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ON FARM PHENOTYPIC CHARACTERIZATION OF INDIGENOUS GOAT POPULATIONS IN GAMO GOFA ZONE SOUTH WESTERN ETHIOPIA

BELAY ZELEKE[1]*, MESERETU MELESE[2]

[1] Arba Minch University College of Agricultural Sciences, P.O.Box 21, Arba Minch, Ethiopia

[2]Arba Minch University Biological and cultural diversity research center, Arba Minch Ethiopia

*Email: belayzeleke63@yahoo.com

Belay Zeleke

ABSTRACT

The study was carried out in three districts of Gamo Gofa zone south Western Ethiopia. The objective of the study was to carry out phenotypic characterization of local goat population in the study area under farmers' management condition. A total of 1125 goats were randomly sampled. Data were gathered through field observations and linear body measurements of sample populations. The Sampled indigenous goats were identified by sex, age and district. The GLM procedure of SAS was employed to quantify the effect of independent variables. The most dominant coat color pattern was plain. Brown dominant, Fawn and white dominant were the most frequent coat colors in the population. All the quantitative traits were significantly (P< 0.05) affected by sex and location of the animal except tail length and horn length. The average body weight was 26.17±0.33 kg and 28.61±0.23 for male and female goat population. The average chest girth in the current study was 71.09 ± 0.38 cm for male and 73.62±0.23 cm for female population. Similarly, overall mean of body length of male and female population were 58.54 ± 0.29 cm and 60.65 ± 0.22 cm respectively. And height at wither was 64.03 ± 0.24 cm and 65.60 ± 0.23 cm for male and female. An average body weight of 26.17±0.33 kg and 28.61±0.23 for male and female goat population were observed. The studied population had 16.11±0.09 cm, 11.23 ± 0.29 cm, 15.27±0.12 cm of ear length, horn length and tail length for male; and 16.52 ± 0.06 cm, 11.30 ± 0.20 cm and 15.49 ± 0.09 cm for females. Generally the linear body measurement result showed that the studied population was generally better than Woito Guji goat population. Hence categorizing Gamo Gofa goats under Woito Guji goats should be reconsidered. Since two goat populations exist in zone viz: the Gamo highland and the Gamo lowland goats further work is required to quantify the sufficient difference and productive performance of the indigenous breeds through monitoring.

Keywords: Body weight, indigenous goat, linear body measurement, phenotypic characterization, Gamo Goffa Zone, Southwestern Ethiopia

INTRODUCTION

In developing countries, livestock production is mostly subsistence oriented and fulfills multiple functions that contribute more for food security [1, 2]. Similarly, in Ethiopia, Livestock support and sustain livelihoods for 80% of the rural community and 35 – 40 % of all livestock are located in the pastoral areas [3]. The country has one of the largest livestock resources in Africa with a national herd estimated to be 59.5 million cattle, 30.7 million sheep, 30.2 million goat and 56.53 million poultry. These population are widely distributed across diverse agro ecological zones of the country and not been fully exploited. In southern Nations, Nationalities and peoples Regional state (SNNPRS) 5.26 million goats are reared in various agro

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ecologies [4]. The total goat population of Ethiopia has increased by 30% in the last 12 years. Goats comprise 5.32% of the total tropical livestock units of Ethiopia, contribute an estimated 12 to 14% of meat products, 10.5% of milk production and 6% of all animals exported [5]

Goat production is one of the integral parts of livestock farming activities of the country. It has been estimated that about 70% of the goat population is found in the lowlands and the rest 30% is found in the highland Agro ecologies [6, 7]. Goats have unique features like adapting a wide range of agro -climatic condition, selective feeding behavior, fast reproduction, low capital investment.

A comprehensive phenotypic characterization of Ethiopian goats was done by Farm Africa. Based on the analysis of morphological data along with geographic distribution, fourteen distinct goat populations were identified across Ethiopia and Eritrea [8].These were categorized into four major families including the Nubian (Nubian, Barka), Rift valley (Worre, Afar,Abergelle, Arsi-Bale, Woyto-Guji), Somali (Hararghe highland, short-eared Somali, long-eared Somali) and the small East African (central highland, western Highland, western lowland, Keffa) goat families(5).

