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Brief Communication

Morphological characterization of the Motilona goat from Norte de Santander, Colombia

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ABSTRACT

Objective. To describe the morphological characteristics of the Motilona goat of Norte de Santander. **Material and methods.** A population of 300 individuals (266 females and 34 males) was randomly selected from 8 different farms in the department of Norte de Santander. The morphological characterization of the Motilona goat was done by means of information on 7 qualitative morphological traits and 11 quantitative traits from which 14 zoometric indexes were derived. **Results.** Sexual dimorphism was found to exist in the qualitative traits of horn type, ear position and number of color layers. Sexual dimorphism was also found to exist among quantitative traits such as face length, head width, withers height, rump width, shank girth and thorax girth. **Conclusions.** The results of this study suggest that the Motilona goat is a population with homogeneous traits and therefore future studies are required to deepen the knowledge of characterization of other morphological traits and also its productive characteristics.

Keywords: Goats; animal morphology; conservation programs (*Fuente: CAB*).

RESUMEN

Objetivo. Describir las características morfológicas de la cabra Motilona de Norte de Santander. **Material y métodos.** Se utilizó una población de 300 individuos (266 hembras y 34 machos) que fueron seleccionadas de forma aleatoria en 8 granjas diferentes del departamento Norte de Santander. La caracterización morfológica de la cabra Motilona se hizo mediante información de 7 rasgos morfológicos cualitativos y 11 rasgos cuantitativos de los cuales se derivaron 14 índices zoométricos. **Resultados.** Se encontró que existe dimorfismo sexual en los rasgos cualitativos de tipo de cuernos, posición de las orejas y el número de capas de color. Se encontró también que existe dimorfismo sexual entre rasgos cuantitativos como longitud de la cara, anchura de la cabeza, alzada de la cruz, anchura de la grupa, perímetro de la caña y perímetro del tórax. **Conclusiones.** Los resultados de este estudio sugieren que la cabra Motilona es una población con rasgos homogéneos y por lo tanto se requiere de futuros estudios para profundizar en el conocimiento de caracterización de otros rasgos morfológicos y además en sus características productivas.

Palabras clave: Cabras; morfología animal; programas de conservación (*Fuente: CAB*).

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INTRODUCTION

In the region of Norte de Santander (Colombia), goat breeding is carried out mainly for meat and milk production for human consumption. This livestock activity, which has been increasing in recent years not only in the region but also in Colombia (1,2), requires greater attention to improve production systems. Therefore, characterizing the populations of each region is essential to have an inventory of the animal resources available (3). This will allow for the sustainable use of these animal resources to supply a continuously growing population on one hand, and, on the other hand, to maintain animal genetic resources (4). This is achieved with morphological characterization, which is a commonly used alternative to expand the understanding of unknown goat populations (3,4,5,6,7,8).

The racial characterization of a species is important for its conservation, but in the context of animal production, this characterization is relevant to implement genetic improvement programs (3). Characterization is carried out through zoometric measurements, which are considered as morphostructural variables obtained from the phenotype of the animals which, along with the phaneroptic characteristics, are also all of genetic origin and serve as external markers to measure those characteristics of economic importance in animal production (9,10,11). On the other hand, the study of live body measurements of an animal allows for obtaining a racial group with a defined conformation for a zootechnical purpose, for example, to establish the degree of association of a certain body measurement with some characteristic of productive interest, such as the estimation of meat weight (7). The objective of this study is to characterize the morphological structure of the Motilona goat to determine its productive purpose and to define its phenotypic characteristics.

MATERIAL AND METHODS

Study population. For this study, individuals were selected from different localities of the city of Cúcuta and its metropolitan area. This ensured that the individuals of the sampled population all belonged to the same climatic conditions of a geographic region, located at an altitude of 320 MSNM, with an average temperature range 22-36°C and an average relative humidity range of 40-95% year round. Between 2013 and 2016, 8 farms were visited to collect data for females and 7 for males. Data were collected for a total of 300 animals: 266 females and 34 males. These animals had a grass-based diet acquired during the grazing period, which started around 7 am and ended around 6 pm. Concerning the grass, this was based mainly on stubble obtained from different tree species of the region among which are some such as Pardillos, Urapos or Yátagos. throughout the day, they were outside eating, and during the night they were kept again in the corrals. This feeding system allowed the breeders to carry out periodic inspections related to the health and body condition of the animals during the night.

