Phenotypic Characterization of Indigenous Goat Population Reared in Uba Debre-Tsehay and Zala Districts of Gofa Zone, South Ethiopia

***Dereje Dea*[*1], *Ermias Eramo*[1], *Otoro Olke*[2]**

[1]Arba Minch Agricultural Research Center, Arba Minch, Ethiopia
[2]South Agricultural Research Institute, AGP-II Program, Hawassa, Ethiopia
***Corresponding author:** deredea12@gmail.com

Received: March 18, 2021 Accepted: November 7, 2021

Abstract: *The objective of this study was to describe the morphological features of indigenous goats in two lowland districts of Gofa zone in their home tract, Ethiopia. A total of 170 goats (50 males and 120 females) were used for the morphological characterization. Results confirmed that there were morphological variations in terms of coat color patterns. Accordingly, about 49.2% of goats showed plain followed by patchy (27.8); the dominant coat color was brown (44.7%) followed by white (32.7%). About 98.5% goats were characterized by possessing horn, 80.5% curved horn-shape, 54.5% with obliquely-upward horn orientation, 75.2% horizontal ear-orientation, 88.0% straight head-profile, 92.0% partially-sprit scrotum-type, 6% wattle presence, 38.0% beard and 2.5% ruff. There were no statistically significant morphological variations between males and females ($p>0.05$). These may be due to the high off-take rate of male goats at an early age. A significant difference ($p<0.05$) was observed between age and linear body measurements. There were significant correlations found among body weight with body length ($r=0.81$), wither height ($r=0.67$), chest girth ($r=0.82$), head length ($r=0.64$) and horn length ($r=0.61$). Morphological traits' variations suggest that this goat population has not yet been selected through structured selective breeding*.

Keywords: Goat, Gofa Zone, Phenotypic characterization

1. Introduction

Ethiopia has an estimated over 23 million heads of goats (CSA, 2020). Despite the wide distribution and large size of the Ethiopian goat population, the productivity per unit of animal and the contribution of this sector to the national economy is relatively low. This may be due to different factors such as poor nutrition, the prevalence of diseases, lack of appropriate breeding strategies, and poor understanding of the production system as a whole (Tesfaye *et al.*,, 2010).

Designing of goat improvement programs will only be successful when characterization of local genetic resources (based on morphological traits) based on size and shape in turn which can be to some extent reasonable economic indicator (Okpeku *et al.*, 2011).

Different research works (particularly phenotypic and genetic characterizations research activities) had been executed in different parts of the country by different organizations and individuals (FARM Africa, 1996; Tesfaye, 2004; Grum, 2010; Tesfaye, 2010; Halima *et al.*, 2012a; Halima *et al.*, 2012b). Despite the researches done, still, there are major gaps in the coverage of phenotypic characterization activities and information for monitoring populations' trends and hence unknown current risk status for many breeds. Gaps are particularly prominent in developing countries like Ethiopia (FAO, 2015).

Gofa Zone of South Region is a lowland part of the country. Characterizing goat populations around this area in the existing production environment was very essential to design management and utilization strategies. Therefore, this study was designed with the objective to characterize the physical characteristics of indigenous goat populations.

2. Materials and Methods

2.1. Description of the study areas

The study was conducted in Zala and Uba Debre-Tsehay districts of Gofa administrative zone, which is one of the 17 Zones in Southern Nations, Nationalities, and Peoplels` Region of Ethiopia. Sawla is the capital town of Gofa zone and located

514 km away from Addis Ababa, at an elevation of 1285 meters above sea level. Gofa zone is part of a region known for hilly and undulating midland and upper lowland terrain. Food crops include maize, enset. Sweet potatoes, taro, teff, and yams are grown in Gofa zone.

Zala district is bordered on the southwest by Uba Debretsehay, on the northwest by Demba Gofa, on the northeast by Kucha, on the east by Deramalo, and on the southeast by Kemba districts. Uba Debretsehay is bordered on the south and west by the Debub Omo Zone, on the north by Oyda and Demba Gofa, on the northeast by Zala, and on the east by Kemba districts.

The temperature, rainfall and altitude of Zala district is 18-25°C, 1401-1,600 mm, and 501-2,000 m, respectively, while the corresponding parameters in Uba Debre-Tsehay district are 10-27°C, 1200-1,600 mm and 5001-3.500 m

2.2. Sampling procedures

A rapid reconnaissance survey was carried out before the actual survey work with zonal and district livestock experts, development agents, local farmers, village leaders and socially respected individuals who had known to have better knowledge to locate the distribution of goat and production systems. Then, phenotypic characterization was conducted in both Zala and Uba Debre-Tsehay districts. The two districts were selected purposively based on goat population potential and accessibility.

