



Original

Characterization of Grazing Goat Biotypes in the Municipality of Jimaguayú, Camagüey

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ABSTRACT

Background: Morphological characterization is considered a valid tool that contributes to an objective and reliable prediction of the potential performance of each animal within production systems. **Aim.** To characterize productive goat biotypes grazing in Jimaguayú, Camagüey. **Materials and methods:** Morphometric measurements were taken from 217 goats from 20 farms in the region, between April and July 2022. The variables were divided into morphological variables and productive response variables. *K-means* cluster analysis was used. The groups obtained were called biotypes, and each was assigned a productive aptitude according to its similarity with the average morphological characteristics of the Saanen, Anglo-Nubian, and Creole (undefined) breeds. A canonical discriminant analysis was performed to determine the relationship of the obtained sets and to verify the effectiveness of the grouping. The differences in the productive response of the biotypes were evaluated by analysis of variance. **Results:** Three biotypes were obtained as dairy, dual-purpose, and undefined aptitude, although milk production does not differ between them. **Conclusions:** The study has a clear focus on the characterization of the species, with a detailed analysis of the herds, serving as a tool aimed at improving the productivity and sustainability of goat ecosystems, which is vital for the food and nutritional security of the municipality.

Keywords: dairy goat, climate change, animal morphology (*Source: AGROVOC*)

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INTRODUCTION

Currently, there are nearly one billion goats worldwide, with the regions of Asia and Africa hosting more than 90%, and only 8.2% in America (Getaneh *et al.*, 2022). In the Americas, the leading countries in goat milk production are Jamaica, Mexico, and Brazil, while in Europe, the largest producers are France, Spain, and Greece. In the Netherlands, a significant upward trend for this product was observed (FAO, 2021).

Studies of external characteristics determined by qualitative (phenotypic) and quantitative variables of shape and structure (morphometric) were conducted for the racial characterization of a species. According to Oliveira *et al.* (2020), the study of external morphology fulfills two fundamental missions: (a) serving as the basis for the natural identification of the individual or breed group (to describe and differentiate them), and (b) providing a zootechnical assessment that allows for the approximation or collaboration in predicting their productive possibilities.

The morphological characterization of animals is considered a valid tool that provides information to define morphofunctional variables that allow predicting the growth and production of milk and meat (Castellaro *et al.*, 2019). The study of the exterior of animals is a branch of zootechnics that allows observing, studying, and judging animals, considering their external appearance and evaluating their merits, defects, and specific qualities that make them suitable for certain productive purposes (Steffen *et al.*, 2022).

Additionally, characterization activities should contribute to an objective and reliable prediction of animal performance in defined environments, facilitating the comparison of potential performance within the most relevant production systems in the region. The information obtained will enable various interested groups to make decisions about priorities in the management of zoogenetic resources. In the absence of such analyses and studies, there is a risk of ignoring the development and production of local breeds, favoring the introduction of exotic germplasm or indiscriminate crossbreeding that could result in the erosion of native breeds (FAO, 2021).

Different goat breeds have great variability in terms of live weight and body measurements, and since these variables directly influence animal productivity, knowledge of these values in a given herd is very useful for classifying animals, as well as for selecting, developing, and conserving native goat breeds with specific production potentials (Castellaro *et al.* 2019; Abarca *et al.* 2020).

A biotype is the set of morphological characteristics that give an individual specificity in its production. In goats, there is a meat-producing biotype, a milk-producing biotype, an intermediate biotype (dual-purpose), and a specific hair-producing biotype. (Martínez and Suárez., 2018).

This study was preceded by those of Delgado *et al.* (2016) and Gispert *et al.* (2019), who characterized goat production systems in Ciego de Ávila and the municipality of Camagüey,

respectively. It is worth noting that in Cuba, goat production systems are managed by small producers who mostly use traditional methods to manage their herds (Bidot, 2018; Bidot and Paretas, 2018), which is ultimately reflected in the productivity and competitiveness of the goat sector.

Considering these elements, the objective of the research was to characterize biotypes in grazing goat herds in the municipality of Jimaguayú, Camagüey.

MATERIALS AND METHODS

Location, soil, and climate

The study was conducted on farms in the municipality of Jimaguayú, Camagüey, with a land area of 799.0 km² and located between 21° 16' 0" North and 77° 49' 49" West, with an average altitude of 113 meters above sea level (Acosta *et al.* (2018); Martínez *et al.* (2020)). The predominant soils are of agro-productive category III, classified as typical Brown, non-carbonated Brown, and grayish Brown, according to the Soil Classification of Cuba of 2015 (Hernández-Jiménez *et al.*, 2019).

The climate is tropical sub-humid inland plain, with an annual precipitation of 1 240.2 mm, with approximately 79% of the rains occurring between May and October (Camagüey Meteorological Center, 2022).

A stratified random sampling with proportional allocation was applied according to the geographical conditions in the study region, resulting in the selection of 20 farms. For the selection of producers (farms), the following inclusion criteria were considered: being associated with a Credit and Services Cooperative (CCS): having stable annual goat milk productions prior to the study, having a contract with the Provincial Dairy Company of Camagüey, and possessing herds consisting of 20 or more adult goats.

