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Phenotypic Characterization of Indigenous Cattle Populations in Gamo Gofa Zone South Western Ethiopia

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Abstract: The study was carried out in three districts of Gamo Gofa zone south Western Ethiopia. This study aimed to characterize the phenotype of local cattle population in the study area under farmers' management condition. A total of 576 head were sampled randomly for characterization of phenotypic traits. Data were gathered through field observations and linear body measurements of sample populations. The sampled indigenous cattle were identified by sex and district (agro ecology). The most dominant coat color pattern was plain and spotted is also present in some extent. Fawn dark red and brown are the most frequent coat colors in the population. All the quantitative dependent variables were significantly ($P < 0.05$) affected by sex of the animal. The average chest girth in the current study was 138.01+1.57 cm for male and 135.42+0.811 cm for female population. Similarly, body lengths of male and female populations were 108.05+1.03cm and 107.15+0.62 cm respectively. Height at wither was 109.054+ 1.06 cm and 107.18+0.588 for male and female populations. Overall, cattle populations in the study areas varied from former local cattle bred that were identified in Gamo Gofa zone. Therefore further characterization of local cattle in the study area with specially emphasis on highland area of the zone at molecular level should be required.

Key words: Phenotypic characterization · Indigenous cattle population · Gamo Goffa Zone · Southwestern Ethiopia

INTRODUCTION

According to FAO [1] Ethiopia has the 5th largest cattle population in the world and the presence of diverse ecology favored diversification of these resources. According to CSA [2] the current livestock population in Ethiopia except the non-sedentary population of the three zones of the Afar region and six zones of Somali region was estimated to be 59.5 million cattle, 30.7 million sheep, 30.2 million goat, 1.21 million camel, 56.53 million poultry, 2.16million horses, 0.41 million mules and 8.44 million donkeys. These population are widely distributed across diverse agro ecological zones of the country and not been fully exploited.

The Domestic Animal Genetic Resources Information System (DAGRIS) database summarized that there are 34 recognized indigenous cattle breeds in Ethiopia [3]. The genetic diversity within and among indigenous livestock breeds and gene combinations are useful for the future to satisfy changing market conditions, social needs, new knowledge of human nutritional requirements, threats to animal health and environmental changes in general [4]. Hence, understanding the diversity, distribution, basic characteristics, comparative performance and the current status of a country's animal genetics resources is essential for their efficient and sustainable use, development and conservation [5]. However, only a small number of recognized cattle breed types have a fair description of their physical appearance, indications of their level of production, reproduction and genetic attributes [6].

Proper identification, optimum utilization and conservation of these germ plasm resources can be achieved through characterization and formation of inventory of breed resource. Information on phenotypic and/ or molecular characteristics is either completely lacking or incomplete for the majority of indigenous breeds. In addition to their specific adaptive attributes,

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the genetic worth of indigenous livestock are derived from the diversity of ways, in which these resources support human livelihoods (e.g. consumption and marketable products, input services, socio-economic uses) and their local availability [7].

The notional effort in Ethiopia towards systematic characterization and documentation of livestock biodiversity has been negligible let alone planned interventions to curb the continuing threats of loss of genetic diversity [6]. However, Food and Agricultural Organization of the United Nations, the United Nations Environment Program and the European Association of Animal Production have launched breed identification and conservation programs. In addition, The International Livestock Research Institute (ILRI) has been emphasizing the need for characterization and conservation of indigenous animal genetic resources in developing countries. Following this different works have been done to identify potential local breeds. Even though attempts have been done to characterize cattle population in few Gamo areas of Gamo-Gofa zone with the presence of a gap of information in most Gamo areas and whole Gofa areas. Therefore, the objective of this study was to characterize phenotypic characteristics of local cattle population in three districts of Gamo Gofa zone south Western Ethiopia.

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 CSA [2], the estimated livestock 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. Study districts were stratified based on agro ecology in to three strata; lowland, midland and highland. Based on secondary source of information, Kucha for mid and high-altitude, Demba Goffa for Mid-Attitude and Uba-Debre Tsehay for low-altitude part of the Zone were selected for actual data collection. Kebeles were selected from each stratum purposively based on cattle population potential, agro ecology and accessibility. Therefore, a total of 3 woredas, 12 kebeles, 192 households and 576 matured zebu cattle were sampled at zone level.