For linear body measurements, a total of 50 males and 120 females from two districts were sampled, of which the majorities were adults following the phenotypic descriptor of FAO (2012). Measurements were taken early in the morning to avoid the effect of feeding and watering on the animal's size and conformation and when they are in a normal standing position during the same season (FAO, 2012).

The age of the animals was estimated by recall and dentition methods. Adult goats were classified in to five age groups based on pair of the permanent incisor 0PPI, 1PPI, 2PPI, 3PPI, and 4PPI, which represent the age 0-1 year, 1-2 years, 2-3 years, 3-4 years and 4-5 years, respectively as described by Gerald (1994) and FAO (2012) for tropical goat breeds.

2.3. Data collection

Quantitative data was collected by using measuring tapes and weighing scale (50 Kg spring balance) and for qualitative data coding sheets, Global Positioning System (GPS, Garmin 6.2) and Digital Camera.

Qualitative variables collected were sex, district, age, coat color pattern, coat color, horn type, horn shape, horn orientation, ear orientation, head profile, scrotum type, wattle, beard and ruff presence (Halima *et al*., 2012a).

Quantitative variables collected were: BW (bodyweight), body length (BL), Height at wither (HW), Chest Girth (CG), head length (HL), Horn Length (HL), Ear Length (EL), Scrotal circumference (SC) and Teat Length (TL) (FAO, 2012). Pregnant and highly emaciated animals were excluded from the measurement to avoid over and under-estimation, respectively.

2.4. Data analysis

All qualitative and quantitative data were analyzed by using SPSS Software version 20. The data emanating from the qualitative data (non-parametric data) were described using descriptive statistics and compared using the chi-square test

2.4.1. *Models for quantitative data analysis*

The model indicated below (Hulunim, 2014) was used for the analysis of adult body weight and linear body measurements (LBMs) except scrotum circumference and teat length.

$$yijk = \mu + Ai + Sj + \text{Dk} + \text{eijk} \quad [1]$$

Where

- yijk = the observation of body weight and LBMs in i^{th} age group, j^{th} sex and k^{th} district
- μ = overall mean
- Ai = the fixed effect of i^{th} age group (I = 1PPI, 2PPI, 3PPI, 4PPI)
- Sj= the fixed effect of j^{th} sex (j = female and male)
- Dk= the fixed effect of k^{th} district (K = Uba Debre-Tsehay and Zala)
- eijk = random residual error

The multiple regression models indicated below were used for estimation of body weight from linear body measurements (Hulunim, 2014).

$$Yj = \propto + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 + \beta 6X6 + \beta 7X7 + \beta 8X8 + ej \quad [2]$$

Where:

- Y_j = Response variable (body weight)
- α = Intercept
- X_1…., X_8 = Explanatory variables (body length, Height at wither, Chest Girth, head length, Horn Length, Ear Length, Scrotal circumference and Teat Length
- β_1…, β_8 = Regression coefficients of the variables X_1…, X_8
- e_j = Random error

3. Results and Discussion

3.1. Phenotypic description of Gofa area goat population

3.1.1. *Qualitative characteristics*

The frequency and their percentage of qualitative traits of Gofa goat population are presented in Table 1. The observed overall coat color patterns were 49.2% plain, 27.8% patchy and 22.9% spotted. According to Tesfaye *et al*. (2006) report, a higher proportion (93%) of plain coat color patterns for central highland goats around South Wollo and North Shewa. The dominant coat color types in both study districts were brown (44.7%) followed by white (32.7%), which in agreement with the findings of Halima *et al*. (2012a) and Grum (2010) where a wide range of coat colors were reported. Goats observed in the present study across all study districts were about 98.5% (horned), 54.5% (obliquely up-ward horn orientation), 75.2% (horizontal ear orientation), 92.0% (split scrotum type), 94.0% (absent wattle), 62.0% (absent beard) and 97.7% (absent ruff) (Figure 1 and 2).