Morphometric measurements of lactating goats

Zoometric measurements were taken from 217 adult goats over two years old and with 60 to 70 days of lactation. The live weight (kg) and measurements of each animal were determined based on quantitative variables, using the methodology proposed by Capello *et al.* (2017); Castellaro *et al.* (2019) and Steffen *et al.* (2022) (Table 1).

Table 1. Quantitative characters obtained from lactating goats

Zoometric Measurement	Viscosity coefficient measurements
Thoracic perimeter (cm)	Measuring tape
Body length (cm)	Measuring tape
Withers height (cm)	Zoometric rod
Abdominal perimeter (cm)	Measuring tape

Chest diameter (cm)	Thickness compass
Hip diameter (cm)	Thickness compass
Production per day (L/goat/day)	Milking measurement
Days of lactation (days)	Farmer's records
Number of lactations (Number)	Farmer's records

Statistical analysis

The coefficients of variation and the correlations between the considered variables were determined. Variables with little discriminant power were discarded, that is, those with variation coefficients equal to or less than 10% and correlations equal to or greater than 75%, following the criteria established by Chacón *et al.* (2011).

To characterize the predominant goat biotypes and determine their productive response, the variables were divided into two categories: morphological and productive response. The morphological variables used were: thoracic perimeter, body length, withers height, abdominal perimeter, chest diameter, and hip diameter. *K-means* cluster analysis, which partitions into disjoint groups, was used.

The resulting groups were called biotypes, and each was assigned a productive aptitude based on its similarity with the average morphological characteristics of the Saanen (dairy), Anglo-Nubian (dual-purpose), and Creole (undefined) breeds. The identified biotypes were: 1) Dairy biotype (DB), (2) Dual-purpose biotype (DPB), and (3) Undefined biotype (UNB). A detailed description with the average values and dispersion statistics obtained for each biotype was then performed.

A canonical discriminant analysis was performed, To determine the relationship of the obtained sets and verify the effectiveness of the grouping, which used the formed groups as the dependent variable and the morphometric variables defining each group as independent variables, using the methodology described by Cedeño *et al.* (2024).

The differences in the productive response of the biotypes were evaluated by analysis of variance. A data matrix was created, considering each biotype as the factor under study. The theoretical assumptions of the analysis of variance were verified using the Kolmogorov-Smirnov (1933) test for data normality and Levene's (1960) test for homogeneity of variances. The variables had a normal distribution; a simple analysis of variance was conducted using a general linear model, and Duncan's (1955) multiple range test was used for mean comparison.

The data were processed using the SPSS® version 25 software for Windows, 2017.

RESULTS AND DISCUSSION

In dairy cattle genetic improvement programs, several characteristics are used as selection criteria, including both productive traits, such as milk, fat, and protein production, as well as

functional traits, such as survival, reproduction, health, and other conformation or type traits. All these criteria aim to improve the economic efficiency of milk production (Timaure *et al.*, 2015; Curto *et al.*, 2016; Sánchez Gutiérrez *et al.*, 2018; Romero *et al.*, 2020).

In most tropical regions, goats are an important resource for the survival of local populations. However, the breeding systems applied lack basic records and do not have information about the characteristics and productive performance of the animals, making it difficult to identify the most promising ones. Accordingly, developing any conservation and improvement programs for local goats becomes a challenge, even though many of them have invaluable traits, such as the ability to survive in challenging conditions (Ribas *et al.*, 2003).

Table 2 shows the morphometric variables obtained from the sampled goats, which are distributed into three groups identified as dairy biotype (DB), dual-purpose biotype (DPB), and undefined biotype (UNB), according to their similarity to the patterns of the Saanen, Anglo Nubian, and Creole mixed breeds, respectively.

Table 2. Morphological variables of goat biotypes in lactating herds of Jimaguayú

Variables	Cluster		
	DB (N=82)	DPB (N=52)	UNB (N=83)
Live weight (kg)	42.20	57.20	28.10
Thoracic perimeter (cm)	84.24	76.54	43.07
Body length (cm)	70.07	62.35	61.77
Withers height (cm)	69.35	61.00	55.93
Abdominal perimeter (cm)	94.84	82.46	95.52
Chest diameter (cm)	13.66	13.79	13.36
Hip diameter (cm)	14.33	13.33	12.96

(DB - dairy biotype, DPB - dual-purpose biotype, UNB - undefined biotype).

For the goats of undefined biotype, the lowest values were obtained for all variables, which correspond to the characteristics indicated by Mellado (1997) for Caribbean Island goats. Valencia *et al.* (2010), cited by Sánchez Gutiérrez (2018), defined these genotypes as small-sized, with weights not exceeding 33 kg and modest milk production. However, it should be noted that these animals are raised under traditional systems with very little attention and technology, so their potential is practically unknown. Ribas *et al.* (2003) also noted that Cuban Creole goats, despite their considerable variation in external traits, were medium-sized animals (approximately 33 cm withers height) with coats of various colors. The results in this case exceed the withers height indicated by the authors, which may be related to the uncontrolled introduction of exotic breeds at certain times.

