

# Morphostructural characterization of the Creole goat (*Capra hircus*) of the municipality of Cuajinicuilapa, on the Costa Chica of Guerrero, Mexico

## Abstract

The aim of the present study was to characterize morpho-structurally the Creole goat of the municipality of Cuajinicuilapa, Guerrero. The dispersion of most of the studied body measurements showed a coefficient of variation (CV) with a range of 10.91% (height to the cross, HC) and 32.95% (rump width, RW). The little variation between the HC (65.97 cm) and height at the rump (HR, 64.92 cm) makes it possible to differentiate an inclination of the back train the previous one of the animal. On the other hand, some corporal measures considered of economic importance for the meat genotype HC (65.97%), thoracic perimeter (TP, 74.68 cm) and body length (BL, 68.92 cm), little variation between these variables was observed. On the other hand, the cephalic measurements found in this work were width of the orbital head (WOH, 22.38%), long head LH (12.37%), snout diameter (SD, 15.71%) and ear length (EL, 17.91%). On the other hand, in the analysis of the main components of the Creole goats: LH, HC, HR, height to the sternum (HS), TP, abdomen perimeter (AP), shoulder width (SW) and bicostal diameter (BD) It was found that the variables live weight (LW) and HC presented more than 98% of the variability of the data. In the case of the variables of body condition (BC), AP, BD, they correlated positively with the LH; the SW and DB with the BL; HR and AP with HC; the AP with the TP; with the diameter of the shoulders (DS) with AP and tail length (TL); perimeter of the fetlock (PF), DS; LT with the length of the udder (LU) and the length of the horns (LH) (\*\*P<0.0001). On the other hand, the variables that have \*P<0.05, have a moderate correlation between them. In conclusion, the Creole goats of the municipality of Cuajinicuilapa, Guerrero show a great variability in their morpho-structural characteristics. It was found that the variables LW and HC presented more than 98% of the variability of the data, also a positive correlation was found between the studied characteristics.

**Keywords:** body characteristics, measurements, local goats, tropical region

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**Abbreviations:** SW, shoulder width; TL, tail length; SD, snout diameter; BC, body condition; PF, perimeter of the fetlock; BD, bicostal diameter; BL, body length; RW, rump width; CV, coefficient of variation; DS, diameter of the shoulders; EL, ear length; TP, thoracic perimeter; WHO, width of the orbital head

## Introduction

Goats were introduced to Mexico by the Spaniards during the conquest in the sixteenth century. The main breeds that arrived the country and gave rise to the Mexican Creole goat were the White Celtiberica, the Murciana and the Granadina.<sup>1</sup> The “Creole” of this cattle was probably due to the isolation, the main force of several geographically different local goat populations. A well-marked situation in the country, while further south the frequency of pure Creole flocks increases.<sup>1,2</sup> The morpho-structural characteristics of the mexican Creole goats are differentiated by two types of animals: small (25-32 kg and 60 cm of height at the cross in adult goats) in the center and southwest of the country, and medium (30-40 kg in adults goats) in arid and semi-arid regions of the country.<sup>3,4</sup> On the other hand, the characteristics of Creole goats from Central America (smaller size, 28kg, 71 cm thoracic circumference and 64 cm height at the cross)<sup>5</sup> are smaller than those of Mexico and the Caribbean (18.2-34.4 kg and height at the cross 50 cm).<sup>6</sup> However, due to the lack of information of their origin, reproductive management, genotypic and phenotypic

characterization; isn't possible to differentiate the genetic composition of the goats flocks.<sup>7</sup> In developing countries like Mexico it's necessary to design reproductive and genetic improvement programs more efficient where genetic differences are involved between populations of production systems, this will allow to decide which genotypes introduce to the flocks to make them more efficient.<sup>2,8</sup>

Faced with this situation, the strategy of many government and commercial programs was to introduce genetic material from the United States of America (USA) to absorb the “Creole” goat cattle and obtain fine animals, however, this was not adopted by the producers and there's a mixture of breeds that is difficult to differentiate.<sup>2</sup> For example, in the states that are on the border with the USA, the Creole goat was practically lost, due to the use of European breed male goats in the flocks of Creole goats.<sup>2</sup> According to the FAO, to protect animal genetic resources, it's necessary to establish an inventory and characterization of them, follow up and early responses.<sup>9</sup> In Mexico there is an inventory of goats of about 9 million, of which they are used as a double purpose (meat and milk). For its part, the state of Guerrero ranks fourth nationally with 655,055 head of goat cattle, used for meat production.<sup>10</sup> In the municipality of Cuajinicuilapa Guerrero, the Creole goat morphostructurally is of small size much more marked in some herds than in others.<sup>11</sup> However, an increase in the size and weight of some specimens has been observed; this is probably due to the introduction of genetic material for meat as

Nubian stallions and more recently the Boer.<sup>11,12</sup> There are some easy and simple tools such as body measurements that allow livestock to characterize morphostructurally,<sup>13</sup> however, there are currently some more specialized genetic tools such as morphological and biochemical markers.<sup>14</sup> As well as, several molecular genetic markers such as restriction fragment length polymorphisms, deoxyribonucleic acid, random amplified polymorphism and variable number of repeats in tandem, microsatellites and polymerase chain reaction; confirming with more accuracy the genetic nucleus to which each evaluated herd belongs.<sup>14,15</sup> Therefore, the aim of the present study was to phenotypically characterize the Creole goat from the municipality of Cuajinicuilapa, Guerrero.

