by Pearson correlations, and regression equations were established. Live body weight was regressed on linear body measurements using stepwise multiple linear regression analysis. The coefficient of determination (R^2) was used to assess the accuracy of prediction equations between live body weights and linear body measurements. Separate prediction equations were developed for the male and female.

Results

Descriptive analysis of body weight and morphological traits

Descriptive statistics of LBW and morphometric traits of Shami goats are shown in Table 1. The results showed that there was a numerical mean difference between males and females in all morphometric measurements. However, these differences were not significant ($P < 0.05$) indicating for HG, WH, BL, CD, HEL, and PG. Average live body weight was not significantly ($P < 0.05$) higher in males than in females. While male had higher ($P < 0.05$) SC and NC.

Bivariate correlations between body weight and measurements of Shami goats

The correlation coefficient between live weight and body measurement of the two sexes are shown in Table 2. It is clear that the majority of correlation coefficients between measurements were high and significant ($P < 0.01$) in both males and females. The highest and strongly positive correlation ($P < 0.01$) was recorded between live body weight and heart girth (0.98) for the male and of body length (0.95) for female goats. On the other hand, lower estimates were recorded for the correlation of LBW with both CD ($r = 0.76$) for male and of NC ($r = 0.69$) for female does.

Prediction of body weight from body measurements

Based on the importance of the independent variables in predicting the live weight of Shami goats, three body measurements, namely BL, HG, and NC were found to be more efficient. Body length was the first independent variable to enter the model followed by hip HG, and NC entered the best-fitted regression models. Thus, they were the variables entered to obtain the optimal regression models. It is necessary here to say that live weight of Shami goats can be predicted from BL and HG with a coefficient of determination 0.92 and HG and NC with a coefficient of 0.98 for Shami male. Heart girth was not the best variable to estimate live body weight for female goats. It was the BL and PG with a coefficient of 0.93, which was used to estimate weight for female. The best-fitted regression models in each group were included in Table 3.

Weight values corresponding to HG and BL measures for male and female of Shami goats

Predicted live weights based on HG measurements had a 0.96 correlation coefficient to the actual live body weights for male, while predicted live weights obtained using BL model gave a correlation coefficient of 0.90 to the actual live body weights for female (Table 4).

Table 1 Descriptive statistics of the morphological traits of Shami goats based on sex

Traits	Shami goats ($n = 30$)				Male ($n = 15$)			Female ($n = 15$)		
	Mean	SE	SD	CV (%)	Mean	SE	SD	Mean	SE	SD
LBW	34.43	1.95	10.68	31.01	35.40[a]	3.05	11.82	33.46[a]	2.51	9.73
HG	76.43	1.85	10.18	13.31	78.73[a]	3.04	11.79	74.13[a]	2.07	8.03
WH	64.96	1.18	6.51	10.02	64.80[a]	1.94	7.54	65.13[a]	1.43	5.56
BL	76.26	1.84	10.09	13.23	77.80[a]	2.54	9.86	74.73[a]	2.69	10.43
CD	34.83	0.74	4.06	11.65	35.80[a]	1.06	4.12	33.86[a]	1.00	3.88
SC	8.40	0.21	1.19	14.16	8.86[a]	0.36	1.40	7.93[b]	.180	.700
HEL	17.93	0.31	1.74	9.70	18.06[a]	0.45	1.75	17.80[a]	.450	1.78
PG	33.20	0.69	3.82	11.50	32.93[a]	2.13	8.28	33.46[a]	2.11	8.20
NC	33.06	1.20	6.62	20.0	36.26[a]	1.93	7.48	29.86[b]	.920	3.58

Superscripts a and b mean within rows are significantly different ($P < 0.05$)
SD standard deviation, SE standard error, CV coefficient of variation

Table 2 Bivariate correlations among morphological traits and LBW of male (above diagonal) and female (below diagonal) Shami goats