Figure 1: Typical Gofa area goat population (A: Breeding buck, B: Breeding doe)

Figure 2: Scrotum type observed in the study are (A: Partially split; B: single)

Table 1: Qualitative traits of Gofa area goat population (Uba Debre-Tsehay =74, Zala = 96 and Total=170)

Parameters		District		
		Uba-D/Tsehay (%)	Zala (%)	Total (%)
Coat color pattern	Plain	41.9	52.1	49.2
	Patchy	16.2	32.3	27.8
	Spot	41.9	15.6	22.9
Coat color	White	44.6	28.1	32.7
	Brown	36.5	47.9	44.7
	Spot	2.7	2.1	2.3
	Gray	8.1	7.3	7.5
	Black	8.1	14.6	12.8
Horn type	Horned	100.0	97.9	98.5
	Polled	0.0	2.1	1.5
Horn shape	Straight	51.4	7.3	19.5
	Curved	48.6	92.7	80.5*
Horn orientation	Erect	5.4	6.2	6.0
	Obliquely upward	47.3	57.3	54.5
	Obliquely backward	47.3	36.5	39.5
Ear orientation	Horizontal	86.5	70.8	75.2*
	Semi-pendulous	13.5	29.2	24.8
Head profile	Straight	67.6	95.8	88.0*
	Partially convex	32.4	4.2	12.0
Scrotum type	Partially split	4.0	8.0	6.7
	Split	92.0	92.0	92.0
Wattle	Present	10.8	4.2	6.0
	Absent	89.2	95.8	94.0*
Beard	Present	36.5	38.5	38.0
	Absent	63.5	61.5	62.0
Ruff	Present	2.7	2.1	2.3
	Absent	97.3	97.9	97.7

3.1.2. *Live body weight and linear body measurement*

Body weight and linear body measurements of the study goat by sex, district, and age are presented in Table 2. Males showed higher values than females on the head length and horn length (p<0.05). However, body weight, body length, height at wither, chest girth and ear length were not significantly affected by sex (p<0.05). This could be due to the high off-take rate of male goats at the young stage (Hulunim, 2014).

All linear measurements except teat were significantly affected across districts (p<0.05). Except for ear length, goats in Uba Debre-Tsehay district revealed higher values on body weight, body length, height at wither, chest girth, head length and horn length (p<0.05). This could be due to variation of the management practices in the study areas mainly in Uba Debre-Tsehay district.

Age had significant effect on linear body measurements except for ear length and scrotum circumference (p<0.05). Body weight, body length, height at withers, chest girth, head length, horn length, and teat length increased when the goats get older. Knowledge of quantitative characteristics is important to implement genetic improvement through selection so as to facilitate their sustainable use and estimate live body weight from simple and more easily measurable variable as well as market value in terms of the cost of the animals (Hulunim, 2014).

Table 1: Quantitative traits (mean ±SE) of indigenous goats in Zala and Uba Debre-Tsehay districts

Parameters	BW	BL	HW	CG	HL	HoL	EL	SC	TL
Overall means	29.55±0.45	61.96±0.53	65.16±0.32	72.46±0.41	19.38±0.14	12.17±0.29	13.65±0.10	25.14±0.38	3.49±0.07
CV	13.44	6.73	5.23	5.11	6.30	23.20	8.43	8.37	18.52
R^2	0.56	0.64	0.36	0.54	0.57	0.44	0.28	0.34	0.23
Sex	NS	NS	NS	NS	*	*	NS	NS	NS
Male	29.49±0.98	61.25±1.06	66.20±0.77	72.08±0.80	20.21±0.35^{a}	14.08±0.63^{a}	13.26±0.19		
Female	29.57±0.51	62.19±0.61	64.82±0.34	72.59±0.48	19.10±0.14^{b}	11.51±0.30^{b}	13.78±0.12		
District	*	*	*	*	*	*	*	*	NS
U.D-Tsehay	32.76±0.57^{a}	66.79±0.73^{a}	66.29±0.53^{a}	74.79±0.55^{a}	20.57±0.18^{a}	13.04±0.40^{a}	13.15±0.12^{b}	26.17±0.63^{a}	3.49±0.10
Zala	27.18±0.55^{b}	58.38±0.47^{b}	64.33±0.38^{b}	70.74±0.52^{b}	18.49±0.15^{b}	11.51±0.39^{b}	14.016±0.14^{a}	24.26±.37^{b}	3.49±0.09
Age	*	*	*	*	*	*	NS	NS	*
1PPI	24.43 ±1.15^{c}	56.04±1.25^{c}	63.09±0.87^{b}	67.04±0.88^{c}	18.46±0.44^{b}	10.22±0.72^{c}	13.28±0.26	24.60±0.68	2.56±0.24^{c}
2PPI	28.83±1.14^{b}	60.65±1.22^{b}	64.31±0.70^{ab}	71.73±1.08^{b}	19.65±0.40^{a}	12.38±0.80^{ab}	13.54±0.22	25.54±0.61	3.36±0.18^{ab}
3PPI	26.59±1.08^{bc}	59.09±1.09^{b}	64.26±0.92^{ab}	69.70±0.79^{b}	18.96±.33^{ab}	10.91±0.69^{bc}	13.52±0.27	25.33±0.67	3.09±0.17^{b}
4PPI	31.88±0.49^{a}	64.64±0.63^{a}	66.19±0.41^{a}	74.82±0.44^{a}	19.65±0.17^{a}	12.95±0.36^{a}	13.81±0.14	25.50±1.56	3.67±0.07^{a}