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 cattle 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 [8]. Linear body measurements were taken using a standard textile measuring tape and standard steel tape. Qualitative and quantitative traits were recorded through prepared check list from 164 mature males and 412 mature females. A total of 19 qualitative traits were observed: coat color pattern, coat color type, facial profile, muzzle color, presence of horn, horn shape, horn color, ear shape, ear orientation, rump profile, hump shape, hump position, hump size, Skin color, eyelid color, hoof color, hair type, Dewlap Size and tail length. Similarly, 8 quantitative traits were measured in different sex categories for adult animals included body length, height at wither, chest girth, ear length, horn length, pelvic width, hoof circumference and muzzle circumference.

Data Management and Statistical Analysis: All data were entered, cleaned and managed using MS Excel© worksheet. Box plots, scatter plots and tests of normality was be done to check normality of quantitative variables prior to taking data to analysis. Simple descriptive statistics was used to compile the observed categorical variables. To quantify the effect of independent variable (dentition class) on the linear body measurements (dependent variables) of the sample cattle, the GLM procedure of SAS was employed [9] and 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 parity as fixed main effects:

$$Yijk = \mu + Li + Pj + Ak + eijkl,$$

where Yijk is the observed value of the linear body measurements, ì is the overall mean, Li is the fixed effect of location i (i = 1. . .5), Pj is the fixed effect of parity j (j =1. . .3), where parity will be categorized as 0-2 = 1, 3-4 = 2 and >4 = 3, A_k is the fixed effect of age class j (j = 1. . .3), where age in years will be categorized as 3-5 = 1, >5–7 = 2 and >7 years = 3 and eijk is the residual error. Similarly, taking location and age class as fixed main effects, the following model was used to analyze quantitative data from males:

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

where Yijk is the observed value of the linear body measurements, Li is the fixed effect of Location i (i = 1. . .5), Aj is the fixed effect of age class j (j = 1. . .3), where age in years will be categorized as 3-5 = 1, >5–7 = 2 and >7 years = 3 and eijk is the residual error.

All interaction effects for both models were not statistically significant and so dropped from the final model.

RESULTS AND DISCUSSION

Quantitative Variation: All the quantitative dependent variables were significantly ($P < 0.05$) affected by sex of the animal (Table 1), confirming the widely held notion that male and female populations have markedly different body form as measured in the quantitative variables. As a result, analyses of variance (ANOVAs) on quantitative variables were performed separately for the two sexes. Similar results were reported by Tenagne *et al*. [10] and Chebo *et al*. [11].

Chest Girth (CG): The average chest girth in the current study was 138.01+1.57 cm for male and 135.42+0.811 cm for female population (table 1). The result is higher than 136.5 20 [12] for Sheko breed; and comparable with 141.30 [11]. However, it was lower than 146.04±0.27 [10], 149.6±9.64 [13] for boran and 150.11±8.20 [14] for Ogaden cattle; 149.8 cm [7] for Ghana Shorthorn. The apparent lower values obtained for study may be due to shortage of feed which causes small body condition.

Body Length (BL): The overall mean of body length of male and female population was 108.05+1.03cm and 107.15+0.62 cm respectively, which is almost similar with 108.79 [11] and comparable with 110.2 [12]. Our results is lower than the report of Tenagne *et al*. [10] and Solomon Tekle [13] and Getinet Mekuriaw [14] 115.41±0.24, 120.0±7.02 and 121.09 ± 7.18 respectively.

Height at Wither (HW): The average height at wither was of 109.054+ 1.06 cm and 107.18+0.588 for male and female population this was higher than the report of Takele Taye [12] and Chebo *et al*. [11] 99.4 and 102.10 ± 0.42 for Sheko breed and female cattle population of gamo gofa zone respectively. However, it is lower than 115.47 ± 7.71 [14], 114.8±4.97 [13] and 114.5±0.24 [10].

Pelvic Width (PW): The mean pelvic width in the current study was 38.10+0.526 for male and 37.63 + 0.28 for female cm which is comparable with the finding of Chebo *et al*. [11] 37.06 ± 0.17, 37.06 ± 0.17 [13] and higher than 33.5 [12].

Ear Length, Horn Length, Muzzle Circumference and Hoof Circumference: The current study revealed that the presence of long curved horn as a common feature in most of the animal. Hence, the studied population has the 19.56 cm, 30.84 cm, 25.745cm and 40.177 cm of ear length, hoof circumference, horn length and muzzle circumference respectively for male; and 19.54+0.199, 29.42 +0.29 cm, 27.02+1.82cm and 39.09+0.24 cm for females. The result of horn length is higher than the work of Chebo *et al*. [11] and Takele Taye [12] and Solomon Tekle [13] and Getinet Mekuriaw [14] for different Ethiopian cattle breed.