Phenotypic evaluation. To evaluate the phenotypic characteristics of the Motilona goat, morphological records were taken from young males that had offspring in the population. In females, morphological records were taken from those individuals that were in lactation after having had their first or second parturition. In this way, morphological records were collected from animals that were in the productive stage and had reached sexual maturity. Eleven quantitative variables commonly used for morphological characterization of goats (3, 8) were measured using a zoometer stick and a tape measure: head length (LC), face length (LR), head width (AC), withers height (ALCR), rump width (AG), longitudinal diameter (DL), sternal dorsal diameter (DE), bicostal diameter (DB), rump length (LG), cane circumference (PC), and thorax circumference (PT). Fourteen zoometric indices were derived from these measurements: Body index (ICO=DLx100/PT), thoracic index (ITO=DBx100/DE), cephalic index (ICE=ACx100/LC), pelvic index (IPE=AGx100/LG), proportionality index (IPRO=DLx100/ALCR), metacarpal-costal index (IMETO=PCx100/PT), metacarpal-costal index (IMCOS=PCx100/DB), relative thoracic depth index (IPRP=DEx100/ALCR), transverse pelvic index (IPET=AGx100/ALCR), longitudinal pelvic index (IPEL=LGx100/ALCR), compactness index (ICOMP=Px100/ALCR) and relative cane thickness index (IERCAÑ=PCx100/ALCR). In addition to these quantitative variables, the live weight of the animals (P) was also measured using a weighing tape. An analysis of variance (ANOVA) was performed to compare *post hoc* means between locations and also between sexes with the Ryan-Einot-Gabriel-Welsch multiple F-test (12). Quantitative variables were grouped and related by principal component analysis (PCA). The factor loadings were rotated with the Varimax

method to minimize the variables with high saturations in each component (13). In addition, a discriminant analysis (14) was performed to explore how animals are classified between sexes.

Statistical analysis. For the study of phaneroptic traits (8), 7 qualitative variables were measured: type of horns, presence of mammellae, dorsal-lumbar line, position of the ears, inclination of the rump, angularity, and the number of hair layers. For these variables, absolute and relative frequencies were calculated, along with chi-square (X^2) statistical significance tests for the contrast between sexes, a multiple correspondence analysis (MCA) was also performed to describe the dependence of the variables and their possible relationships (15). This MCA method, as well as the PCA and discriminant analysis mentioned above, were performed with the SPSS v. 20 statistical software (SPSS inc, Chicago, Illinois, USA).

RESULTS

Table 1 shows the values of the descriptive statistics calculated for each of the quantitative traits and the zoometric indices derived from them. The results of the quantitative variables showed that there is sexual dimorphism in the population for the variables LC, LR, AC, ALCR, DE, PC and PT, together with the body indexes IPRO, IMCOS, IPET, ICOMP and IERCAÑ because these were found to have significant differences between sexes ($p<0.05$). With respect to the different localities where the female population under study was distributed, significant differences were found in all variables ($p<0.05$), except LG, PC, PT, IPRO and IPRP. The coefficient of variation (CV) for the quantitative variables of females and males ranged from 4.90-16.48 and 8.05-34.37, respectively. While the CV of body indexes in females and males ranged from 5.87-19.25 and 6.70-28.58, respectively.

Table 1. Mean (M), standard deviation (SD) and coefficient of variation (CV) of the quantitative variables and zoometric indices of the Motilona goat.