Traits	LBW	HG	WH	BL	CD	SC	HEL	PG	NC
LBW	–	0.979[b]	0.940[b]	0.905[b]	0.764[b]	0.922[b]	0.854[b]	0.854[b]	0.961[b]
HG	0.830[b]	–	0.969[b]	0.871[b]	0.731[b]	0.923[b]	0.779[b]	0.879[b]	0.915[b]
WH	0.796[b]	0.761[b]	–	0.821[b]	0.593[a]	0.899[b]	0.699[b]	0.785[b]	0.853[b]
BL	0.947[b]	0.774[b]	0.805[b]	–	0.792[b]	0.831[b]	0.915[b]	0.860[b]	0.887[b]
CD	0.715[b]	0.718[b]	0.799[b]	0.729[b]	–	0.782[b]	0.753[b]	0.721[b]	0.820[b]
SC	0.776[b]	0.482	0.714[b]	0.766[b]	0.727[b]	–	0.786[b]	0.727[b]	0.871[b]
HEL	0.858[b]	0.806[b]	0.637[a]	0.839[b]	0.563[a]	0.559[a]	–	0.742[b]	0.892[b]
PG	0.846[b]	0.842[b]	0.786[b]	0.765[b]	0.712[b]	0.490	0.707[b]	–	0.811[b]
NC	0.692[b]	0.487	0.674[b]	0.700[b]	0.696[b]	0.733[b]	0.578[a]	0.569[a]	–

[a]Correlation is significant at the 0.05 level (two-tailed)
[b]Correlation is significant at the 0.01 level (two-tailed)

Discussion

Descriptive analysis of body weight and morphological traits

The higher values reported for the morphometric traits of males compared to females seem in accordance with earlier reports on goats (Vargas et al., 2007). The results thus obtained in this study are likely connected with our previous studies. The previous results have shown that the higher live body weight of male kids after weaning may be attributed to their birth weight; this is because they were born heavier than females in crossbred Boer goats (Abd-Allah, 2014 and Abd-Allah et al., 2016). Isaac (2005) reported that sexual dimorphism in body size is clearly widespread among many mammalian taxa, with male-biased dimorphism being the more common, but certainly not the exclusive pattern. It is important that the coefficient of variation in the morphometric traits ranged from 9.70–20.0%; this indicates homogeneity between traits under study. The findings of the present study show that BL is 76.26 cm, HG is 76.43 cm, and WH is 64.96 cm in Shami goats. The observations of the current investigation are somewhat different from those of Alsheikh (2013) who reported that low mean lives in BL, HG, and WH were 57.21, 31.66, and 41.76, respectively, in Shami does of the same environmental condition in Sinai, Egypt. Also, our values were higher than that reported by Moaeen-ud-Din et al.(2006) who reported 64.97 cm body length, 70.23 cm height at withers, and 61.29 cm heart girth, for crossbred goats. The variation in various body measurements in different studies on the same breed may be due to the difference in the environment, size of data set, and other management practices.

Table 3 Regression equations developed to estimate weight from linear body measurements of Shami goats

Groups	Model	R	R^2	Adj. R^2	S.E	R^2 change	F change	Sig. F change
Total	1	0.917[a]	0.841	0.835	4.34079	0.841	147.846	0.000
	2	0.961[b]	0.923	0.918	3.06535	0.083	29.148	0.000
	Model summary				Regression equations			
	a. Predictors: (constant), BL				LBW = − 200939.582 + 0.970* BL			
	b. Predictors: (constant), BL, HG				LBW = − 46.726 + 0.542* BL + 0.521* HG			
Male	1	0.979[a]	0.958	0.955	2.52153	0.958	294.891	0.000
	2	0.992[b]	0.984	0.982	1.60140	0.027	20.231	0.001
	Model summary				Regression equations			
	a. Predictors: (constant), HG				LBW = − 41.864 + .981* HG			
	b. Predictors: (constant), HG, NC				LBW = − 35.829 + 0.611* HG + 0.637* NC			
Female	1	0.947[a]	0.897	0.889	3.23887	0.897	113.568	0.000
	2	0.966[b]	0.933	0.922	2.72650	0.036	6.345	0.027
	Model summary				Prediction equations			
	a. Predictors: (constant), BL				LBW = − 32.589 + 0.884* BL			
	b. Predictors: (constant), BL, PG				LBW = − 48.080 + 0.675* BL + 0.347* PG			

Superscripts a and b mean within rows are significantly different ($P < 0.05$)
*. Correlation is significant at the 0.05 level (2-tailed)