Halima [9] identified six morphologically distinct indigenous goat populations in the Amhara region, namely: Gumuz, Begia-Medir, Agew, Bati, Central Abergelle and Abergelle. Gumuz and Agew were distributed in both Amhara and Benishangul Gumuz regions. Similarly, in the southwestern part of Ethiopia, Tegegne [10] defined two goat ecotypes: Meanit and Sheko which are most likely ecotypes of Keffa goats previously characterized in the adjoining area [5]. Moreover, different researchers have used different terms (breed, population, ecotypes, type) to describe different phenotypic variants of goats, leading to a lack of clarity in the distinctions between breeds, populations and ecotypes [11].

Knowledge of the adapted goat genetic resources is a pre requisite for designing appropriate breeding and utilization programs. Characterization of livestock breeds based on their morphological traits variations are the first step towards the use of the available animal genetic resource [9]. Morphological characterization is one of the crucial means for describing the goat breeds. It is essential to characterize a breed for its conservation [12]. Body measurements in addition to weight estimate describe the individual or population of small ruminant [13].

The fact that Ethiopia has many different Goat breeds and diverse agro-ecology ranging from cold high lands to that low lands and diverse goat production system indicates that undertaking characterization of the goat population in various agro-ecology in very vital, as it would provide a bench mark for genetic improvement and biodiversity conservation. Moreover Gamo Gofa zone has huge numbers of goat population and diverse agro ecology. Though the goat populations of the zone have been generally categorized under woito guji goat breed, there was no documented study on the group of goat breed and their unique feature at zonal level. Hence further research is required to fill the gaps for further breeding purpose and for selection. Therefore, the present study was conducted with the following objectives:

- To make on-farm Phenotypic characterization of Indigenous Goats type in Gamo gofa zone using linear body measurement and qualitative physical characteristics.

MATERIALS AND METHODS

Description of the study Area

The study was conducted in Gamo Goffa zone of south-western Ethiopia. Gamo Goffa zone is one of 13 zones of the Southern Nations, Nationalities and People Regional State (SNNPRS) and consists of 15 rural districts and two town administrations. It laid near the center of the region around 5°57″–6°71″N latitude and 36°37″–37°98″E longitude. Its general elevation ranges from 680 to 4207 masl; it receives 600–1600 mm rainfall per annum and annual temperature ranges from 10°C to 34°C. According to [4] the estimated livestock

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population and beehives of Gamo Goffa zone were; 1,301,056 cattle; 476,329 sheep; 392,380 goats; 50,296 horses; 15,244 mules; 65,441 donkeys; 1,029,170 poultry and 63,479 bee hives.

Sampling technique and procedure

Multi-stage purpose sampling technique was employed to select the districts and kebeles for the study. Districts were stratified based on agro ecology in to three strata; lowland, midland and highland. Based on secondary source of information, Boreda for high altitude, Kucha for mid altitude and Arba Minch zuria woreda for low-altitude part of the Zone were selected for actual data collection. Kebeles were selected from each stratum purposively based on goat population potential, agro ecology and accessibility. Therefore, a total of 3 woredas, 15 kebeles and 1125 matured goat were sampled and studied at zone level.

Figure 1. typical coat color and hair coat type in the study area

Figure 2. Goat from highland area (Boreda woreda)

Data collection

Information of the area, topography, climatic data and population size were obtained from secondary data from districts agricultural development offices. In each sampling site, the selected goat owners were briefed about the importance and objectives of the study before the commencement of the actual data collection. Visual observation was made and morphological features were recorded based on breed morphological characteristics description list [14]. Linear body measurements were taken using a standard textile measuring tape and standard steel tape. Body weight was taken by weighing balance. Qualitative and quantitative traits were recorded through prepared check list from 375 mature males and 750 mature females. A total of 11 quantitative traits such as, Coat color pattern, Coat color type, Hair coat type, Head profile, Beard, Wattles , toggle, Horn shape, Skin color , Horn presence , Ear form. Similarly, 9 quantitative traits were measured in different sex categories for adult animals included; body length, Body weight, height at wither, chest girth, ear length, horn length, pelvic width, scrotum circumference and Tail length.

Data management and statistical analysis

All data were entered, cleaned and managed using MS Excel© worksheet. Box plots, scatter plots and tests of normality were done to check normality of quantitative variables prior to taking data to analysis.