Variables	Females (n=266)			Males (n=34)			Sexes	Farms	
	M	DT	CV(%)	M	DT	CV(%)		Females	Males
P, kg	44.63	7.36	16.49	55.56	19.10	34.37	*	*	n.s.
LC, cm	23.98	1.60	6.67	25.66	2.69	10.48	*	*	n.s.
LR, cm	14.50	1.32	9.10	15.15	2.20	14.52	*	*	*
AC, cm	12.91	0.85	6.58	13.54	1.45	10.70	*	*	n.s.
ALCR, cm	68.94	3.38	4.90	74.10	5.97	8.05	*	*	n.s.
AG, cm	17.66	1.26	7.13	17.77	1.87	10.52	n.s.	*	*
DL, cm	63.66	4.09	6.42	64.28	10.47	16.29	n.s.	*	*
DE, cm	30.36	2.20	7.25	32.69	4.59	14.04	*	*	n.s.
DB, cm	11.88	1.69	14.23	12.03	2.05	17.04	n.s.	*	*
LG, cm	16.17	1.11	6.86	16.51	1.72	10.42	n.s.	n.s.	n.s.
PC, cm	9.82	1.71	17.41	10.07	1.10	10.10	*	n.s.	n.s.
PT, cm	79.54	5.25	6.60	82.65	8.58	10.38	*	n.s.	n.s.
ICO	80.24	5.52	6.88	77.99	11.44	14.67	n.s.	*	*
ITO	38.67	5.51	14.04	37.24	6.74	18.10	n.s.	*	n.s.
ICE	54.01	4.40	8.15	52.87	3.72	7.03	n.s.	*	*
IPE	109.51	7.85	7.17	108.47	13.60	12.54	n.s.	*	n.s.
IPRO	92.42	5.42	5.87	86.75	12.15	14.00	*	n.s.	*
IMETO	17.64	1.81	10.25	18.83	1.26	6.70	n.s.	*	n.s.
IMCOS	119.46	16.13	13.51	131.86	21.06	15.97	*	*	*
IPRP	44.10	3.37	7.63	44.10	4.94	11.21	n.s.	n.s.	n.s.
IPET	25.65	1.83	7.15	24.03	2.17	9.01	*	*	*
IPEL	23.48	1.61	6.87	23.30	1.79	8.03	n.s.	*	n.s.
ICOMP	64.65	9.58	14.82	73.99	21.15	28.58	*	*	*
IERCAÑ	20.30	1.70	8.39	20.99	1.77	8.45	*	*	n.s.

P: live weight of animals, LC: head length, LR: face length, AC: head width, ALCR: withers height, AG: rump width, DL: longitudinal diameter, DE: dorsal sternal diameter, DB: bicostal diameter, LG: rump length, PC: canine circumference, PT: thoracic circumference, ICO: body index, ITO: thoracic index, ICE: cephalic index, IPE: pelvic index, IPRO: proportionality index, IMETO: metacarpomothoracic index, IMCOS: metacarpocostal index, IPRP: relative chest depth index, IPET: transverse pelvic index, IPEL: longitudinal pelvic index, ICOMP: compactness index, IERCAÑ: relative shank thickness index. CV: coefficient of variation, SD: standard deviation. Statistically significant differences ($p<0.05$), n.s.: no significant differences.

The rotated principal component analysis for the Motilona goat showed that the variables that are associated according to the rotation matrix are ALCR, AG, DL, DE, LG, PC and PT of component one with LC, LR and AC of component two, and, also, with AG and DB of component three. These three components explained 62.5% of the total variance. An important point of these results is that component one was found to be related to those measurements that were taken on the thorax and limbs of the animals, while component two was found to be related to measurements that were taken on the head of the animals (Table 2). On the other hand, the results of the discriminant analysis showed that P, ALCR, DE and PC were the variables that best discriminated between both sexes (Table 3).

Table 2. Rotated principal components matrix for the quantitative variables measured in the 300 individuals.

Variables	Component 1	Component 2	Component 3
LC	0.476	0.587	0.269
LR	0.105	0.826	0.242
AC	0.193	0.794	-0.211
ALCR	0.636	0.401	0.131
AG	0.627	0.205	-0.510
DL	0.692	0.190	0.022
DE	0.606	0.182	0.226
DB	0.211	0.163	0.802
LG	0.781	0.135	-0.039
PC	0.638	-0.016	0.419
PT	0.742	0.188	0.123
% de varianza	40.874	11.099	10.572

KMO = 0.856. Bartlett's sphericity p<0.001. LC: head length, LR: face length, AC: head width, ALCR: withers height, AG: rump width, DL: longitudinal diameter, DE: sternal dorsal diameter, DB: bicostal diameter, LG: rump length, PC: canine perimeter, PT: thorax perimeter.

