

Phenotypic Characterization of Indigenous Goat Population in Batticaloa District, Sri Lanka

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Abstract: Information on variation of phenotypic characters plays an important role in characterization of goat population for selective breeding and genetic resource conservation. The study was conducted to identify and characterize the phenotypes using linear body measurements and physical body characteristics of indigenous goat population in Batticaloa district, Sri Lanka. In this study indigenous goats were selected from preferred areas within the district using purposive and random sampling methods. About 100 indigenous goats were selected for the study. Data were statistically analyzed using General linear model procedure (PROC GLM) of SAS 9.2, 2008 and descriptive statistical analysis. Most of the male and female goats had straight head profile (64%) and pendulous ear type (75%). Predominant coat colour was black and white (29%) and the coat colour pattern was patchy (56%). Majority of the goats had back horn orientation (55%) in the study area. Some of the goats in the study population contained wattle and bear. Significant effect ($p < 0.05$) of sex and age was observed on live body weight and linear body measurements. Positive correlations were observed between live body weight and other linear body measurements.

Keywords: Indigenous goats, linear body measurements, live body weight, phenotypic characterization.

INTRODUCTION

Small ruminant are reared in Asia as an important subsector of animal production. In Sri Lanka goats are reared majorly as small ruminants and goat production is a main source of income for some livestock farmers.

Goat rearing plays a vital role in Sri Lanka's rural economy. In Sri Lanka the indigenous goats and the cross breeds are reared largely under extensive management system [1]. The goat population in Sri Lanka has stayed relatively constant about 0.5 million since 1991 [2]. Mostly in dry zone districts mostly indigenous goat breeds are reared.

The indigenous goats can be improved by mass selection based on the phenotypic characters and also individuals containing superior characteristics can be selected as parents for the next generation [3]. Knowledge on variation of phenotypic traits which have played a basic role in classification of livestock based on size and shapes is important for the characterization of local genetic resources [4, 5]. The first approach to sustainable use of animal genetic resources is breed characterization [6]. Phenotypic characterization of indigenous goat population is very essential to make effective utilization of their potential. Identification, characterization and documentation of goat traits are vital for the improvement of animals. Without documentation, it may be difficult to recognize the animals and their potential [7]. Proper breeding

programmes cannot be designed for animals which have not been characterized phenotypically and genetically [8]. Live weight is a general measure of animal performance because it gives reliable and useful information for feeding, management, selection and decision making on market price [9]. Information from phenotypic characterization will be helpful for designing suitable selection systems and breeding programmes for genetic conservation and genetic improvement of indigenous goat breeds. Therefore, the aims of this study were identification and phenotypic characterization of indigenous goats found in Batticaloa district, Sri Lanka using linear body measurements and physical body characteristics.

MATERIALS AND METHODOLOGY

Description of the study area

The study was conducted in Batticaloa district, Sri Lanka. It is located at Latitude of $7^{\circ} 42' 36.72''$ N and Longitude of $81^{\circ} 41' 32.64''$ E. Samples of goats were obtained from selected veterinary ranges within the district based on the goat's population. Goat's population data were obtained from Divisional

Veterinary Office of Department of Animal Production and Health, Batticaloa.

Collection of physical body characters

Visual observation was made and physical characters were recorded for 100 indigenous goats. Each goat was identified by its sex and age of the goats was calculated based on dentition. Age of the goats were grouped into 4 age group categories: 0 PPI (under 1 year), 1 PPI (1 to 1.5 years), 2 PPI (2 years), 3 PPI (2.5 years) and 4 PPI (3 years and above).

Collection of body measurements

Live body weight and other linear body measurements were measured using measuring tape for 100 indigenous goat breeds in the sampling sites. The goats were separated according to the sex and age before taking measurements. The linear body measurements were made using plastic measuring tape and live body weight of goats was measured using suspended spring balance.

Statistical analysis

Sex and age of the goats were fitted as independent variables and live body weight and linear body measurements were fitted as dependent variables. Statistical differences between quantitative variables of selected goats were analyzed using General linear model procedure (PROC GLM) of SAS 9.2, 2008. Least square means with their corresponding standard errors were calculated for each body trait over sex and age. The Duncan Multiple Range test was used to separate significance ($p < 0.05$) of least-square means.