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Simple descriptive statistics was used to compile the observed categorical variables. The GLM procedure of SAS [15] was employed to quantify the effect of independent variables (age and location) on the linear body measurements (dependent variables). Because of known biological differences between males and females in the measured quantitative variables, and hence to avoid confounding effects of sex, data for the male and female populations were analyzed separately. The presences of any significant effect were checked by using Tukey multiple range tests. The following model was used for analyzing quantitative phenotypic variation between the female sample populations by considering site and age as fixed main effects:

$$Yijk = \mu + Li + Aj + eijk,$$

where Yijk is the observed value of the linear body measurements, μ is the overall mean, Li is the fixed effect of location (i = Kucha, Boreda and Arba Minch Zuria), Aj is the fixed effect of age class j (j = 1, 2, 3, and 4), where age in years were categorized as, 1-1 1/2 years = 1PPI, 1½-2years =2PPI, 2½-3=3PPI and more than three years =4PPI [33] and eijk is the residual error. Similar model was used to analyze quantitative data from males. All interaction effects were not statistically significant and so dropped from the final model.

RESULTS AND DISCUSSION

Quantitative variation

Except tail length and horn length all the quantitative dependent variables were significantly ($P < 0.05$) affected by sex of the animal (Table 1), which confirmed the widely held notion that male and female populations have markedly different body form as measured in the quantitative variables. Similar results were reported by [16; 17; 18; 19 and 20]. The present finding showed that females had higher bodyweight. This was in agreement with the report of [21; 22; 23 and [24] were female have higher body weight and other body measurements than male counterpart. The current finding was in contrast with the reports of [25] and [26]. The difference in live body weight between male and female indicates that these parameters are sex dependent.

Chest girth (CG)

The average chest girth in the current study was 71.09 + 0.38 cm for male and 73.62 + 0.23 cm for female population (table 1). The result is higher than 70.02 ± 0.56, 70.56 ± 0.93 and 70.53±0.66 for Bati, Abergelle and central Abergelle goats respectively [9]. Similarly, it was higher than 66.6±0.23 [19] for Hararghe highland goats; 66.5±.2 [20] for Woito guji goats; 70.15 ± 0.27 [27] for Meanit and Sheko ecotypes; 64.91±3.74 [28] for Nuer goats. However, it was lower than 74.87 + 0.36 (Bekalu et al., 2016) for west Gojjam goats and 74.38±0.23 [16] for shebelle zone indigenous goats.

Table 1 - Least square means ± SE of quantitative body measurements (cm) for all location by sex

Dependent variable	Male N= 350	Female N=749	Sex (*Pr >F*) value
Chest Girth	71.09 ± 0.38	73.62 ± 0.23	<.0001***
Height at Wither	64.03 ± 0.24	65.60 ± 0.23	<.0001***
Body Length	58.54 ± 0.29	60.65 ± 0.22	<.0001***
Body Weight (kg)	26.17 ± 0.33	28.61 ± 0.23	<.0001***
Pelvic Width	16.35 ± 0.12	16.95 ± 0.09	0.0002**
Ear Length	16.11 ± 0.09	16.52 ± 0.06	0.0001**
Tail Length	15.27 ± 0.12	15.49 ± 0.09	0.3119ns
Horn Length	11.23 ± 0.29	11.30 ± 0.20	0.7855ns
Scrotum Circumference	23.53 ± 0.18		0.0002**

*P < 0.05; ** P < 0.01; *** P < 0.001; NS = not significant

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Body length (BL)

The overall mean of body length of male and female population were 58.54 + 0.29 cm and 60.65 + 0.22 cm respectively. It was higher than the finding of [25] 56.02±0.14 for bale goats; [29] 59.72±0.34 and 55.64±0.22 for Woito Guji goats. And it was comparable with the report of [20] for Woito Guji goat 58.5±.2. However, it was lower than the report of [9] 63.69 cm, 63. 52cm, 64.35 cm, 61.78 cm, 61.38 cm and 63.15 cm for Gumuz, Agew, Begia Medir, Bati, Abergelle and Central Abergelle goats respectively.

Body weight (BWT)

The average body weight in the current study was 26.17 + 0.33 kg and 28.61 + 0.23 for male and female goat population. This was lower than 28.03±0.33 [18] for bale goats; 33.97±0.49 and 31.49±0.36 [30] for Bati and Borena goat. However, it was higher than 22 ± 0.2 [20] for Woito Guji goat; 23.9±4.66 [19] for Hararghe highland goat and 25 + 3.6 [17] for Bale goats.

Height at wither (HW)

The average height at wither was 64.03 + 0.24 cm and 65.60 + 0.23 cm for male and female population this was higher than 59.8±0.2 [20]; and lower than 66.65±4.011 [29]; 66.66±0.16 [25]; 68.74±0.29, 68.91 ±0.22 [30] for male Bati and Borena goats and 57.65±3.34 [28] for Nuer goats. The variation in height at wither between Ethiopian breed could be due to breed, location difference and feed availability.