## Materials and methods

The experimental procedures were carried out according to the Official Mexican Norm; NOM-062-ZOO-1999, with technical specifications for the production, use and care of laboratory animals.<sup>16</sup> As well as accepted guidelines for the ethical use, care and welfare of animals used in research according to international standards.<sup>17</sup>

### Study area

The present study was conducted during the months of March to June of 2017 in the municipality of Cuajinicuilapa, Guerrero, Mexico. Which is part of the Costa Chica region of the state and belongs to the tropics (latitudes: 16° 28' of LN and 98° 25' of LO), has maximum average temperatures (33.6°C) during the summer and minimum (21.2°C) during the winter.<sup>18</sup>

### Animals and sampling

Were randomly sampled 300 empty, multiparous Creole goats (*Capra hircus*), with average live weight of 33.44±0.03 and body condition of 2.8±0.001 (scale 1 (thin) to 4 (fat) with increments between units of 0.5).<sup>19</sup> These females belonged to 30 flocks of 6 communities of the municipality: Cuajinicuilapa, San Nicolás, El Pitahayo, Montecillos, Maldonado and Punta Maldonado. In each community, 50 goats from 5 flocks (10 per flock) were measured. In the region a subsistence goat production is practiced, in the morning (0800h) the animals are taken out to graze and in the evenings-nights (1900 h) they are enclosed in open pens without nutritional supplementation. The criteria for the selection of flocks and animals were: with permission of the goatchers, the distance between flocks and the density of the animals.

### Study variables

The phenotypic characteristics of the goats were obtained with measurements according to the methodology described by Agraz-García<sup>13</sup> Body length (BL), height to the cross (HC), height at the rump (HR), height at the sternum (HS), thoracic perimeter (TP), abdomen perimeter (AP), shoulder width (SW), bicostal diameter (BD), rump width (RW), width of the orbital head (WOH), length of head (LH), snout diameter (SD), length of ear (LE), perimeter of fetlock (PF), tail length (TL), length of udder (LU) weight live (WL) and body condition (BC). All measurements were made by 3 people previously trained, one of them was responsible for catching the goat and hold it during the measurement process, the second made the body measurements and the third recorded the measurements. Definitions: Body length (BL), height to the cross (HC), height at the rump (HR), height at the sternum (HS), thoracic perimeter (TP), abdomen perimeter (AP), shoulder width (SW), bicostal diameter (BD), rump width (RW), width of the orbital head (WOH), length of

the head (LH), snout diameter (SD) and length of the ear (LE).

### Statistical analysis

To carry out the measurements, a metric tape graduated in centimeters was used, as well as sheets and pen to record the data. Calculations of central tendency and dispersion measures were performed. To study the variability among goats, their degree of similarity and the association between the variables, the principal components analysis was used. This analysis seeks to reduce the dimension of the space in which the original variables are represented, which in this case are quantitative, to detect structures of variability and, perform groupings by similarity of the female goats.<sup>21</sup> All data were analyzed with the statistical program R version 2.10.0 (2009-10-26) Copyright (C) 2009 The R Foundation for Statistical Computing.<sup>22</sup>

## Results and discussion

### Use of basic statistics in the morpho-structural measurements of goats

In the study it was found that most of the data presented a wide dispersion 10.91% (HC) and 32.95% (RW); reflecting that the sample studied had a high degree of homogeneity. The variables related to the HC (10.91%) and HR (14.94%), allow to define the body profile of the goats. Indeed, the little variation between the HC (64.92 cm) and HR (65.97 cm) denotes a tilt of the train posterior to the previous one of the animal (Table 1). Therefore, it can be considered that the studied goats are of small size, below 68 to 78 cm measures that have some Spanish breeds such as Payoya, Granadina, Malagueña; among others.<sup>23</sup> They can also be considered to be on the border between small (51-55 cm) and large breeds (>65 cm).<sup>24</sup> Other researchers<sup>1,23</sup> recorded values similar to those of the present study in Creole goats of the Caribbean, Central America, South America and Brazil (range: 49-69 cm). On the other hand, some body measurements considered as genotype economic importance for meat: HR (65.97 cm), TP (74.68 cm) and BL (68.92 cm) had little variation among them, this shows that there have been few changes in the size and corpulence of this goat population of this municipality of Costa Chica of Guerrero. This is very likely due to the fact that smaller goats consume less food and have more facilities to move and find less competition.