The model fitted for analyses of body weight and other linear body measurements was:

$$Y = \beta_0 - \beta_1 X_1 + \beta_2 X_2 + e$$

Y = Dependant Variables (Body weight or linear body measurements)

β_0 = Intercept

β_1, β_2 = Partial regression coefficients

X_1 = Effect of sex group (0 – Male and 1 – Female)

X_2 = Effect of age group

e = Random residual error

RESULTS AND DISCUSSION

Physical body characters of indigenous goat population

Physical body characters of the indigenous goat population was shown in Table 1. Out of the total sample goat population (100 goats) male goats were 46% and female goats were 54%. Majority of the goat population 64% had straight head, 35% had slightly convex head and only 1% of the goats had slightly

convex head. In the study area predominant ear type was pendulous and it was 75% and 25% was horizontal ear type. Goats in the study area had variety of coat colour such as white, black, brown and combination of these colours. Among them majority of the goats had white colour in their coat including the mixed coat colour type compared to plain black and brown coat colour. Since Batticaloa district is a dry zone with high amount of solar radiation white coat colour provides an adaptation mechanism to heat. So, majority of the indigenous goats in this area show tolerance to the heat stress. White coat colour could be a benefit to animals in high solar radiation areas due its reflective property [10]. The goats which had only one coat colour (white or black or brown) were plain in coat colour pattern and the goats which had more than one colour had patchy and spotted coat colour pattern. Coat colour pattern of patchy was nearly half (56%) compared to plain and spotted coat colour pattern.

Half (55%) of the goats had back horn orientation and 39% and 6% of the goats had rudimentary and front horn orientation respectively. Out of the total goat population 31% of the goats had wattle and 69% of the goats had no wattles. 26.1% of total male population contained bear and 73.9% of the goats had no bear. Majority of the goats in the study area had horns. 78% of goats had horns and 22% of the goats did not have horns. Presence of horns in indigenous goats is an important mechanism of self-defending [11].

Live body weight and linear measurements of indigenous goat population

Least square mean and standard deviation for sex and age effect on live body weight and linear body measurements are shown in Table 2. Males had 3.13 kg higher the body weight ($p < 0.05$) compared to female. Males had higher values for linear body measurements ($p < 0.05$) than female. These results were in agreement with the finding of Gelana and Asefa, [12] in indigenous goats of South East Ethiopia. On the other hand these results were in contrast with the results of Jimmy *et al.* [13] and Okbeku *et al.* [14] who reported female goats had higher body weight and linear body measurements compared to male.

The variation in live body weight and other linear body measurements between males and females shows that these traits are sex dependant and the increase in live body weight and other linear body measurements with the age (0 PPI to 4 PPI) indicated that these traits are also age dependant. These findings were supported by [12].

Table-1: Physical body characters of indigenous goat population

| Physical body characters | Variables | Male (%) | Female (%) | Total (%) |
|--------------------------|------------------------|----------|------------|-----------|
| Head Profile | Straight | 54.3 | 72.2 | 64.0 |
| | Slightly convex | 43.5 | 27.8 | 35.0 |
| | Slightly concave | 2.2 | 0.0 | 1.0 |
| Ear Type | Pendulous | 65.2 | 83.3 | 75.0 |
| | Horizontal | 34.8 | 16.7 | 25.0 |
| Coat Colour Type | White | 15.2 | 18.5 | 17.0 |
| | Black | 6.5 | 5.6 | 6.0 |
| | Brown | 8.7 | 5.6 | 7.0 |
| | White and Black | 26.1 | 31.5 | 29.0 |
| | White and Brown | 15.2 | 14.8 | 15.0 |
| | Black and Brown | 6.5 | 1.9 | 4.0 |
| | White, Black and Brown | 21.7 | 22.2 | 22.0 |
| Coat Colour Pattern | Plain | 30.4 | 29.6 | 30.0 |
| | Patchy | 56.5 | 55.6 | 56.0 |
| | Spotted | 13 | 14.8 | 14.0 |
| Horn Orientation | Rudimentary | 39.1 | 38.9 | 39.0 |
| | Front | 8.7 | 3.7 | 6.0 |
| | Back | 52.2 | 57.4 | 55.0 |
| Wattle | Present | 37 | 25.9 | 31.0 |
| | Absent | 63 | 74.1 | 69.0 |
| Bear | Present | 26.1 | 0.0 | 12.0 |
| | Absent | 73.9 | 100 | 88.0 |
| Horn | Present | 73.9 | 81.5 | 78.0 |
| | Absent | 26.1 | 18.5 | 22.0 |

