Phenotypic characterization of Northwestern highland goat in West Gojjam Zone of Amhara Region, Ethiopia

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Abstract

The study was conducted in four districts of west Gojjam zone of Amhara National Regional State with objectives of characterizing the phonotypic characteristics of North Western Highland Goat in the area. The study was conducted by observing and recording of goat qualitative characters, by measuring and recording body weight and linear body measurements. Four hundred thirty two mature male and female animals and 37 morphological variables were used. Different procedures of Statistical Package for Social Science was used to assess the effect of sex and location on the morphological traits and body weight of the animal and also to analyze both the morphological and body weight data. Sex of the goat had a significant effect ($p<0.05$) on all quantitative traits except ear length and on all qualitative traits except the presence/absence of ruff and beard. Females had smaller mean values of body weight, chest girth, height at wither, body length, ear length and pelvis width than males. Most males have ruff and beard while most females are without ruff and beard. Location had no significant effect ($p>0.05$) on all quantitative and qualitative traits. It was concluded that goat types of the area are phenotypic ally characterized by large goat breed type (Mean height at wither 71.8±0.29 and 69.9±0.14 cm for buck and for doe, respectively); long-eared (Mean ear length 15.5±0.05 and 14.9±0.02 cm for buck and for does, respectively), and with dominant white plain coat colour.

Key words: Characterization, phenotypic, Northwestern.

Introduction

Goats form an important component of the livestock system, in all agro-climatic zones of Ethiopia and have a variety of functions for the owner (Alemayehu Reda, 2003). Although goats' contribution to the economic well being of the small holder farmers is significant, these animals have never been a subject of much attention for research and development (Jansen, 1996). Despite the large size of the country goat population and their high apparent potential, the productivity per unit of animal and the contribution of this sector to the national economy is relatively low (Alemayehu Reda, 2003). One of the main factors which contribute for this is low genetic potential of the available local

breed. Therefore, there is a need in the improvement of the genetic potential of the animal which in turn improves the productivity of the animal. This activity involves identification, classification and characterization of the breeds or strains of livestock under village condition (Kosgey and Okeyo, 2007).Thus, this study was aimed at phenotypic characterization of Northwestern highland goat in West Gojjam administrative zone, in their respective environments.

Materials and methods

The study areas

The study was conducted in four (Semen Achefer, Mecha, Gonji kulela, and Bahirdar Zuria) districts of West Gojjam Administrative Zone, Amhara National Regional State. According to the respective Woreda Office of Agriculture and Rural Development (WOARD, 2001) of the four districts, the four districts are located within longitude of 15º 16'N and latitude of 37º 29'E with altitude ranging from 700 to 2635 meter above sea level (m a.s.l). The temperature in the areas is as high as 35 ^{O}C and as low as 10 ^{O}C (WOARD, 2001). The study area has uni-modal rainfall pattern and the rainy season extends from end of May to the end of September. The predominant farming system is mixed crop-livestock production.

Data collection and management

Four representative districts (study areas) mentioned above and three peasant associations from each selected districts (Semen Achefer: Sankira, Kunzilla, and Denbola; Mecha: Andinet, Goragot, & Bachimma; Gonji kulela:Woyzazirt, Zegansa and Wolekea and from Bahirdar Zuria: Zemochinazelanbet, Majdebrenigist and Achader) were selected purposively. Data on phenotypic characteristics were collected from 432 mature animals using 37 breed descriptor variables (discreet and continuous variables).

The discreet variables include coat colour pattern, coat colour type, head profile, horn shape, horn orientation, hair type, ear form, ruff, wattle, and beard. Data on the discrete variables were collected using the pre-coded format through rapid observation of each sampled goat (Workneh and Rowlands, 2004). Continuous variables such as mature

body weight (BW); body length (BL); chest girth (CG); wither height (WH); pelvic width (PW); ear length (EL). Data on the mature body weight was taken using the prepared format and 100 kg x 500 g Salter weighting balance suspended from a portable tripods where as data on the linear body measurements were collected using the prepared format and 2 m x 10 cm tailors measuring tape (Workneh and Rowlands, 2004). In each peasant associations, one goat flock was taken to collect information on phenotypic characteristics of the animal. Each experimental animal was identified by sex, site and flock number. Finally, the data collected from each site was checked for any mistake, coded and entered into the computer for further analysis.