The results of the qualitative traits are presented in Table 4, where sexual dimorphism between males and females was also observed for the variables: type of horns, rump inclination, body angularity and number of layers. In the case of horn type, males tended to have, in most cases, short horns and spiral horns (41% and 32%, respectively), while most of the female population (63%) presented curved horns and only 26% of the females studied had short horns (p< 0.001). Regarding the rump slope trait, most of the female population (66.5%) had a straight slope, while half of the sampled males (50%) had a very sloped rump and 44% of the males had a slightly sloped rump (p<0.001).

Table 3. Percentage of animals that classify well for sex according to the variable evaluated according to the results of the discriminant analysis for the 300 individuals.

Variables	H (%)	M (%)	PD (%)	Test M for Box	Test Wiks Lambda
P	76.7	47.1	73.3	*	*
LC	69.9	55.9	68.3	*	*
LR	61.3	55.9	60.7	*	*
AC	68.0	52.9	66.3	*	*
ALCR	78.2	58.8	76.0	*	*
AG	52.3	44.1	51.3	*	n.s.
DL	56.0	50.0	55.3	*	n.s.
DE	74.8	55.9	72.7	*	*
DB	51.5	52.9	51.7	n.s.	n.s.
LG	56.0	47.1	55.0	*	n.s.
PC	86.1	73.5	84.7	n.s.	*
PT	64.7	47.1	62.7	*	*
P+ALCR+ DE+PC	82.0	61.8	79.7	*	*
ALCR+PC	81.6	67.6	80.0	*	*

P: live weight, LC: head length, LR: face length, AC: head width, ALCR: withers height, AG: rump width, DL: longitudinal diameter, DE: dorsal sternal diameter, DB: bicostal diameter, LG: rump length, PC: canine circumference, PT: thorax circumference. H: females, M: males, PD: percentage of the 300 animals that classified well for their respective sex according to the variable evaluated. P<0.05, n.s.: no significant differences.

Regarding body angularity, males presented a tendency to be of intermediate to wide angularity, while the opposite was observed in females, intermediate to slender angularity (p< 0.001). Regarding the number of layers of females and males, both had a tendency to have between 2 and 3 layers of different colors, however, the percentage of females sampled with 3 layers was 51.5% and females with 2 layers was 33.8%, while in males these percentages were 23.5% and 41%, respectively (p<0.001). Regarding the position of the ears in females, 97.7% of the population showed to have elongated hanging ears, while in males 73.5% were observed to have this type of ears, but in addition 26.4% of the males also had ears in horizontal position (p<0.001).

Table 4. Absolute frequencies and relative frequencies of the qualitative traits measured in the Motilona goat**.**

Trait	Category	Females (n=266)		Males (n=34)		Sig.
		AF	RF	AF	RF	
Shape of the horns	Short	70	26.32	14	41.18	*
	Curved	168	63.16	9	26.47	*
	Spiral	14	5.26	11	32.35	*
	Intermediate	14	5.26	0	0	ns
Mamellas or tendrils	Presence	39	14.66	5	14.71	ns
	Absence	227	85.34	29	85.29	ns
Dorsal-lumbar line	Straight	126	47.37	18	52.94	ns
	Concave	6	2.26	2	5.88	ns
	Convex	134	50.38	14	41.18	ns
Ear position	Horizontal	6	2.26	9	26.47	*
	Vertical	0	0	0	0	ns
	Hanging	260	97.74	25	73.53	*
Croup inclination	Straight	177	66.54	2	5.89	*
	Slightly inclined	75	28.19	15	44.11	*
	Very steep	14	5.26	17	50.00	*
Body angularity	Thin	81	30.45	8	23.53	ns
	Intermediate	115	43.23	12	35.29	ns
	Wide	70	26.32	14	41.18	*
Color layers	One layer	9	3.38	5	14.71	*
	Two layers	90	33.83	14	41.18	ns
	Three layers	137	51.50	8	23.53	*
	Four layers	30	11.28	7	20.59	ns

AF: absolute frequency, RF: relative frequency. *p< 0.05, ns: no statistically significant differences.