Table-2: Least square means (LSM) and standard deviation (\pm SD) of live body weight (kg) and linear body measurements (cm) for indigenous sample goat population

| Variables | OPPI | | 1PPI | | 2PPI | | 3PPI | | 4PPI | |
|-----------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|------------------------------|-----------------------------|
| | Male | Female | Male | Female | Male | Female | Male | Female | Male | Female |
| LBW | 8.6 \pm 2.8 ^a | 6.5 \pm 2.86 ^b | 17.3 \pm 6.3 ^a | 14.2 \pm 5.7 ^b | 24.5 \pm 4.2 ^a | 17.9 \pm 3.9 ^b | 27.4 \pm 1.3 ^a | 21.7 \pm 1.9 ^b | 30.4 \pm 11.3 ^a | 24.6 \pm 3.9 ^b |
| HG | 48.6 \pm 7.4 ^a | 48.2 \pm 4.7 ^a | 49.3 \pm 8.5 ^a | 48.5 \pm 7.5 ^a | 56.6 \pm 0.9 ^a | 49.4 \pm 3.1 ^b | 59.4 \pm 5.0 ^a | 55.1 \pm 2.8 ^b | 63.1 \pm 10.2 ^a | 56.2 \pm 3.4 ^b |
| RH | 44.9 \pm 7.8 ^a | 44.3 \pm 5.4 ^a | 48.2 \pm 5.2 ^a | 47.7 \pm 5.2 ^a | 53.7 \pm 2.6 ^a | 48.8 \pm 2.6 ^b | 55.2 \pm 6.4 ^a | 51.8 \pm 4.2 ^a | 57.4 \pm 2.7 ^a | 53.8 \pm 2.2 ^b |
| HW | 43.1 \pm 6.8 ^a | 42.1 \pm 7.4 ^a | 46.8 \pm 6 ^a | 46.1 \pm 4.8 ^a | 52.1 \pm 0.6 ^a | 45.9 \pm 2.7 ^b | 53.1 \pm 5.8 ^a | 48.3 \pm 4.1 ^a | 54.3 \pm 4.1 ^a | 49.0 \pm 4.6 ^a |
| BL | 42 \pm 7.1 ^a | 41.7 \pm 4.8 ^a | 47.3 \pm 9.2 ^a | 45.1 \pm 6.1 ^a | 51.7 \pm 5.1 ^a | 47.1 \pm 3.7 ^a | 51.4 \pm 5.7 ^a | 47.6 \pm 4.7 ^a | 53.3 \pm 7.4 ^a | 50.2 \pm 3.1 ^a |
| EL | 5.2 \pm 4.24 ^a | 4.6 \pm 2.7 ^a | 6.3 \pm 6.2 ^a | 5.1 \pm 2.7 ^a | 7.3 \pm 1.9 ^a | 5.9 \pm 0.9 ^a | 7.4 \pm 2.6 ^a | 6.9 \pm 1.7 ^a | 7.9 \pm 3.1 ^a | 7.4 \pm 2.2 ^a |
| HL | 13.6 \pm 1.6 ^a | 12.5 \pm 2.7 ^a | 14.5 \pm 2.3 ^a | 13.3 \pm 3.4 ^a | 15.5 \pm 1.2 ^a | 14.9 \pm 3.1 ^a | 15.6 \pm 0.4 ^a | 15.2 \pm 0.7 ^a | 16.6 \pm 1.5 ^a | 16.4 \pm 1.9 ^a |
| TL | 11.5 \pm 2.2 ^a | 11.3 \pm 2.0 ^a | 14.2 \pm 3.0 ^a | 13.2 \pm 2.2 ^a | 16.2 \pm 2.1 ^a | 14.8 \pm 4.8 ^a | 16.2 \pm 1.4 ^a | 15.2 \pm 0.8 ^a | 17.1 \pm 4.9 ^a | 16.8 \pm 2.8 ^a |
| SC | 9.2 \pm 2.7 | - | 10.9 \pm 2.8 | - | 12.4 \pm 1.7 | - | 13.6 \pm 0.8 | - | 16.8 \pm 7.6 | - |