In line with the above, the presence of dairy and dual-purpose biotypes in the herds possibly occurs due to the unplanned introduction of Saanen and Nubian breeds, which can be a positive

action to increase milk and meat volumes, but only when well-conceived improvement programs are applied that ensure the conservation of local goats (Chacón *et al.*, 2011). Some authors such as Curto *et al.* (2016); Feldmann *et al.* (2019); Sharma *et al.* (2019); Misra *et al.* (2020); Moyao *et al.* (2021) highlight the importance of dual-purpose biotypes for medium to low-intensity systems, as they provide products like milk and meat in conditions where more specialized breeds are not productive.

Figure 1 highlights the existence of the three biotypes in the sampled goats. Identifying the predominant biotype in the region's herds can be important to guide breeding objectives in each case. The breeder should adequately combine production, functional, and conformation characteristics when making decisions about the use of breeders and the selection of animals within the herds. According to Silva *et al.* (2019) and Worku and Tadisise (2024), studies of biotypes within goat populations that lack racial classification can be useful for understanding their genetic variability.

On the other hand, improving some conformation traits can contribute to reducing production costs through a decrease in the incidence of diseases such as mastitis, lower replacement costs, and an increase in herd production levels (Vera and Estupiñán, 2022).

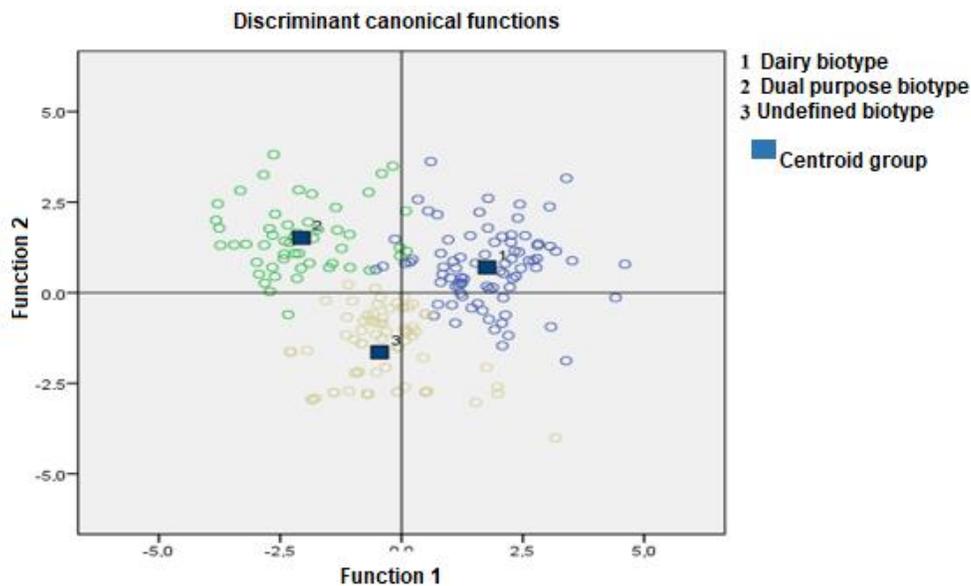


Figure 1 Distribution of groups or biotypes according to the canonical discriminant analysis (1 DB dairy biotype, 2 DPB dual-purpose biotype, 3 UNB undefined biotype)

In relation to the productive indicators (Table 3), no significant differences were observed between the biotypes for any of the analyzed variables, which is logical in the case of the days of lactation and the number of lactations, since the goats in the sample were selected considering that these two variables were between 60 to 70 days and two years of age, respectively.

Table 3. Productive indicators of the identified biotypes in the goats of Jimaguayú

Variables	Biotype				
	DB	DPB	UNB	SE	P
Production per day (L/goat/day)	0.91	1.04	0.72	.03012	.138
Days of lactation (d)	66.52	67.40	67.29	.73480	.867
Number of lactations	2.73	2.52	2.54	.03687	.132

(DB - dairy biotype, DPB - dual-purpose biotype, UNB - undefined biotype).

In the case of milk production levels, they are within the range reported in Cuba for goat herds under similar conditions to those in the study (Delgado *et al.*, 2016; Gisper *et al.*, 2019), without differences between the biotypes. This could be due to the type of management applied to the goats without differentiating their productive aptitudes. The greater the productive specialization of the animals, the higher environmental requirements, and individuals with higher productive potential may be more affected when environmental conditions and management are not adequate, significantly reducing their production. This is the case for the much more modest productive performance in the tropics of exotic dairy goat breeds according to Ribas *et al.* (2001); Yemane and Melesse (2021).

CONCLUSION

The goats in the region can be grouped into three biotypes related to possible productive orientation, although no differences were observed in the productive variables.

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AUTHOR CONTRIBUTION STATEMENT

Research conception and design: EVR, GRPC, JJPM, LMCR; data analysis and interpretation: EVR, GRPC, JJPM, LMCR; redaction of the manuscript: EVR, GRPC, JJPM, LMCR.

CONFLICT OF INTEREST STATEMENT

The authors state there are no conflicts of interest whatsoever.