* Significant at P<0.05, NS = not significant at P<0.05, BW = body weight, BL = body length, HW = Height at wither, CG = Chest girth, HL = Head length, HoL = Horn length, EL = Ear length, SC = Scrotal circumference, TL = Teat length, SE = standard error of mean, means with the same letter within the column and factors are not significant

3.1.3. *Relationships between body weight and other body measurements*

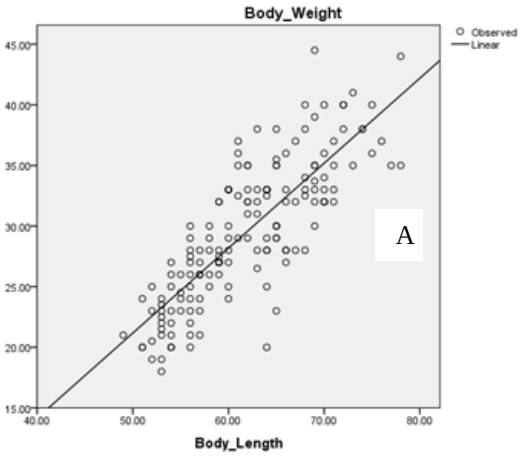
Correlation coefficient between body weight and studied traits varied from strong (0.81) to low (-0.11) at (p<0.05) (Table 3). Most measurements (BL, HW, CG, HL, HoL, and SC) depicted a positive and highly significant (p<0.05) correlation with live body weight. Therefore, the selection of one or more of these traits except horn length (biologically which is not acceptable), may increase the live body weight of these goat populations as indicated by Hulunim (2014).

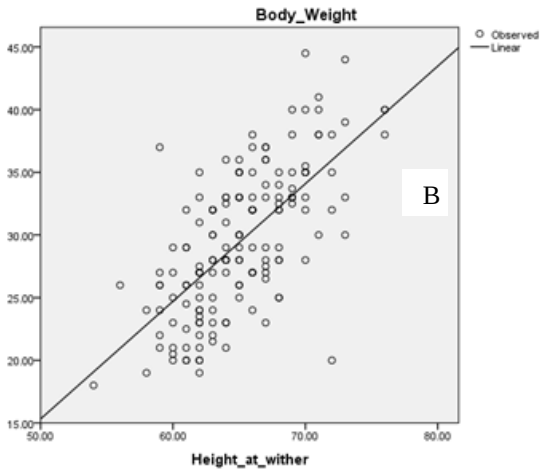
Due to the positive and highly significant correlation between body weight and other linear body measurements, traits in combination or individually could be measured to predict live body weight. Particularly, body length, height at wither, chest girth, and horn length would provide a good estimate for predicting live body weight as indicated with equation [3] and Figure 3.

$$Y = -38.97 + 0.36BL = 0.17HW + 0.46CG + 0.16HoL$$

Where:

- Y= Body weight
- BL= Body length
- HW= Body height at wither
- CG= Chest girth
- HoL = Horn length





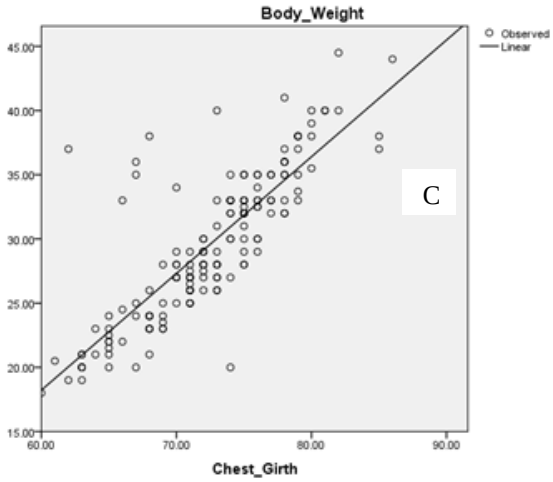


Figure 3: Regression of body weight with body length (A), height at wither (B) and chest-girth (C) of Gofa area indigenous goats

Table 3: Relationships between body weight and linear body measurements of Gofa area indigenous goats