Mean within age group are connected with different letters differ significantly ($P < 0.05$).

LBW = Live Body Weight; HG = Heart girth; RH = Rump height; HW = Height at wither; BL = Body length; EL = Ear Length; HL = Horn Length; TL = Tail Length; SC = Scrotum circumference.

OPPI = 0 Pair of Permanent Incisors; 1PPI = 1 Pair of Permanent Incisors; 2 PPI = 2 Pairs of Permanent Incisors; 3PPI = 3 Pairs of Permanent Incisors; 4PPI = 4 Pairs of Permanent Incisors.

In this study body weight and other body measurements were sex and age dependant. The measurements obtained in this study were in agreement with the findings of Belete *et al.* [15] and Hassen *et al.* [16]. Most of the linear body measurements were not significant ($p > 0.05$) between males and females for each age groups. However, live body weight showed significance variation ($p < 0.05$) between both sexes.

Live body weight and linear body measurements for indigenous goats of different age groups are shown in Table 3. Live body weight and the other body measurements were significantly ($P < 0.05$) affected by age group. Live body weight was significantly ($P < 0.05$) differed among the four age groups. Live body weight and other linear measurements were increasing with the increase of age. This was in agreement with the report of Otoikhian *et al.* [17]; Gelana and Asefa [12].

Table-3: Least square means (LSM) and standard deviation (\pm SD) of live body weight (kg) and linear body measurements (cm) for indigenous sample goat population for different age groups

| Variables | 0PPI | 1PPI | 2PPI | 3PPI | 4PPI |
|-----------|-----------------------------|------------------------------|-------------------------------|------------------------------|-----------------------------|
| LBW | 7.6 \pm 3.0 ^e | 15.3 \pm 6.6 ^d | 20.2 \pm 5.0 ^c | 24.6 \pm 3.5 ^b | 27.8 \pm 9.0 ^a |
| HG | 48.4 \pm 6.2 ^b | 48.8 \pm 7.8 ^b | 51.8 \pm 4.4 ^b | 57.3 \pm 4.3 ^a | 59.9 \pm 8.4 ^a |
| HR | 44.6 \pm 6.7 ^d | 47.9 \pm 5.1 ^c | 50.4 \pm 3.5 ^{bc} | 53.6 \pm 5.2 ^{ab} | 55.7 \pm 3.0 ^a |
| HW | 42.6 \pm 7.0 ^c | 46.4 \pm 5.2 ^{bc} | 48 \pm 3.8 ^{ab} | 50.7 \pm 5.2 ^a | 51.9 \pm 5 ^a |
| BL | 41.9 \pm 6.0 ^c | 45.2 \pm 7.3 ^{bc} | 48.6 \pm 4.6 ^{ab} | 49.5 \pm 5.2 ^{ab} | 51.9 \pm 6.0 ^a |
| EL | 4.2 \pm 3.9 ^b | 5.6 \pm 4.3 ^{ab} | 6.4 \pm 1.4 ^{ab} | 7.2 \pm 2.0 ^a | 7.7 \pm 2.6 ^a |
| HL | 13.1 \pm 2.2 ^c | 13.8 \pm 3.1 ^c | 15.1 \pm 2.6 ^b | 15.4 \pm 0.6 ^{ab} | 16.5 \pm 1.6 ^a |
| TL | 11.5 \pm 2.1 ^c | 13.6 \pm 2.6 ^b | 15.3 \pm 4.1 ^{ab} | 15.7 \pm 1.1 ^a | 17 \pm 3.7 ^a |
| SC | 9.2 \pm 2.7 ^c | 10.9 \pm 2.8 ^{bc} | 12.4 \pm 1.7 ^{abc} | 13.6 \pm 0.8 ^{ab} | 16.8 \pm 7.6 ^a |

Mean within age group are connected with different letters differ significantly ($P < 0.05$).

