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CORRELATION BETWEEN THORACIC PERIMETER AND BODY WEIGHT IN SAANEN AND SAANEN-BOER CROSSBRED CAPRINE

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ABSTRACT - Among the animal data, we have biometric measures related to the development and production of goats. Thus, the objective of this study was to evaluate the correlation between live weight and thoracic perimeter in the caprine species, in order to obtain a barometric tape to estimate the live weight of the animal, without the use of the scale. Caprines from 10 to 42 kg live weight were used; males and females; pure Saanen race and Saanen-Boer crossbred. The thoracic perimeter of each animal was measured after weighing, in which it was measured at the external circumference of the thoracic cavity, just below the axillae, with steel cable to minimize possible errors from the elasticity of the tape measure, with the animal in the correct position of legs angulations. All parameters were recorded with the fasting animal for 12 h. Subsequently the live weight was estimated by regression equations with high correlation coefficients. The study showed a strong positive correlation between live weight (kg) of the animal and the thoracic perimeter (cm). The barometric tape for Saanen and Saanen x Boer crossbreed presented 97% efficacy for the estimation of the weight of Saanen and crossbreed. The thoracic perimeter provides a high efficiency in the estimation of the live weight of caprines and can be used as an alternative when scales are not available, being more appropriate the separation by race and sex before adjusting the equation to be calculated.
Keywords: *Capra hircus*, body measurements, body weight, barimetry, morphometric measurement.

CORRELAÇÃO ENTRE PERÍMETRO TORÁCICO E PESO CORPORAL EM CAPRINOS DA RAÇA SAANEN E MESTIÇOES SAANEN-BOER

RESUMO - Entre os dados dos animais, temos medidas biométricas relacionadas a desenvolvimento e produção de cabras. Desta forma, objetivou-se com **e**ste estudo avaliar a correlação entre peso vivo e perímetro torácico em caprinos, a fim de obter uma fita barométrica para estimar o peso vivo do animal, sem o uso da escala. Cabras de 10 a 42 kg de peso vivo foram utilizadas; machos e fêmeas; da raça Saanen e mestiços Saanen-Boer. Os animais foram pesados e tiveram seu perímetro torácico medido. O perímetro torácico de cada animal foi medido após pesagem, no qual foi medido na circunferência externa da cavidade torácica, logo abaixo das axilas, com cabo de aço para minimizar possíveis erros de elasticidade da fita métrica. Todos os parâmetros foram registrados com o animal em jejum por 12 horas. Posteriormente, o peso vivo foi estimado por equações de regressão com altos coeficientes de correlação. O estudo mostrou uma forte correlação positiva entre o peso vivo (kg) do animal e o perímetro torácico. A fita barométrica para os cruzamentos Saanen e Saanen x Boer apresentou 97% de eficácia para a estimativa do peso de Saanen e mestiços. O perímetro torácico proporciona alta eficiência na estimativa do peso vivo de caprinos e pode ser utilizado como alternativa quando as balanças não estiverem disponíveis, sendo mais apropriada a separação por raça e sexo antes de ajustar a equação a ser calculada.
Palavras-chave: *Capra hircus*, medidas corporais, peso corporal, barimetria, medida morfométrica.

INTRODUCTION

The herd of caprines in Brazil reached its highest level in terms of animal numbers in 2016 (SOUZA et al., 2018). That is, caprine farming has increased its participation in the Brazilian agricultural scenario and can be considered as a profitable activity that can bring development to the small Brazilian producer.

Worldwide, Brazil has the twenty-second herd of caprines, with about 9.8 million animals, with dairy production being the largest in South America (FAO, 2018). The Northeastern region concentrates around 93% of the national caprine herd and 74% of Brazilian dairy production, increasing at a rate of 5.5% per year, considering the range from 2004 to 2016, with the increase in national consumption being 5.9% per year for the same period (IBGE, 2018). Brazil presents 21 races of the caprine species, which highlights it with the greatest racial diversity in South America (DAD-IS, 2018).

An important advance, from the point of view of the political articulations, for caprine breeding with action

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of the National Confederation of Agriculture (CNA - Brazil) including the financing of the retention of ovine and caprine matrices in the Agricultural and Livestock Plan 2017/2018 (CNA, 2017). Thus, as in other segments of the Brazilian agribusiness, there is a growing demand for technological innovations that provide improvements in the activity (TEIXEIRA et al., 2013).