Independent Variable Effect: ANOVA of quantitative traits in the male sample population showed that, except horn length and pelvic width all phenotypic characters were not significantly affected by location (Table 2). This is in contrast with the finding of Tenagne *et al*. [10], Chebo *et al*. [11], Takele Taye [12], Solomon Tekle [13] and Biruh Tesfahun [15]. The highest (51.07 %) rate of determination (R^2) values was calculated for horn length and the smallest value for ear length (22.52 %). On the other hand, coefficient of variability ranged from 47.46 to 6.76 percent for horn length and body length, respectively.

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

Dependent variable	Male N= 164	Female N=413	Sex (*Pr >F*) value
Body Length	108.05±1.03	107.15±0.62	0.0056*
Chest Girth	138.01±1.57	135.42±0.811	0.0006*
Ear Length	19.56±0.32	19.54±0.199	0.7993ns
Hoof Circumference	30.83±0.423	29.42±0.299	<.0001***
Horn Length	26.74± 1.747	27.02±1.82	0.7438ns
Height at Wither	109.054± 1.06	107.18±0.588	0.0006*
Muzzle Circumference	40.157±0.41	39.09±0.24	<.0001***
Pelvic Width	38.10±0.53	37.63±0.28	0.0485*

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
BL	108.055	0.5955	0.0130*	36.53	6.766
CG	138.018	0.8078	0.5949	41.08	8.01
EL	19.558	0.3891	0.5655	22.52	11.521
HC	30.836	0.0672	0.0292*	46.48	9.621
HL	25.745	0.0297*	0.0110*	51.07	47.466
HW	108.921	0.4779	0.8792	41.13	6.885
MC	40.177	0.3429	0.0407*	45.4	7.268
PW	38.848	0.0006*	0.7916	39.36	9.779

Table 3: Level of significance of main effects for quantitative variables and their associated R^2 values for female sample population

Dependent variable	Mean values	Woreda Pr>F	Age class Pr>F	R^2	CV
BL	107.15+0.62	0.0002**	0.021*	46.2	5.937
CG	135.42+0.811	0.0286*	0.3569ns	32.39	6.137
EL	19.54+ 0.199	<.0001***	0.3069ns	40.4	10.417
HC	29.42 + 0.299	0.2789ns	0.8217ns	34.87	10.41
HL	27.02+ 1.82	<.0001***	0.023*	37.5	69.00
HW	107.18+0.588	0.0053**	0.8665ns	42.98	5.616
MC	39.09 +0.24	0.0404*	0.7839ns	41.58	6.38
PW	37.63 + 0.28	<.0001***	0.0663ns	43.18	7.862

Pair-wise comparisons of the least squares means of variables between location revealed that male sample populations from Uba Debretsehay woreda had the largest measurement values for most variables than from Demba Gofa and Kucha districts. This shows that cattle populations sampled from lowland area were larger in their linear measurements than highland ones that agreed with the report of Chebo *et al*. [11].

ANOVA in quantitative traits in the female sample population showed that location cause significant effect on the total variation of all quantitative traits except hoof circumference (Table 3). R^2 values ranged from 0.813 to 46.2 % for chest girth and body length respectively. Coefficient variability of female sample population explained by the model ranged from 5.62 % for height at withers to 69.0 % for horn length, respectively.

Qualitative Variation: On farm phenotypic characterization of cattle breed includes all the qualitative description and morphological measurements of the animal. Qualitative trait of indigenous cattle types found in Low land, High land and Mid land agro-ecologies are presented in Table 1. The most frequent color patterns observed in the study area were Plain (69.55%), Spotted (20.41%) and patchy (8.997%). The studied population has a diversified coat color. Of the twelve observed coat color, Fawn (26.82%), Dark red (15.22%) and brown dominant color were the most frequent coat colors. The facial profile varied straight (80.77%) to slightly concave (19.23%) appearance. Most of them (67.1%) had glossy hair type. Tail length observed include medium (48.08%), long (43.18%) to short (8.74%). The population has a pigmented skin color (70.45%), Muzzle color (84.79%), eyelid color (91.02%) and horn color (90.91%). Presence of horn was common (98.44%) in the population, curved shape (49.13%) was also dominant horn shape. However, 1.56% of them were pooled. Rounded (95.63%) lateral (60.84%) ear, small hump size (86.89%), erected hump shape (91.26%) with thoracic hump position (86.71%) were the common qualitative characters in the studied population. Small dewlap size (75.17%) and flat rump profile (79.37%) were also the common features.