LBW = Live Body Weight; HG = Heart girth; RH = Rump height; HW = Height at wither; BL = Body length; EL = Ear Length; HL = Horn Length; TL = Tail Length; SC = Scrotum circumference.
 0PPI = 0 Pair of Permanent Incisors; 1PPI = 1 Pair of Permanent Incisors; 2 PPI = 2 Pairs of Permanent Incisors; 3PPI = 3 Pairs of Permanent Incisors; 4PPI = 4 Pairs of Permanent Incisors

Correlation between body weight and linear body measurements of indigenous goat population

The Pearson coefficient of correlation amongst different body measurements of indigenous goats in the study area is shown in Table 4. Correlation coefficient between live body weight and other linear body measurements were positive and had significant variation for the sample population of indigenous goats in the study area. The correlation of live body weight with other linear body measurements ranged from weak to modest correlation. This was in agreement with the

findings of Gelana and Asefa [12]. The highest correlation was observed between rump height and height at wither with correlation coefficient of 0.870. Moderate Correlation was observed between live body weight and heart girth with the correlation coefficient of 0.682 and live body weight and body length with the correlation coefficient of 0.616. Hassen *et al.*, [16] found high correlation between body weight and chest girth with the correlation coefficient of 0.89 and body weight and body length with the correlation coefficient of 0.73 in west Amhara region goat population.

Table-4: Correlation between body weight and linear body measurements of indigenous sample goat population

| Variables | Correlations | | | | | | | | |
|-----------|--------------|--------|--------|--------|--------|--------|--------|--------|--------|
| | LBW | HG | RH | TL | HW | BL | EL | HL | SC |
| LBW | 1 | .682** | .624** | .639** | .598** | .616** | .375** | .361** | .425** |
| HG | .682** | 1 | .761** | .460** | .754** | .825** | .138 | .335** | .410** |
| RH | .624** | .761** | 1 | .510** | .870** | .807** | .280** | .347** | .340** |
| TL | .639** | .460** | .510** | 1 | .485** | .470** | .274** | .115 | .291** |
| HW | .598** | .754** | .870** | .485** | 1 | .786** | .136 | .312** | .370** |
| BL | .616** | .825** | .807** | .470** | .786** | 1 | .208* | .444** | .355** |
| EL | .375** | .138 | .280** | .274** | .136 | .208* | 1 | .165 | .273** |
| HL | .361** | .335** | .347** | .115 | .312** | .444** | .165 | 1 | .191 |
| SC | .425** | .410** | .340** | .291** | .370** | .355** | .273** | .191 | 1 |

** . Correlation is significant at the 0.01 level.

* . Correlation is significant at the 0.05 level.

LBW = Live Body Weight; HG = Heart girth; RH = Rump height; HW = Height at wither; BL = Body length; EL = Ear Length; HL = Horn Length; TL = Tail Length; SC = Scrotum circumference.

An increase in one of the linear body measurement would result in a corresponding increase in body weight due to the positive correlation between body weight and linear body measurements [9]. Positive correlation between live body weight and other linear body measurement indicates that these traits could be used in selection criteria since the traits may have same genetic influences [9]. The positive correlation between these body traits is also largely useful in multiple selection method especially in tandem selection.

CONCLUSION

Physical and body characters of indigenous goat population were identified and characterized in this study. Female goat population was higher in the study area compared to male goat population. The age distribution of goats in the sample population was 0PPI to 4 PPI. There were variations in live body weight and other linear measurements due to sex and age effect. Positive correlation between live body weight and linear body measurements was observed in the sample population of indigenous goats in Batticaloa district, Sri Lanka. In addition, identification and phenotypic

characterization are the primary requirements to design the breeding programmes for goats and to conserve germplasm of goats. The present study was conducted as a preliminary study to gather information regarding indigenous goat phenotypic characters.

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