Parameters	BW	BL	HW	CG	HL	HoL	EL	SC	TL
Body Weight		0.81*	0.67*	0.82*	0.64*	0.61*	-0.11NS	0.71*	0.31*
Body Length	0.81*		0.59*	0.67*	0.65*	0.48*	-0.21*	0.57*	0.34
Height at wither	0.67*	0.59*		0.60*	0.48*	0.58	-0.05NS	0.59*	0.24*
Chest Girth	0.82*	0.67*	0.60*		0.55*	0.58	-0.06NS	0.57*	0.38*
Head Length	0.64*	0.65*	0.48*	0.55*		0.55*	-0.12NS	0.50*	0.20*
Horn Length	0.61*	0.48*	0.58*	0.58*	0.55*		-0.02NS	0.29NS	0.35*
Ear Length	-0.11NS	-0.21*	-0.05NS	-0.06NS	-0.12NS	-0.02NS		-0.08NS	0.27*
Scrotum Circumference	0.71*	0.57*	0.59*	0.57*	0.50*	0.29NS	-0.08NS		-
Teat Length	0.31*	0.34*	0.24	0.38*	0.19NS	0.35*	0.27*	-	

4. Conclusion

All linear body measurements and body weight were significantly affected by districts ($p<0.05$). This could be due to variation of the management practices in the study areas mainly in Uba Debre-Tsehay district. As age increases, most of the linear measurements were also increased to certain age limits ($p<0.05$). The higher correlation was observed among body length, height at wither and chest girth, and body weight in Gofa area goat types, which could be used as selection criteria.

Conflict of Interest

The authors declared that there is no conflict of interest.

Acknowledgment

The authors would like to thank AGP-II Program for funding and Arbaminch Agricultural Research Center (AMARC) for facilitating field research works.

References

CSA. (2020). *Agricultural Sample Survey Report on Livestock and Livestock Characteristics. Vol. II,* Statistical Bulletin 587. Central Statistical Agency, Addis Ababa, Ethiopia.

FAO. (2015). *The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture*. In: Scherf, B.D. and Pilling, D. (eds.). FAO Commission on Genetic Resources for Food and Agriculture Assessments, Rome.

FAO (2012). *Phenotypic characterization of animal genetic resources*. Food and Agricultural Organization of the United Nations FAO Animal Production and Health Guidelines No.11. Rome, Italy.

FARM Africa, (1996). *Goat types of Ethiopia and Eritrea.* Physical description and management systems. Published jointly by FARM-Africa, London, United Kingdom, and ILRI (International Livestock Research Institute), Nairobi, Kenya, 76p.

Gerald, W. (1994). *The Tropical Agriculturalist.* Macmillan Press Ltd. London, pp. 54-57.

Grum, G. (2010). *Community-Based Participatory Characterization of the Short Eared Somali Goat Population around Dire Dawa* (M.Sc. thesis). Haramaya University, Ethiopia: 129p.

Halima, H., Lababidi, S., Rischkowsky, B., Baum, M., and Markos, T. (2012a). *Phenotypic characterization of Ethiopian indigenous goat populations. African Journal of Biotechnology 11(73):* 13838-13846.

Halima, H., Lababidi, S., Rischkowsky, B., Baum, M., and Markos, T. (2012b). Molecular characterization of Ethiopian indigenous goat populations. *Tropical Animal Health and Production 44: 1239–1246.* https://doi.org/10.1007/s11250-011-0064-2

Hulunim, G. (2014). *On-Farm Phenotypic Characterization and Performance Evaluation of Bati, Borena and Short-Eared Somali Goat Populations of Ethiopia.* (M.Sc. thesis). Haramaya University, Ethiopia.

Okpeku, M., Yakubu, A., Peters, S., Ozoje, M., Ikeobi, C., Adebambo, O., Imumorin, I. (2011). Application of Multivariate Principal Component Analysis to Morphological Characterization of Indigenous Goats in Southern Nigeria. *Acta Argiculturae Slovenica, 98 (2): 101-109.*

Tesfaye, A. (2004). *Genetic characterization of indigenous goat populations of Ethiopia using microsatellite DNA markers.* (PhD

Dissertation). National Dairy Institute, Haryana, India, 188p.

Tesfaye, G., Sisay, L, Dereje, T., Abebe, M., and Solomon, G. (2006). Growth and Reproductive Performance of Central Highland Goats in North Shoa and South Wollo. In: Sisay, L. and Eshete, D. (eds.). *Proceeding of the first annual conference on completed livestock research activity.* August 14-17, Amhara Region Agriculture Research Institute. Bhar Dar, Ethiopia, pp. 7-13.

Tesfaye, K. (2010). *Assessment of On-Farm Breeding Practices and Estimation of Genetic and Phenotypic Parameters for Reproductive and Survival Traits in Indigenous Arsi Bale Goats* (M.Sc. thesis). Haramaya University, Ethiopia, 142p.