**Table 1** Basic statistics analysis of the morphometric measurements of the Creole goats of the municipality of Cuajinicuilapa, Guerrero

Variable n=300	Average	ED	Minimum	Maximum	CV
BL	68.92	9.34	45	89	13.55
HC	65.97	7.2	39	89	10.91
HR	64.92	9.7	30	86	14.94
HS	40.91	6.27	29	70	15.32
TP	74.68	10.32	31	101	13.81
AP	84.51	13.15	36	118	15.56
SW	43.81	9.93	18	96	22.66
RW	17.62	5.8	11	66	32.91
WOH	14.61	3.27	10	41	22.38
LH	21.57	2.67	12	30	12.37
SD	22.14	3.48	2	36	15.71
LE	17.91	3.68	8	29	20.54

In this context, Aparicio<sup>25</sup> mentions that TP (74.68 cm) reflects the variations in the shape of the thorax at higher value (it's more circular) as in beef cattle and at lower value (more elliptical) as in cattle milk. In this context, the Creole goats studied in the present study have the characteristics of specialized goats for meat presenting the most circular thorax. This was demonstrated by the cephalic measures (WOH, 22.8%, BL, 12.37%, SD, 15.71% and LE, 17.91%) found in the present work; the representative feature is LE, which was similar to the one reported by Dorantes<sup>26</sup> in Amatepec and Tejupilco State of Mexico, and superior to that reported (15.37 cm) by Abarca et al.<sup>27</sup> in Colima, and De los Santos<sup>28</sup> in the Valley of the Free Puebla. These characteristics of small body size goats are probably due to the fact that this nucleus of Creole animals have been set apart in the Costa Chica region of the state where at some times of the year food is lacking and the environmental temperatures are high during the summer, situations that they contributed strongly to the survival of the animals.

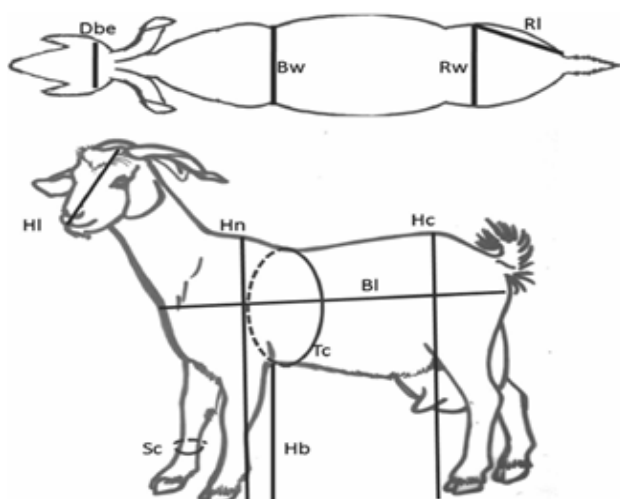
### Main components and correlation between variables

In the analysis of the main components of the Creole goats: BL, HC, HR, HS, TP, AP, SW, BD it was found that the variables LW and HC presented more than 98% of the variability of the data (Figure 1). On the other hand, the values of correlation between the morphometric measurements of goats are presented in Table 2 and Figure 2. In effect, the variables BC, AP, BD, correlated positively with the LW; the SW

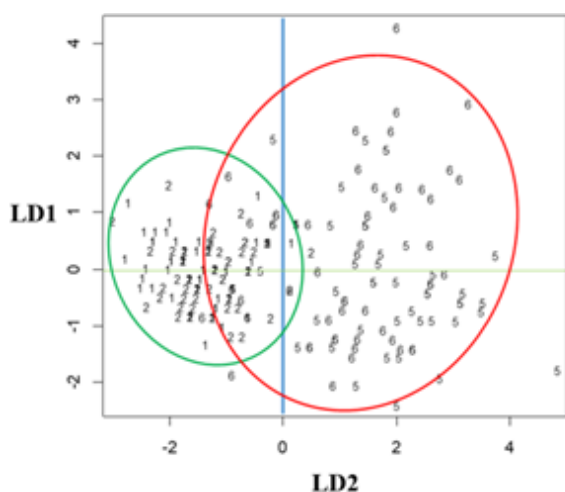
and BD with the BL; HR and AP with HC; the AP with the TP; SD with AP and LT; PF with the SD; LT with the LD and the LH (\*\*P<0.0001). On the other hand, the variables that have \*P<0.05, have a moderate correlation between them. On the other hand, the variables that present a negative correlation are indicated by a \* and a negative sign. Finally, the variables that do not correlate do not present any sign that differentiated them (P>0.05). The biometric characteristics of small ruminants are related to economic and productive functions, instead; the external characters of an animal vary according to its zootechnical function (meat or milk). For example, sheep that produce meat must have a thin skeleton, a long and broad body, denoting good musculature.<sup>29</sup> In the present study a high correlation (>0.50) of LW was found with some variables of economic importance for meat goats; BC, AP, BD, SW and HR;<sup>11,29</sup> although this cattle retains some phenotypic characteristics similar to the Spanish milk goats.<sup>25</sup> Other studies<sup>30</sup> indicate that most of the variables are moderately related (>0.40 and <0.50) among them: BL, HC, RW, HS and TP. For its part, the relationship between variables decreases as also change the bodily characteristics of economic importance. These results indicate that there is an important correlation between the corporal characteristics of the local goats of the municipality of Cuajinicuilapa, Costa Chica region, serving as an indicator to select quantitative characteristics of the carcass. This is important since the state of Guerrero is among the main producers of goats in the country, and this is sold in the local market mainly for barbecue (Figure 3).