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Table 4 Predicted live body weight (kg) of Shami goats given HG (cm) for male and BL (cm) for female

N	Male			Female		
	HG (cm)	ALBW (kg)	PLBW (kg)	BL (cm)	ALBW (kg)	PLBW (kg)
1	83.00	44.00	39.38	87.00	42.00	44.32
2	96.00	53.00	52.31	93.00	50.00	49.62
3	97.00	53.00	53.29	83.00	41.00	40.78
4	72.00	30.00	28.77	85.00	44.00	42.55
5	75.00	33.00	31.70	70.00	30.00	29.29
6	80.00	33.00	36.54	60.00	22.00	20.45
7	82.00	36.00	38.58	60.00	23.00	20.45
8	58.00	14.00	15.00	74.00	33.00	32.83
9	69.00	23.00	25.83	81.00	41.00	39.00
10	61.00	20.00	17.97	67.00	25.00	26.63
11	83.00	43.00	39.56	77.00	27.00	35.48
12	96.00	52.00	52.31	79.00	41.00	36.75
13	72.00	30.00	28.77	78.00	40.00	36.36
14	75.00	32.00	31.71	60.00	20.00	20.45
15	82.00	35.00	38.58	67.00	23.00	26.63

ALBW actual live bodyweight, *PLBW* predicted live body weight, *HG* heart girth, *BL* body length

Bivariate correlations between body weight and measurements of Shami goats

The results are supported by Abdel-Mageed and Ghanem (2013), who decided that both HG ($r = 0.91$) and BL ($r = 0.90$) presented the highest correlations with LBW of Shami kids. BL and HG may be used as good reliable predictors to assess live weight according to Bhattacharya et al. (1984) and Islam et al. (1991) reported that heart girth in males is a good predictor of live weight in Bengal goats. There was a correlation of LBW with length, height, and HG in Black Bengal goats (Prasad et al., 1981). Since there are high correlation coefficients between live body weight and body measurements, either of these variables or combination could provide a good estimate for predicting live weight in Shami goats. Khan et al. (2006) concluded that since the body measurements had a high correlation with the live body weight, this may be used as selection criteria. On the other hand, Ott (1986) recorded that determination of scrotal length and circumference is an important aspect of breeding soundness examination (BSE) and scrotal circumference has great value as an indicator of genetic trait, puberty, and total spermatozoa production.

Prediction of body weight from body measurements

According to the results of this study, the highest correlation was determined between LBW and HG in male group. These findings are in harmony with that of Bhattacharya et al. (1984) and Islam et al. (1991), who reported that body length and heart girth may be used as good reliable predictors to assess live weight according to reported that heart girth in males is a good predictor of live weight in Bengal goats. The result is generally in agreement with Taye et al. (2010) who reported that HG is the best predictor of weight. Nevertheless, HG parameter is the easiest way to use for live weight prediction in field conditions.

Live weight values corresponding to HG and BL measures for male and female Shami goats

The R^2 value of 0.96 for the exponential model with HG as the sole finding of this investigation in the study is in close agreement with de Villiers et al. (2009), who used nonlinear regression models on data collected from 1202 Boer goats and reported an R^2 value of 89.4 for a heart girth-based prediction model. The high correlation values between predicted and actual live body weight measurements give credence to the validity of using these models for predicting live weights of Shami goats. Also, the obtained results of this study is in close agreement with de Villiers et al. (2009), who indicted that measurements give credence to the validity of using these models for predicting live weights of Swazi goats.

Conclusion

Shami goats is one of the goats' breeds that can be used to improve the local breeds of goats genetically by crossing in Egypt, especially as it is an attractive morphological strain of great potential for milk and fattening compared with other local breeds in Egypt. In the same way, we may conclude that in order to practice good animal husbandry, the measurement of live body weight is totally essential for breeding, nutrition, and health management. The positive and significant correlation of weight with linear body measurements indicate that linear body measurements can be used as a marker to estimate weight using regression equations. In the current study, both of the effects of age and location study did not evaluate, but this area of research in subtropical Shami goat needs further studies with increasing the sample size to clarify the influence of each age and location on the predicting models.

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