In the breeding of production animals, there is a difficulty in evaluating the weight of the animals, especially in small properties, where there are no weighing scales for the animals. The knowledge of the live weight of the animals is important for the correct application of medicines, evaluation of growth and development of the animal, calculations of nutritional requirements, selection of the herd and slaughter weight.

The biometric or barometric evaluation is the measurements of body measurements, such as: height of the withers, height of the hip, length of the body, length of the croup, thoracic perimeter; and the body weight and body measurements were influenced by race, age, body condition and physiological state of the animal (SILVA et al., 2006).

As a result of the high correlations with body weight, some authors (MORENO et al., 2006) suggest that morphometric measures, especially the thoracic perimeter, can be used to determine the weight of the animal in the absence of a scale. Thus, this objective was to establish mathematical models that express the live weight of caprines through the measurement of the thoracic perimeter.

MATERIAL AND METHODS

The experiment was conducted at the Animal Husbandry Sector of the Federal Rural University of Rio de Janeiro (UFRRJ), in Seropédica county, Rio de Janeiro State, Brazil (latitude: 22º46'59" S, Longitude: 43º40'45" W and altitude average of 33 m). The installation of the Goat and Sheep's Sector had slatted wood floor, well ventilated, with collective bays. According to data collected at the Agricultural Research Company of the State of Rio de Janeiro (PESAGRO) in Seropédica county, the maximum and minimum average temperature was 27.4 and 16.6 in the winter and 29.7 and 21.6 in the summer and relative air humidity was 65.0 in winter and 75.0 in summer, during the experiment.

The animals were kept in a semi-extensive system, where in the morning they were released on pickets of *Brachiaria brizantha* Stapf. (Syn: *Urochloa brizantha*) and overnight were collected and placed in collective bays, receiving *Andropogon gayanus* chopped and concentrated formulated with wheat bran (450 g kg^{-1}), maize corn (250 g kg^{-1}) and soybean meal (300 g kg^{-1}), mixed in the trough. Water and mineral salt were offered at will.

The variables measured were the live weight (kg) of the animal and the thoracic perimeter (cm). The animals were weighed in a manual pendulum scale. The thoracic perimeter of each animal was measured after weighing, in which it was measured at the external circumference of the thoracic cavity, just below the axillae, with steel cable to minimize possible errors from the elasticity of the tape measure, with the animal in the correct position of legs angulations, according to Costa Junior et al. (2006). All parameters were recorded with the fasting animal for 12 h.

The correlation between two quantitative variables (live weight and thoracic perimeter) was evaluated by Pearson's correlation. Values of $p < 0.05$ were considered significant. In order to obtain the data, 75 females and 60 males of Saanen and 177 Saanen ½ x Boer were used, totaling 312 animals, with weight ranging between 10 and 42 kg of live weight, and age between 2 months and 15 months were evaluated by the BioEstat 5.0 program (AYRES et al., 2007).

First, curve fitting tests were performed to identify which regression, among linear, geometric, exponential and logarithmic, resulted in a higher coefficient of determination (R^2). After this evaluation, the linear regression was used to correlate the live weight (kg) with the thoracic perimeter (cm), through the Equation 1:

$$LW = -a + b \times TP \qquad \text{(Equation 1)}$$

Where:

LW = live weight,

TP = thoracic perimeter; to the intercept of the equation and

b = regression coefficient.

The regressions were evaluated by the Student-Newman-Keuls test, at the 1% probability level.

RESULTS AND DISCUSSION

There was no significant difference ($P < 0.01$) between the analyzed data. Data were assessed in their entirety and then separated by sex and race. Linear regressions provided equations for estimation of live weight in relation to the thoracic perimeter with a high coefficient of determination and correlation (Table 1). The residue analysis showed that the live weight of the animal diverged from the live weight estimated by the equations by a maximum of 2 kg, plus or minus, for all categories studied.

TABLE 1 - Coefficient of determination (R^2), coefficient of correlation (r) and coefficient of variation (CV) between live weight and thoracic perimeter of caprines.

Categories	R^2 (%)	r (%)	CV (%)
Total herd	94	97	50
Male animals	79	89	52
Female animals	95	98	46
Pure animals (Saanen)	84	92	53
Saanen-Boer crossbred	94	97	49

The total data of the herd generated the equation 2 with determination coefficient (R^2) of 0.9374, allowing a high estimation of the live weight as a function of the thoracic perimeter (Figure 1). Parés et al. (2012) studying the chest circumference and live weight of 41 caprine (30 females and 11 males) in southern Zambia, estimated the live weight using a linear model and obtained a coefficient of determination (R^2) of 0.71.