Data analysis

Data analysis was done separately for different data types. The linear body measurement and body weight data were analyzed using the General Linear Model/Least-square mean procedure of statistical package for social science (SPSS, version 16) where as the qualitative morphological data using the frequency occurrence procedure. Cross tabulation procedure/Pearson chi-square test was employed to test the effect of sex and location (district) on the qualitative trait while the General Linear Model (GLM) procedure was employed to test the effect of sex and location on linear body measurements and body weight, separately. The model for GLM for different linear body measurements and body weight is as follows

$$Y_{ijk} = \mu + S_i + L_j + e_{ijk}$$

Where, Y_{ijk} = the observed k (body weight or linear body measurements in the i^{th} sex and j^{th} location; μ = overall mean; S_i = the effect of i^{th} sex (i= intact male or female); L_j = the j^{th} location effect (j = 1, 2, 3 or 4); e_{ijk} = random residual error.

Results and discussion

The Phenotypic characteristics of goats in the study area were observed, recorded and measured for both female and male sample population separately. The least square means and standard errors of the quantitative and the frequency occurrences of the qualitative characters were extracted from the sample goat population. The analysis of variance for the effect of sex and location on the quantitative traits and the chi-square

test of the qualitative traits for the effect of sex and location showed no significant phenotypic variations between the different goat types in the different locations or districts ($p>0.05$) but there was a significant morph metric variation between the different goat types in female and male population ($p<0.05$).

Figure1. Buck (Right) and Doe (Left).

The frequency of occurrences of the qualitative traits for female sample population

Three patterns of coat colour were observed and recorded with 52.02 % plain, 34.43% patchy, and 13.55% spotted. White plain (50.18%), Arda (21.98%), and Sora (15.75%) were the dominant coat colour types frequently observed from the female sample population. Three variations of hair types were observed at frequencies of 80.59% for smooth and short hair, 12.82% for fur with hairy thighs and 6.59% for fur with hairy on abdomen and back. The head profile ranged from markedly concave through straight to convex but it was mostly concave (56.41%). Ear form varied between horizontal, semi-pendulous and forwarded. They have mostly horizontal and semi-pendulous ears. There is no any hairy goat observed in all the study sites since hairy goats are usually found in the highlands. Horn scurs observed not only in the kids but also in mature male and female goats. Almost all female goats in the population were without ruff and only 7.33% had ruff which indicated that the presence of ruff is the typical characteristics of male goat. The frequency occurrence of the qualitative traits for female sample population is presented in Table 1.

The frequency occurrences of the qualitative traits for male sample population

Out of 159 male goats, 50.94% were with plain, 33.96% patchy and 15% spotted coat colour patterns. White plain (45.28%), Arda (19.5%), Sora (16.35%) and plain red were

the major coat colour types frequently observed from the male sample population. Three variations of hair types were observed at frequencies of 72.96% for smooth and short hair, 17.61% for fur with hairy thighs, and 9.43% for fur with hairy on abdomen and back. Nearly 56.6% of the male population had concave head profile while 25.77% had straight head profile and the rest had convex head profile.

Table 1. The frequency occurrences of the qualitative traits for female sample population.

Character and Attribute	N	%	Character and Attribute *(Horn shape contu)*	N	%
Coat colour Pattern			Curved	100	36.63
Plain	142	52.02	Spiral	13	4.76
Patchy	94	34.43	Overall	273	100
Spotted	37	13.55	Horn Orientation		
Overall	273	100	Backward	165	60.44
Coat colour Type			Upward	69	25.27
White	137	50.18	Scurs	23	8.42
Arda	60	21.98	Pooldness	16	5.86
Sora	43	15.75	Overall	273	100
Red	14	5.13	Ear form		
Mendile	12	4.4	Horizontal	138	50.55
Black	7	2.56	Semi-pendulous	72	26.37
Overall	273	100	Forward	63	23.08
Head profile			Overall	273	100
Concave	154	56.41	Ruff		
Straight	70	25.64		20	7.33
			Present		
Convex	49	17.95	Absent	253	92.67
Overall	273	100		273	100
			Overall		
Hair type			Beard		
short & smooth	220	80.59		71	26.01
			Present		
hairy thighs	35	12.82	Absent	202	73.99
Hairy abdomen	18	6.59		273	100
			Overall		
Overall	273	100	Wattle		
Horn shape				37	13.55
			Present		
Straight	160	58.61	Absent	236	86.45
				159	100
			Overall		

N = Number of mature female goats with that particular trait *Arda* = Red plain coat colour on white dominant or vis-versal, *Sora* = Mixture of red and black in spotted form on white dominant plain, *Mendile* = White plain coat colour on black dominant or vis-versa.

The predominant ear form observed in above 49.69% of the sample population was horizontal and semi-pendulous. Horn shape was mostly either straight (52.2%) or curved (42.14%) with obliquely upward (20.75%) or backward (62.89%) oriented. Pooledness and presence of wattle is also observed among some goats. Most males have ruff and beard while most females were without ruff and beard which indicated that the presence of ruff and beared is the typical characteristics of male goat. The major qualitative traits of male population are presented in Table 2.