Pelvic width (PW)

The mean pelvic width in the current study was 16.35 + 0.12 cm and 16.95 + 0.09 cm for male and female population this was higher than [25], [29] 9.52±0.04 and 13.21±1.46 for Bale and Woito Guji goats. Similarly, it was higher than report of [30] 14.36±0.09 for Bati, 14.17±0.07 for Borena and 13.73±0.13 for Short eared Somali goats.

Scrotum circumference (SC)

The size of the scrotum is associated with the fertility of the animal. The animals with largest scrotum circumference produce more sperm than the smaller circumference. The scrotum circumference in the current study was 23.53 + 0.18 cm. And it was higher than 21.26±0.18 and 16.56±2.77 cm (18 and 29) for West Gojjam goats and Woito Guji goats respectively.

Ear length, Horn length and Tail length

The current study revealed that the presence of horn as a common feature in most of the animal. Hence, the studied population has 16.11 + 0.09 cm, 11.23 + 0.29 cm, 15.27 + 0.12 cm of ear length, horn length and tail length for male; and 16.52 + 0.06 cm, 11.30 + 0.20 cm and 15.49 + 0.09 cm for females. The current finding was higher than the report of [9, 18 and 20]. On the other hand similar horn length was reported by [17] for Bale goats.

Independent variable effect

ANOVA of quantitative traits in the male sample population showed that, except tail length and scrotum circumference all phenotypic characters were significantly affected by location (Table 2). This was in agreement with [20; 29, 31 and 32]. However, Belete [25] reported a non significant effect of location. The variation caused by location in this study could be attributed that the zone has different agro ecologies which allowed the existence both highland and lowland goat breeds in the zone. In addition it could be explained by the different management system, types of farming system, or even it could be possibility of presence of strains or ecotypes within breed.

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Table 2. Level of significance of main effects for quantitative variables and their associated R^2 values for the male sample population.

Dependent variable	Mean values	Location Pr>F	Age class Pr>F	R^2	CV
Chest Girth	71.17	0.0084**	0.6348ns	3.742	9.99
Height at Wither	64.16	0.0384*	0.2859ns	5.08	7.05
Body Length	58.68	0.0002**	0.3608ns	6.37	9.24
Body Weight(Kg)	26.29	0.0023*	0.3901ns	6.66	23.34
Pelvic Width	16.35	<.0001***	0.0026**	12.45	14.07
Ear Length	16.16	0.0357*	0.1622ns	7.73	10.18
Tail Length	15.32	0.1250ns	0.8382ns	2.15	14.62
Horn Length	11.11	0.0299*	0.2802ns	3.24	48.63
Scrotum Circumference	23.58	0.2532ns	0.1338ns	5.42	8.59

*P < 0.05; ** P < 0.01; *** P < 0.001; NS = not significant

Pair-wise comparisons of the least squares means of variables between location revealed that male sample populations from Arba Minch Zuria woreda had the largest measurement values for most variables than from Boreda and Kucha districts. This shows that goat populations sampled from lowland area were larger in their linear measurements than highland ones. This is in contrast with [29] who reported the lowland goats had a lower measurement than the highland goats.

Unlike location age class didn't cause any significant variation in the study population except on pelvic width. This is in contrast with [20 and25]. R^2 values ranged from 2.15 to 12.45 % for tail length and Pelvic width respectively. Coefficient variability of male sample population explained by the model ranged from 7.5 % for height at withers to 48.63 % for horn length, respectively.

ANOVA in quantitative traits in the female sample population showed that location didn't cause significant effect on the total variation of all quantitative traits except horn length (Table 3). Similarly, age class didn't cause any significant variation on all quantitative variation except tail length and horn length. Similar result has been reported by [25]. However, a lot of reports [20, 29, 31 and 32] showed that a significant effect of location on quantitative traits. R^2 values ranged from 0.41 to 6.12 % for height at wither and horn length respectively. Coefficient variability of female sample population explained by the model ranged from 8.57 % for chest girth to 48.97 % for horn length, respectively.