The results of the multiple correspondence analysis showed that the variables that are associated in both dimensions, in order of importance according to their magnitude, are rump slope (0.87 - 0.70) and body angularity (0.90 - 0.76). However, horn shape was a variable that also presented an important magnitude in both dimensions, but its values were lower compared to the two variables initially mentioned for this analysis (0.19-0.15). With respect to the latter case, the dorsal-lumbar line was the only variable that presented a value close to this one, but only in the first dimension (0.15). The total variance explained by dimensions one and two was 30.9% and 25.5%, respectively (Table 5).

Table 5. Discrimination matrix obtained with the multiple correspondence analysis for the qualitative characters of the 300 individuals.

Variables	Dimensión 1	Dimensión 2	Mean
Shape of the horns	0.185	0.145	0.165
Mamellas or tendrils	0.023	0.010	0.017
Dorsal-lumbar line	0.146	0.023	0.084
Ear position	0.013	0.009	0.011
Croup inclination	0.871	0.704	0.788
Body angularity	0.902	0.764	0.833
Color layers	0.020	0.062	0.041
% variance	30.855	25.540	27.697

Average Cronbach's alpha = 0.565.

DISCUSSION

This study presents the first results of morphological characterization for the Motilona goat of the Norte de Santander region, where it was observed that the quantitative and qualitative variables measured in these 300 individuals presented an important degree of homogeneity among individuals. According to these results, the Motilona goat could be defined as an autochthonous breed of the study region because the high degree of homogeneity is evidence of an isolated population that adapted to a production system under environmental conditions of a specific geographic region (7). In relation to this, the CV is a descriptive parameter of the data that allows determining the homogeneity of a population, where CV values lower than 50% indicate the presence of homogeneity, but values close to 20% and 5% indicate moderate and high homogeneity, respectively (16). For this reason, it can be affirmed that the quantitative traits measured in the Motilona goat present a moderate to high degree of homogeneity. According to Silva-Jarquin et al (7), homogeneity can be said to exist in the morphological variables of a goat population if the CV does not exceed the value of 30, as occurred in the case of the females in

this study. However, in another study conducted with sheep, it is argued that morphological variables with CV values greater than 24 indicate an absence of homogeneity (17). In this sense, for the case of the variables measured in males, the CV of all traits were within the limits of homogeneity, except for the ICOMP index (28%). The high CV value for this index could be because the weight of the males had a high variation and consequently affected the ALCR trait. In relation to this, Castellaro et al (3) argue that it is normal to find these variations in the weight of males due, on the one hand, to environmental factors such as feeding or climatic conditions where the animals are raised and, on the other hand, to the genes of the individuals themselves.

The body indexes used in this study were used to explore the racial and functional characteristics of the population under study. As described by Abarca-Vargas et al (18), the racial indexes ICO, ITO, ICE and IPE define the Motilona goat as a brevilinear, longilinear, dolichocephalic and concavilinear animal. With respect to functional characteristics (3, 18), the body indices IPRO, IMETO, IMCOS and IPEL indicate that the Motilona goat is an animal that presents morphological characteristics for meat production, while the body indices IPRP, IPET and ICOMP, relate it to a body structure suitable for milk production. These results are because the Motilona goat is used for both purposes and for this reason these body indexes do not classify it as a single purpose animal.

In terms of qualitative traits, the population studied was dominated by females with curved horns, no mammels, long hanging ears, straight rump, intermediate to thin body angularity and three different hair color layers. In males, the traits of short horns, no mammels, ears similar to females, very sloping rump, intermediate to coarse angularity and two different hair color layers predominated. These results confirm what has been reported in other studies (3, 7), where it has been observed that males tend to be larger, more robust and heavier than females. For this reason, the variables weight, DB and ALCR, horn type and ear length seem to be clearly discriminating variables in a goat population as stated by Gutiérrez et al (19).

This study concludes that the Motilona goat can be defined as an eumetric and brevilinear animal used for meat and milk production in the region of Norte de Santander. In spite of evidencing an important degree of homogeneity in the morphological traits studied, the relationship with the productive characteristics is also important because in this way the Motilona goat could be used in animal improvement programs. Therefore, future studies in this aspect are necessary to deepen the knowledge of the morphological and productive characteristics of the Motilona goat of Norte de Santander.

Conflict of interest

The authors declare no conflict of interest.

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