Table 2. The frequency occurrences of the qualitative traits for male sample population.

Character and Attribute	N	%	Character and Attribute *(Horn shape contu)*	N	%
Coat colour Pattern			Curved	67	42.14
Plain	81	50.94	Spiral	9	5.66
Patchy	54	33.96	Overall	159	100
Spotted	24	15	Horn Orientation		
Overall	159	100	Backward	100	62.89
Coat colour Type			Upward	33	20.75
White	72	45.28	Scurs	16	10.06
Arda	31	19.5	Pooldness	10	6.27
Sora	26	16.35	Overall	159	100
Red	14	8.81	Ear form		
Mendile	9	5.66	Horizontal	79	49.69
Black	7	4.40	Semi- Pendulous	43	27.04
Overall	159	100	Forward	37	23.27
Head profile			Overall	159	100
Concave	90	56.60	Ruff		
Straight	41	25.77	Present	125	78.62
Convex	28	17.61	Absent	34	21.38
Overall	159	100	Overall	159	100
Hair type			Beard		
short & smooth	116	72.96	Present	114	71.70
hairy thighs	28	17.61	Absent	45	28.30
Hairy abdomen	15	9.43	Overall	159	100
Overall	159	100	Wattle		
Horn shape			Present	30	18.87
Straight	83	52.20	Absent	129	81.13
			Overall	159	100

N = Number of male goats with that particular character state.

The head profile with Arsi-bale & Western highland goats (Hailu *et al.*, 2006) and Southern Ethiopia goat types (Workneh Ayalew, 1992); Hair type with central highland goats (Hailu *et al.*, 2006; Tesfaye *et al.*, 2007); Coat colour pattern with western highland & lowland goats, Central highland goats (Hailu *et al*., 2006; Tesfaye *et al*., 2007) and Southern Ethiopia goat types (Workneh Ayalew, 1992); Coat colour type with Hararghe highland goats, Short- and long-eared Somali goats and Western lowland goats (Hailu *et al.*, 2006); Horn shape and orientation with Arsi-bale and Central highland goats, Keffa goats, Short- and long-eared Somali goats, Western highland & lowland goats (Hailu *et al.*, 2006); The presence/absence of beard and ruff with Central highland goats, Western highland and lowland goats and Keffa goats (Hailu *et al.*, 2006); The presence/absence of wattle and pooldness with Arsi-bale goats, Central highland goats, Keffa goats (Hailu *et al.*, 2006) and Southern Ethiopia goat types (Workneh Ayalew, 1992); Ear form of goat types in the study area is concurrent with ear form of Long-eared Somali goats, Western highland and lowland goats (Hailu *et al.*, 2006). The frequency occurrences of the qualitative traits obtained in the study is concurrent with the reports of different authors for different goat breeds/types which indicated that the northwestern highland goat types are qualitatively similar with the above mentioned goat types by different authors.

Body weight (kg) and linear body measurements

The least square means (LSM)±standard errors (SE) of body weight (kg) and linear body measurements (cm) for the effects of sex and location of the female and male sample population are summarized in Table 3. The fixed effects of sex and location were considered. The overall mean body weight, body length, height at withers, and chest girth were 32.7±0.15kg, 48.2±0.17cm, 70.6±0.17cm, and 78.5±0.22cm, respectively. The overall mean ear length and pelvis width were 15.08±0.03 cm and 14.4±0.07 cm, respectively.

The overall mean body weight, body length, height at wither, and chest girth obtained in this study were concurrent with the previous findings obtained in those reported by Nigatu Alemayehu (1994) for Central highland, Western low land and Western high land female goats which suggests that the similarity in quantitative character between the North western highland goats (NWH goat) and Central highland female goats,

Western low land and Western high land female goats. The linear body measurements used for estimation of the body weight of NWHgoat can be also used for body weight estimation of Central highland female goats, Western low land and Western high land female goats.

Table 3. Least square means ± standard errors of body weight (kg) and linear body measurements (cm) for the effect of sex and location.