Table 3. Level of significance of main effects for quantitative variables and their associated R^2 values for the Female sample population

Dependent variable	Mean values	Location Pr>F	Age class Pr>F	R^2	CV
Chest Girth	73.63	0.1858ns	0.3133 ns	1.57	8.57
Height at Wither	65.60	0.9938 ns	0.6214 ns	0.41	9.36
Body Length	60.66	0.3612 ns	0.7397 ns	0.73	10.02
Body Weight(Kg)	28.596	0.4188 ns	0.4492 ns	0.46	21.84
Pelvic Width	16.94	0.1102 ns	0.9212 ns	3.39	13.77
Ear Length	16.52	0.1592 ns	0.6138 ns	0.82	9.25
Tail Length	15.48	0.0752 ns	0.0027**	4.67	15.02
Horn Length	11.31	<.0001***	0.0010**	6.12	48.97

*P < 0.05; ** P < 0.01; *** P < 0.001; NS = not significant

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Qualitative variation

On farm phenotypic characterization of goat breed includes all the qualitative description and morphological measurements of the animal. Qualitative trait of indigenous goat types found in Low land, High land and Midland agro-ecologies are presented in Table 4. The most frequent color patterns observed in the study area were Plain (65.73%) Patchy (22.47 %) and Spotted (11.8%) were also found. The studied population has a diversified coat color. Of the ten observed coat color, Brown dominant (25.28%), Fawn (15.17%) and White Dominant (13.48%) color were the most frequent coat colors. The head profile varied from straight (70.79%) to convex (1.12%). Most of them had glossy (53.37%) and smooth (40.45%) hair type. The presence of horn was common to the population (97.19 %). The population had straight (78.09%) and curved (19.1%) horn shape. The presence of bear (38.20%), toggle (25.84%) and wattle (11.80%) were also observed. The population was described with lateral ear orientation (97.19%).

Table 1. Descriptions of qualitative traits in indigenous goat population in Gamo Gofa zone

Character		male		Female		Over all (%)
		No	(%)	No	(%)	
coat color pattern	patchy	51	4.49	202	17.98	22.47
	plain	215	19.1	525	46.63	65.73
	spotted	25	2.25	107	9.55	11.80
coat color type	black	44	3.93	88	7.87	11.80
	black dominant	13	1.12	95	8.43	9.55
	brown	13	1.12	44	3.93	5.06
	brown dominant	44	3.93	240	21.35	25.28
	fawn	44	3.93	126	11.24	15.17
	grey	13	1.12	70	6.18	7.30
	red	25	2.25	0	0.00	2.25
	roan	32	2.81	19	1.69	4.49
	white	19	1.69	44	3.93	5.62
	white dominant	44	3.93	107	9.55	13.48
hair coat type	curly	6	0.56	6	0.56	1.12
	glossy	152	13.48	449	39.89	53.37
	smooth	114	10.11	341	30.34	40.45
	long straight	19	1.69	38	3.37	5.06
Head profile	concave	101	8.99	215	19.10	28.09
	straight	183	16.29	613	54.49	70.79
	convex	6	0.56	6	0.56	1.12
beard	present	196	17.42	234	20.79	38.20
	absent	95	8.43	600	53.37	61.80
wattles	absent	221	19.66	771	68.54	88.20
	present	70	6.18	63	5.62	11.80
toggle	absent	190	16.85	645	57.30	74.16
	present	101	8.99	190	16.85	25.84
Horn shape	curved	63	5.62	152	13.48	19.10
	straight	234	20.79	645	57.30	78.09

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	pooled	0	0.0	32	2.81	2.81
skin color	pigmented	253	22.47	796	70.79	93.26
	Non pigmented	38	3.37	38	3.37	6.74
Horn presence	present	284	25.28	809	71.91	97.19
	absent	6	0.56	25	2.25	2.81
Ear form	lateral	284	25.28	809	71.91	97.19
	semi pendulous	6	0.56	25	2.25	2.81

CONCLUSIONS AND RECOMMENDATION

This study has identified and characterized goat genetic resources distributed in Gamo Gofa zone. Fawn dark red and brown are the most frequent coat colors in the population. The most dominant coat color pattern was plain. Patchy and spotted were also present in some extent. Brown dominant (25.28%), Fawn (15.17%) and White Dominant (13.48%) color were the most frequent coat colors. Their ears were laterally oriented. The linear body measurement result showed that the studied population was generally better than Woito Guji goat population. Hence categorizing Gamo Gofa goats under Woito Guji should be reconsidered. Since two goat populations exist in zone viz: the Gamo highland and the Gamo lowland goats further work is required to quantify the productive performance of the indigenous breeds through monitoring. In addition, advanced molecular characterization may need to be done to ascertain if there is sufficient difference at genotypic level and to help in identification of genes with potential for use as genetic markers.

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