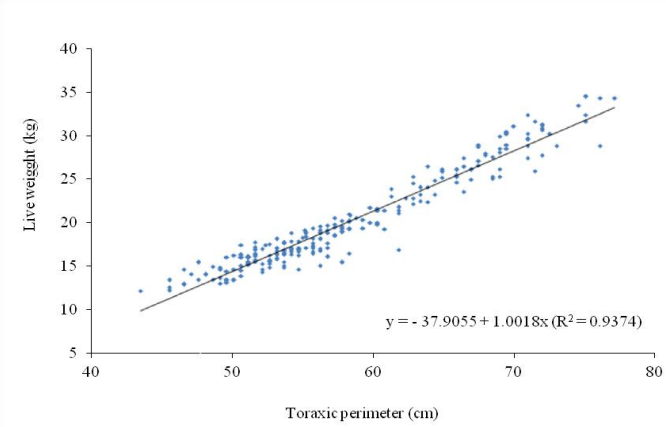

FIGURE 1 - Linear regression between the live weight (LW) and the thoracic perimeter (TP) of the total herd. Equation 2: Y = - 37.9055 + 1.0018 X (R^2= 0.92).

These results agree with Santana et al. (2001) and Reis et al. (2008) who concluded that the thoracic perimeter is the body measurement with the greatest correlation with the live weight. Menezes et al. (2007) and Freneau et al. (2008) verified a high correlation of the thoracic perimeter with the croup width and the live weight.

Linear regression analyzes were performed for sex-separated animals and it was observed that the regression coefficient for females increased (0.9507) in relation to the total herd, while the regression coefficient for males decreased (0.7939) in relation to the total herd. The equations generated in the linear regression were LW = - 39.9066 + 1.0366TP and LW = - 29.5456 + 0.8479TP for females and males, respectively (Figure 2A and 2B). Hagos et al. (2018) studying in Ethiopia the growth and productive performance of the Begait caprine breed and its first-generation (F1) offspring compared to the Abergele caprine breed, observed that the breed had a highly significant effect ($p < 0.0001$) on birth weight and weight at different ages. The average daily gain of lambs' weight was affected by the breed.

These results reveal that the estimated live weight accuracy for females was higher than for males, as described by Costa Junior et al. (2006) and Silva et al. (2006) who evaluated the estimation of live weight of Santa Inês sheep from the thoracic perimeter, and found greater efficiency for females and lambs.

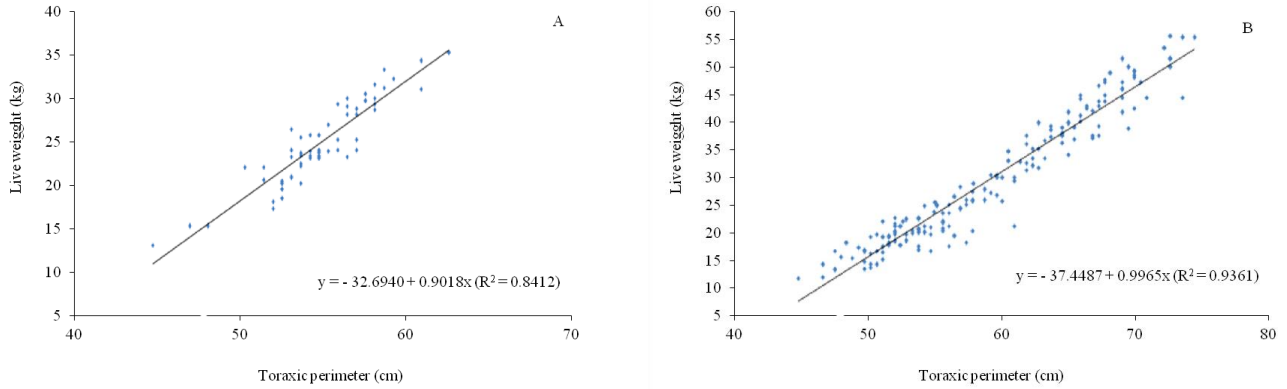

FIGURE 2 - Linear regression between the live weight (LW) and the thoracic perimeter (TP) of females (A) and male (B) caprines.