**Table 2** Pearson correlation between morphometric measurements of Creole goats from the municipality of Cuajinicuilapa, Guerrero

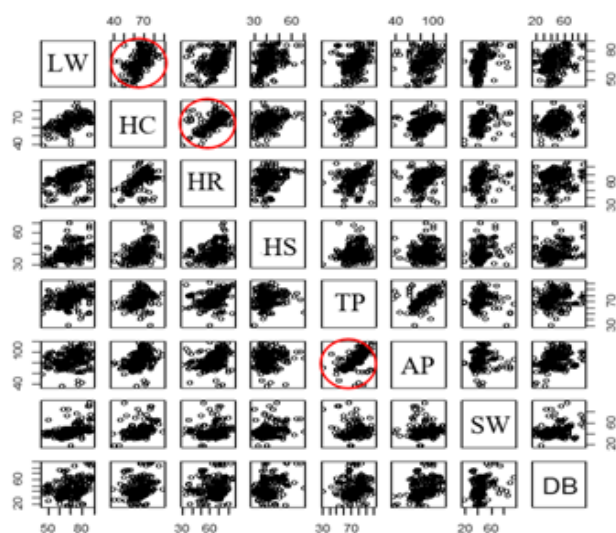
	HC	HR	HS	TP	AP	SW	BD	RW	WOH	BL	SD	LE	PF
BL	0.58**	0.35**	0.37**	0.34**	0.28**	0.43**	0.4**	0.16*	0.22**	0.28**	0.07	0.29**	0.02
HC	-	0.53**	0.38**	0.36**	0.4**	0.34**	0.25**	0	0.11	0.33**	0.21**	0.31**	0.11
HR		-	0.31**	0.35**	0.29**	0.14*	0.11*	0.08	-0.13	0.31**	0.23**	0.29**	0.03
HS			-	0.16*	0.09**	0.28**	0.28**	0.33**	0.12*	0.08	-0.08	0.21*	-0.17
TP				-	0.57**	0.08	0.18*	0.04	0.07	0.38**	0.37**	0.08	0.14**
AP					-	0.14*	0.36**	0.02	0	0.38**	0.53**	0.07	0.31**
SW						-	0.35**	0.29**	0.1	0.07	1	0.21*	0.12*
BD							-	0.13*	0	0.22	0.2**	0.31**	0.03
RW								-	0.11*	-0.02	0.02	0.12*	-0.01
WOH									-	0.1	0.05	-0.11*	0.24**
BL										-	0.43**	0.16*	0.18*
SD											-	0.07	0.46**
LE												-	-0.06



**Figure 1** Some morpho-structural measurements recorded in the present study are exemplified.<sup>20</sup>



**Figure 2** The linear discriminant coefficients (LD) for the LW and HC have the highest number (LD 1; 0.9863) and (LD 2; 0.0137).



**Figure 3** The discriminant analysis is presented in which the variables BL, HC and TP have a higher correlation and the dispersion of the data is lower.

## Conclusion

The Creole goats of the municipality of Cuajinicuilapa, Guerrero show a great variability in their morpho-structural characteristics. It was found that the variables LW and HC presented more than 98% of the variability of the data, also a positive correlation was found between the studied characteristics. Some predominant characteristics, such as goat cephalic measurements, maintain similarities with the Spanish dairy goat breeds, phenotypically highlight the characteristics of goats with economic value for meat. The present study evidenced the formation of new phenotypes, product of the crosses with other breeds like the Boer recently introduced to the local flocks. The characterization of this cattle will allow to take actions to conserve the Creole genotype of tropical regions like the ones presented by the Costa Chica region of the state of Guerrero.

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## Conflicts of interest

All authors manifest that there’s no conflict of interest.

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