Tropical and Subtropical Agroecosystems

NOTA CORTA [SHORT NOTE]

COMPARISSON OF DIFFERENT *IN VIVO* ESTIMATORS OF BODY FAT AND MUSCLE CONTENT IN ADULT CREOLE GOATS

[COMPARACIÓN DE DIFERENTES ESTIMADORES DE GRASA CORPORAL Y CONTENIDO MUSCULAR EN CABRAS CRIOLLAS ADULTAS]

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SUMMARY

The objective of the present study was to compare the effectiveness of ultrasound measurements (ULT), body condition score (BCS) and body mass index (BMI) to predict body fat and muscle in goats. Twenty-four adult, ovariectomized, creole goats were fed individually to achieve dissimilar stable body weights (26 to 66 kg). After a six-week period of stabilization BCS was evaluated (average of 4 separate evaluations) and BMI calculated (BW/(length x height)x10; average of 2 independent length and height measurements). Fat and muscle coverage over the dorsal (12-13th), lumbar (1st) and coxal (1st) vertebrae were measured by ultrasound imaging. Animals were slaughtered and visceral fat dissected and weighed. Left half carcass weights were obtained and muscle and fat were dissected and weighed. Left half carcass data were adjusted to whole carcass data. Simple regression analyses were performed with ULT, BCS and BMI as predictors and visceral (VF), carcass (CF) and total fat (TF), and muscle (MU) as response variables. Coefficients of variation (CV) were calculated for BCS and BMI estimations. ULT measurement of total tissue (fat + muscle) coverage over dorsal vertebrae presented the highest predictive value for ULT measurements; thus this measurement is the only reported. Coefficients of determination (R^2) for VF, CF and TF were .55, .76 and .68; .78, .82 and .87; .81, .81 and .88 for ULT, BCS and BMI as predictors. R^2 for MU were .67, .84 and .76 using ULT, BCS and BMI as predictors. R^2 for proportions of VF/BW, CF/BW and TF/BW were .47, .73 and .65; .75, .78 and .88; .74, .71 and .85; when ULT, BCS and BMI were used as predictors. R^2 for MS/BW were $\leq$ .10 using ULT, BCS and BMI as predictors. CV was greater in BCS estimation as compared to BMI estimation (9.7 vs. 3.1 %). BCS and BMI were more accurate *in vivo* predictors than ULT for body fat content, fat as proportion of BW and body muscle content. ULT, BCS and BMI were completely worthless for predicting muscle as proportion of BW. BMI estimation was less variable than BCS estimation. This study, for the first time, provides a predictive value of BMI for body fat and muscle content in goats.

Key words; Body muscle, Body fat, *In vivo* estimation, Goats

INTRODUCTION

Body energy reserves, mainly represented by fat and muscle body content (Mora et al., 2007), as well as body composition, are important determinants of reproductive performance and carcass quality in livestock. Although body condition score (BCS) has been demonstrated to be an adequate estimator of these body variables under most practical conditions in goats (Santucci et al., 1991; Villaquiran et al., 2005), the qualitative and subjective character of this measurement must be considered when precise and repeatable data are required. Moreover, genotype, age, sex, physiological status and even heterogeneity in the group evaluated might compromise the usefulness of BCS as a predictor for energy reserves and body composition (Santucci et al., 1991). Particularly in goats, the fat storing pattern could be an additional factor. Accordingly, quantitative methods, such as ultrasound measurement of superficial soft tissues at different body regions, had been evaluated and found to be adequate predictors of body composition and carcass quality in male and female goats (Standford et

al., 1995; Delfa et al., 1999). Body mass index (BMI) is a largely used index of fatness in human studies and clinical evaluation, and has been adapted for use in goats (Tanaka, 2002). Even though goat BMI has not been evaluated as a predictor of body energy reserves and/or composition, its relationship with LH secretion, a biological marker of animal energy status, makes it an interesting candidate to evaluate due to the quantitative character of the index (body weight related to body frame). The objective of the present study was to compare the effectiveness of ultrasound measurements (ULT), body condition score and body mass index to predict body fat and muscle in goats.