Table 4: Descriptions of qualitative traits in Uba Debretsehay, Demba Gofa and Kucha woreda , Gamo Gofa zone

Character	Uba Debretsehay (N)	Demba Gofa(N)	Kucha (N)	Total	%
Coat color pattern					
▸ patchy	2	21	29	52	8.997%
▸ plain	119	135	148	402	69.55%
▸ spotted	71	35	12	118	20.415%
▸ missing data	6	0	0	6	1.038%
Coat color					
▸ black	0	10	1	11	1.90%
▸ black dominant	10	4	1	15	2.60%
▸ brown	0	14	1	15	2.60%
▸ brown dominant	23	33	26	82	14.19%
▸ Dark red	17	23	48	88	15.22%
▸ fawn	60	33	62	155	26.82%
▸ grey	11	12	1	24	4.15%
▸ light red	0	8	2	10	1.73%
▸ red	0	30	27	57	9.86%
▸ roan	15	2	0	17	2.94%
▸ white	37	12	7	56	9.69%
▸ white dominant	25	10	13	48	8.30%
Skin color					
▸ non pigmented	149	6	14	169	29.55%
▸ pigmented	43	185	175	403	70.45%
Muzzle color					
▸ non pigmented	78	5	4	87	15.21%
▸ pigmented	114	186	185	485	84.79%
Eyelid color					
▸ non pigmented	44	5	2	51	8.92%
▸ pigmented	148	186	187	521	91.08
Horn presence					
▸ absent		1	8	9	1.56%
▸ present	198	190	181	569	98.44%
Horn color					
▸ black	77	82	75	234	40.91%
▸ brown	101	77	104	282	49.30%
▸ white	14	32	2	48	8.39%
▸ pooled			8	8	1.40%
Horn shape					
▸ curved	95	87	99	281	49.13%
▸ lyre shape	53	51	54	158	27.62%
▸ straight	44	52	28	124	21.68%
▸ pooled		1	8	9	1.57%
Hair type					
▸ curly	1	4	0	5	0.87%
▸ dull	46	28	45	119	20.80%
▸ glossy	95	152	137	384	67.13%
▸ sheen	32	7	7	46	8.04%
▸ straight	18	0	0	18	3.15%
Ear shape					
▸ rounded	183	175	189	547	95.63%
▸ straight	9	16	0	25	4.37%
Ear orientation					
▸ erect	2	33	189	224	39.16%
▸ lateral	190	158	0	348	60.84%
Hump size					
▸ absent	2	1	0	3	0.52%
▸ large		8	0	8	1.40%
▸ medium	17	43	4	64	11.19%
▸ small	173	139	185	497	86.89%

Table 4: Continued

Hump shape					
▸ absent	2	1	0	3	0.52%
▸ dropping	12	7	0	19	3.32%
▸ erect	170	163	189	522	91.26%
▸ sideways	8	20	0	28	4.90%
Hump position					
▸ absent	2	1	0	3	0.52%
▸ Cervico- thoracic	10	63	0	73	12.76%
▸ thoracic	180	127	189	496	86.71%
Facial profile					
▸ concave	77	7	26	110	19.23%
▸ straight	115	184	163	462	80.77%
Dewlap size					
▸ absent		13	0	13	2.27%
▸ large	5	10	2	17	2.97%
▸ medium	18	48	46	112	19.58%
▸ small	169	120	141	430	75.17%
Rump profile					
▸ flat	187	168	99	454	79.37%
▸ roofy		8	10	18	3.15%
▸ sloping	5	15	80	100	17.48%
Tail length					
▸ long	58	94	95	247	43.18%
▸ medium	96	88	91	275	48.08%
▸ short	38	9	3	50	8.74%

Fig. 1: Breeding female in Demba Gofa District

Fig. 2: Typical horn in female

Fig. 3: Breeding herd from Uba Debretsehay

CONCLUSIONS AND RECOMMENDATION

The most dominant coat color pattern (plain and spotted) was also present in some extent. Fawn dark red and brown are the most frequent coat colors in the population. They have generally long horn which is thick at the base and curved. Polled, straight, lyre shaped, horned animals were also encountered. Their ears were laterally oriented. They have also long legs and medium to long tails. They have straight back with flat rump. They have small dewlap and Hump size (86.89%). The linear body measurement result showed that the studied population was generally smaller in size compared to other lowland cattle breed like Ogaden breed in the country. Overall, cattle populations in the study areas varied from former local cattle bred that were identified in Gamo Gofa zone. Therefore, further characterization of local cattle in the study area with specially emphasis on highland area of the zone at molecular level should is duly required.

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