Effects and level	Body weight LSM±SE	Body length LSM±SE	Chest girth LSM±SE	Wither height LSM±SE	Pelvic width LSM±SE	Ear length LSM±SE
Overall	32.7±0.15	48.2±0.17	78.5±0.22	70.6±0.17	14.4±0.07	15.08±0.03
CV%	21.79	12.94	5.68	3.98	9.14	22.48
Sex	*	*	*	*	*	NS
Male	40.6±0.3	55.3±0.31	81.9±0.41	71.8±0.29	15.4±0.15	15.5±0±.05
Female	28.1±0.14	44.1±0.16	76.4±0.21	69.9±0.14	13.9±0.07	14.9±0.02
Location	NS	NS	NS	NS	NS	NS
Achefer	34.4 ±0.20	49.1 ±0.23	79.3 ±0.29	71.0 ±0.21	14.8 ±0.09	15.1±0.03[a]
Mecha	33.8 ±0.23	48.9 ±0.26	78.7 ±0.30	70.3 ±0.25	14.3±0.10	14.3±0.04[b]
Gonji	34.1±0.32	50.1 ±0.35	79.7 ±0.42	71.2 ±0.34	14.8±0.16	15.6±0.06[b]
B/ zuria	33.9±0.24	49.4±0.24	79.2±0.25	70.6±0.26	14.6±0.11	15.4±0.06[b]

*Significant at 0.05, Ns = Non significant.

The average body weight for male population is (40.6±0.29kg) heavier than the average body weight of western low land male goat (35.5±0.20 kg) but almost equal to the average body weight of central high land male goat (41.3±0.31 kg) (Nigatu Alemayeh, 1994). The average height at wither was also higher than the average height at wither for western low land male goat but lower than the average height at wither for western high land male goat and it is close to the average height at wither for central high land male goat (Nigatu Alemayehu, 1994). The same is true for the average chest girth. According to the classification of goat based on height at wither suggested by (Devendra and Burns, 1993), goat types of the study area are classified as large breed goat types. The heavier body weight obtained is partly due to the higher chest girth and height at wither which contribute the higher proportion of the bones and muscles at the chest cavity.

Both the average ear length and pelvis width were higher than the reports of Nigatu Alemayehu, (1994) for goat types of north-western Ethiopia which ranges from 12.01±0.05 to 14.4±0.07 cm. According to the classification of goat based on ear length (Nigatu alemayehu, 1994), goat types of the study area are classified as long-eared goat types.

Effect of sex and location on qualitative traits

In the analysis of the effect of sex and location on the qualitative traits, the fixed effects of location and sex were considered.

Location Effect: Location (district) did not exert a significant source of variation in all qualitative traits (P>0.05) which indicated that goat types of the area are qualitatively similar.

Sex Effect: Sex of the animal did not exert a significant (p>0.05) influence on all the qualitative traits except the presence/absence of ruff and beard. Most males have ruff and beard while most females are without ruff and beard which indicated that the presence of ruff and beard are the typical characteristics of male goat (Table 4).

Table 4. Chi-square test of the qualitative traits for the effect of district and sex.

Traits	Source of variation	Test	
		X^2	P-value
Coat color pattern	District/Location	20.75	0.575
	Sex	3.05	0.877
Coat color type	District/Location	6.88	0.098
	Sex	4.29	0.077
Head /Facial profile	District/Location	.144	.996
	Sex	0.008	0.945
Presence or absence of wattle	District/Location	6.97	.102
	Sex	2.17	0.142
Presence or absence of beard	District/Location	5.93	.383
	Sex	85.47	<0.000
Presence or absence of ruff	District/Location	16.01	.377
	Sex	228.48	<0.000
Ear form	District/Location	0.041	0.890
	Sex	0.017	0.896
Horn shape	District/Location	7.18	.646
	Sex	1.52	0.217
Horn orientation	District/Location	8.19	.159
	Sex	1.30	0.996
Hair type	District/Location	4.33	.112
	Sex	3.39	0.082

Conclusions and recommendations

Goat types of the area are phenotypic ally characterized as large goat breed types with mean height at wither 71.8±0.29 and 69.9±0.14 cm for buck and for doe, respectively; long-eared with mean ear length 15.5 ± 0.05 and 14.9±0.02 cm for buck and for does, respectively, and have predominantly concave facial profile. Their body is mostly covered by smooth and short hair. The most observed coat colour pattern is plain followed by patchy and spotted. The predominant coat colour type observed and recorded were white plain followed by plain red colour in some parts on white plain dominant or vis-versal (*Arda*), a mixture of red and black in spotted form on white dominant plain (*Sora*), and plain red colour. Both males and females have horns and the horns are mostly straight and oriented back ward. Polledness, scurs and presence of wattles were also observed among some goats. In general, females had smaller mean values of body weight, chest girth, height at wither, body length, ear length and pelvis width than males. Most males have ruff and beard while most females are without ruff and beard. Emphasis should be given on the economic importance of the qualitative traits.

Acknowledgements

The authors would like to thank the Amhara Agricultural Research Institute (ARARI) for financial support and facilitating for full write-up of the thesis. The authors also would like to thank the smallholder farmers who participated and volunteer to give their animal for observation and measurement.

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