MATERIALS AND METHODS

This experiment was conducted at the National Centre for Research in Animal Physiology (INIFAP-México), located at 20°43' N and 100°1' W. Twenty four mature, ovariectomized Creole goats were used as experimental animals. Previously to the start of the experiment, animals were subjected to a 6 week period of stabilization in which individual diets and rations were manipulated to achieve a wide range of steady body weights (BW; 26 to 66 kg). After the stabilization period, BCS was independently evaluated by 4 trained people and mean BCS was estimated (Villaquiran et al., 2005). Body weight was obtained after an 18 h fasting period, and body length and height were independently recorded by two people. Fast BW and mean length and height measurements were used to calculate BMI = BW (kg) / [height (m) / length (m)] x 10 (Tanaka, 2002). Fat and muscle coverage over the dorsal (12^{th}-13^{th} ribs), lumbar (1^{st}) and caudal (1^{st}) vertebrae were measured by ultrasound. Animals were slaughtered and whole carcass and left carcass weights were obtained. Visceral (pericardic, omenthal, perirenal and pelvic) fat was dissected and weighed. Left carcasses were maintained at 4 ºC overnight and then muscle and fat were dissected and weighed. Carcass fat and muscle weights were adjusted as whole carcass data. Variables of response were body muscle (MU), and visceral (VF), carcass (CF) and total fat (TF) weights, both as it and as proportion of BW. Simple linear regression analyses were performed on these variables using BCS, BMI and ULT measurements as predictors. Coefficients of determination (R^2) are reported as indicators of the respective predictive value. Mean coefficients of variability (CV) for BCS (4 evaluations/animal) and BMI (2 estimations/animal) were calculated and reported.

RESULTS AND DISCUSION

Ultrasound measurement of total tissue (fat + muscle) coverage over the dorsal vertebrae presented the highest predictive value for ULT measurements; thus this ULT measurement is the only one reported. Mean and range of the variables used as predictors were: ULT 19.5 and 8.4 to 34.8 mm; BCS 2.7 and 1.4 to 3.6; BMI 9.5 and 6.3 to 12.6. Coefficients of regression (R^2) for MU and VF, CF and TF weights and proportions related to body weight are presented in Tables 1 and 2. Except for MU, R^2 was slightly better in all predictors when response variables were expressed as it vs. as proportion of BW. Predictive value for MU expressed as kg of tissue was >0.65 in all cases, but when MU was expressed as proportion of BW, R^2 value was negligible for all predictors;

Table 1. Coefficients of determination (R^2) for dorsal ultrasound (ULT), body condition score (BCS) and body mass index (BMI) when used as predictors of total body fat (TF), visceral fat (VF), carcass fat (CF), and body muscle (MU) weights.

	VF (n=20)	CF (n=20)	TF (n=24)	MU (n=24)
ULT	0.55	0.78	0.81	0.67
BCS	0.76	0.82	0.81	0.84
BMI	0.68	0.87	0.88	0.76

Table 2. Coefficients of determination (R^2) for dorsal ultrasound (ULT), body condition score (BCS) and body mass index (BMI) when used as predictors of total body fat (TF), visceral fat (VF), carcass fat (CF), and body muscle (MU) considered as proportion of body weight.

	VF (n=20)	CF (n=20)	TF (n=24)	MU (n=24)
ULT	0.47	0.73	0.65	0.09
BCS	0.75	0.78	0.87	0.009
BMI	0.74	0.71	0.85	N.S.

similarly to what Ngwa et al. (2006) found for total body protein using BCS as predictor. BCS and BMI presented better predictive value for VF and correspondingly for TF as compared to ULT. Predictive value for CF was similar among predictors. Delfa et al. (1999) found high R^2 values (>.70) when ULT measurements at lumbar and breastbone levels were used to predict body fat stores in Blanca Celtibérica kids; comparable with those observed in this study, except for visceral fat in which R^2 values were lower (0.55 and 0.47). Differences in genotype and age might implicate different distribution of body fat stores and be related to the previous discrepancy. Values of R^2 for BCS as predictor of body fat stores were high even for VF, however R^2 values for CF were higher as compared to VF (Tables 1 and 2). Santucci et al. (1991) also indicated a high correlation (r=.91) between BCS and visceral fat in Sardian but not in Corsican goats. Domingo et al. (2003) found lower correlations (0.60 to 0.80) between BCS and body fat stores in another Creole genotype, with equal correlations in visceral and carcass associated fat. These differences again might be related to genotype.

Moreover, Ngwa et al. (2006) also found a high predictive value of BCS when estimating fat content at tissue level in young castrated male meat goats. The BMI predictive value for body fat stores was high and almost equal to what was observed with BCS. Mean CV was higher when estimating BCS (9.7%) as compared to BMI (3.1%).

CONCLUSION

BCS and BMI were more accurate than ULT as *in vivo* predictors, for body fat content, fat as proportion of BW and body muscle content in a goat Creole genotype. BMI estimation was less variable than BCS estimation, aspect which could favor the use of BMI as predictor of body fat and muscle in goats. Factors which influence these variables imply further studies to validate the use of BMI. This study, for the first time, provides a predictive value of BMI for body fat and muscle content in goats. The almost negligible predictive value of BCS and BMI for muscle as proportion of BW might limit their use as predictors of energy status.

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