The correlation between PC and TP was high (Figures 2 and 3), as in Souza et al. (2009), thus justifying its use in the estimation of animal weight (SILVA et al., 2007) reported correlations of 0.97 and 0.94 between weight and thoracic perimeter for the Morada Nova and Cabugi sheep races, respectively. In Texel sheep (CUNHA FILHO et al., 2010), they estimated this correlation at 0.84.

Linear regressions for the pure Saanen animals (LW = -32.6940 + 0.9018TP) and the Saanen x Boer crossbreed (LW = -37.4487 + 0.9965TP) resulted in regression coefficients of 0.8412 and 0, 9361, respectively (Figure 3). Chinchilla-Vargas et al. (2018) studying the development of regression equations that would allow small farmers to use simple body measurements to accurately predict the live weight of typical African caprines (814 individuals from 40 races or indigenous populations and crosses that included 158 males and 656 females in five countries Africans) and observed that in all cases the models produced lower mean prediction errors than the body measurement method, confirming that the use of body measurements to predict live weight in caprines is a valid strategy to improve marketing management of livestock producers in rural Africa

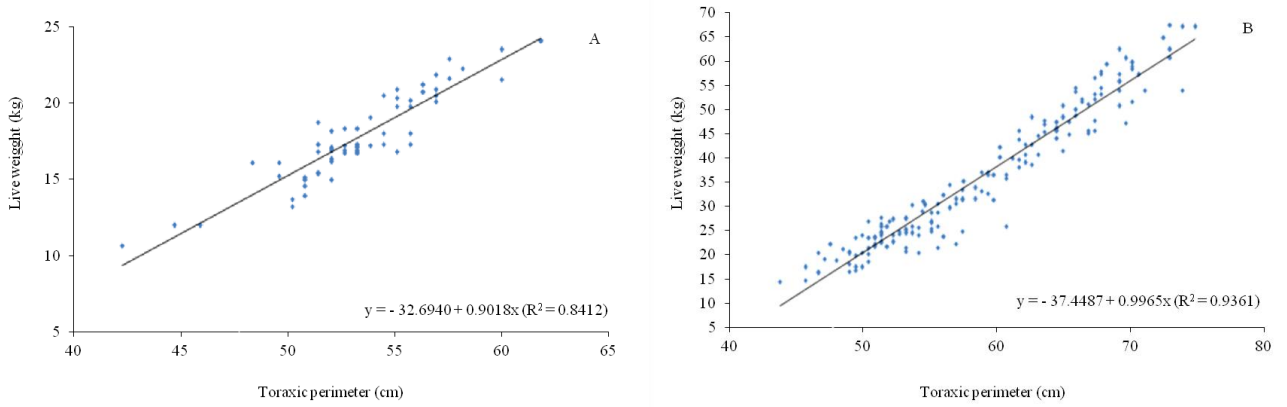

FIGURE 3 - Linear regression between the live weight (LW) and the thoracic perimeter (TP) of Saanen caprines (A) and Saanen-Boer crossbred caprines (B).

These results show a greater efficacy in the estimation of the live weight of cut caprines in relation to the dairy caprines, disagreeing with Yáñez et al. (2004) who accurately estimated the fasting weight of dairy caprines weighing 11 to 35 kg. These results for the effect of the racial group differ from those reported by other authors (DHANDA et al., 1999; LUO et al., 2000, PRIETO et al., 2000), which allows inferring the same considerations made for weight; In other words, Boer crossbred dairy breeds do not differ from dairy animals, especially in feedlot systems where food meets nutritional requirements and does not allow animals to express differences in the ability to tolerate environmental adversities or ability to look for food.

Tekle (2014) performing regression analysis for the development of live weight prediction models for Afar caprines, using data from 318 caprines of different categories and sex in Ethiopia have observed that models based on the thoracic perimeter or combination of body length and pelvic width were considered important for predicting body weight regardless of age and sex. According to Reyes et al. (2005) the measurement of the

thoracic perimeter to obtain weight of the animal at birth, without the use of the scale, is already common in sheep, caprines, horses, pigs and cattle. However, this work showed that animals should be separated as to race and gender for determination of the equation and estimated live weight.

CONCLUSIONS

The barometric tape for Saanen and Saanen x Boer crossbreed presented 97% efficacy for the estimation of the weight of Saanen and crossbreed.

The thoracic perimeter provides a high efficiency in the estimation of the live weight of caprines and can be used as an alternative when scales are not available, being more appropriate the separation by race and sex before adjusting the equation to be calculated.

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