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RESEARCH OPINIONS IN ANIMAL & VETERINARY SCIENCES

Using ultrasound for the estimation of carcass characteristics in crossbreed (*Bos taurus / Bos indicus*) bulls

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Abstract

The objective of this research was to determine the rib eye area (REA) and back fat thickness (BFT) between the 12th and 13th rib, using real-time ultrasound for estimating the yield of total meat produced (YTMP), total meat produced (TMP), yield grade (YG), adjusted yield grade (AYG) and commercial cuts (CC) in a dual-purpose grazing bulls in the tropic to obtain an equation to estimate the hot carcass weight (HCW). Thirty-seven crossbred Holstein/Zebu (Ho/Z) and Brown Swiss/Zebu (BS/Z) bulls were subjected to ultrasound images prior to slaughter at the time when their weight was between 300 and 500 kg. Mean REA and BFT were 76.02 cm^2 and 3.6 mm respectively in comparison to 77.38 cm^2 (REA) and 4.0 mm (BFT) in the ultrasound. The TMP estimated by ultrasound scan did not differ between genotypes and at different slaughter weights. YTMP was better ($P<0.05$) for animals over 450 kg. The YG value was close to 1.0 with 52-54% of CC without significant effect on genetic group and slaughter weight. AYG values of 2 and 50-52% of CC was obtained. With the developed prediction equation HCW (kg) = - 338 + 2.48 carcass length +2.30 carcass width + 2.79 leg depth) $r^2 = 0.92$ and the goodness of fit test was assessed with χ^2 without significant difference ($P>0.05$). The results indicated that ultrasound image may give an estimate of rib eye area (UREA) and back fat thickness (UBFT).

Keywords: Rib eye area; back fat thickness; total meat produced; yield grade

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Introduction

Mexico has 28% tropical regions of the territory where environmental conditions and feed availability make it suitable for meat production as it hosts 68% of the cattle that are part of the national inventory (CONARGEN, 1998) of which the majority (80%) are under a dual purpose (DP) system. Under this system, lack of modern technology and genetic crosses of *Bos taurus* and *Bos indicus* have productivity lesser than other systems (Vilaboa-Arróniz et al., 2009). But these features make the system capable of producing meat of good quality at competitive prices compared to other systems that have high production costs (Zorrilla, 2007). Special emphasis must be given on technological tools to be implemented to improve production.

The use of ultrasound has proved to be a useful tool for estimating cattle's carcass measurements before slaughter such as the rib eye area (REA) and back fat thickness (BFT) (Herring et al., 1994). These features have a deep relationship with the performance and final carcass composition (Greiner et al., 2003), which may

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be used for evaluation of animals for suitability of meat production (Jiménez et al., 2006). There is considerable research that has been conducted in this regard, however, the diversity of production systems or concepts of productivity make it necessary to evaluate the use of this technology. On the other hand, the marketing system of carcasses in the central coast of Veracruz State is influenced by the presence of intermediaries out of Municipal abattoirs which establish rules and prices according to their convenience, for both live cattle and beef carcasses (Loeza et al., 2004) and although there is a classification system of carcasses in the country NMX-FF-078-SCFI-2002 (2002), which identifies premium carcasses, it is not used in many regions and the intermediaries still rely on conventional system of production. Sometimes it is not possible to obtain these data; although slaughterhouses are equipped with high sensitive scales, these may sometime fail to provide the accurate data. In the country, the carcass marketing is handled by intermediaries, who sometimes do not have accurate weighing scales, so some of the parts involved (Intermediate-retailer) may be affected. Therefore, the present research was conducted using real time ultrasound to determine the REA and BFT measurement between the 12th and 13th rib, estimation of YTMP and YG of carcass and establish an equation to estimate the weight of the hot carcass without the use of a scale.

Materials and Methods

Thirty-seven bulls (n = 25 Ho/Z, n = 12 BS/Z) reared on a dual purpose (DP) were weaned at seven months of age and then grazed on African Star Grass (*Cynodon plectostachyus*). During the dry season, supplementation of corn silage and commercial concentrate were also provided. Animals of the same genetic group were sacrificed at different Body Weight (BW), from ~ 300 to ~ 500 kg. They were weighed monthly from weaning to slaughter, with a digital scale for weighing cattle 1000±0.1kg ((Tru-Test ™) and once the weight was reached, ultrasound images of the left side of the back of the animal were taken between the 12th and 13th rib, where the REA (cm^2) and BFT (cm) are found, measured at ¾ from the dorsal to ventral line. Real time ultrasound equipment, FalcoVet (Pie Medical ™), fitted with a 3.5MHz linear array transducer and a flexible cushion was used. The scanned area was shaved and soaked with corn vegetable oil as a means to obtain adequate acoustic contact between the transducer and the animal (Greiner et al., 2003). The measurement of the images was performed using the software Animal Science on the equipment. The amount of kidney, pelvic and heart fat (KPH) was determined as a percentage of the carcass in order to apply the equation to determine the following variable. The YG was estimated by two ways: in the first equation YG = 2.5 + 2.5 (BFT in inches) + 0.2 (KPH percentage) + 0.0038 (HCW in pounds) - 0.32 (REA in square inches). In the second, the short method (AYG) relies on the use of adjusted equations of the quantitative variables and is expressed in whole numbers in the range of 1 (Lean and Muscular) to 5 (Fat and Light) and related to the amount of CC refers to boneless beef loin, ribs and hind limb (Burson, 2005). Each animal was taken to the municipal abattoir of Medellin, Veracruz and processed after fasting. Immediately, the hot carcass weight was taken with a digital scale with a sensitivity of 0.1 kg. In addition, measurement of the length (CL) and width (CW) were taken from the carcass and leg: Length (LL), width (LW), deep (LD) and perimeter (LP). The carcass measurements were taken on the basis established by Alberti et al. (2005).

CL: anterior border of the pubic symphysis in the middle of the front edge, from the visible part of the first rib,

CW: last sternebra to the dorsal end of the spinous of the sixth thoracic vertebra

LL: medial malleolus of the tibia in a straight line to the front edge of the pubic symphysis

LP: maximum horizontal circumference of the leg at the pubic symphysis

LW: the distance between the outermost points of the anterior and posterior surface

LD: the distance between the outermost points of the medial and lateral surface of the leg.

Finally a perpendicular cut was made on the *Longissimus dorsi* muscle between the 12th and 13th rib (REA), where the area was measured in square inches with the transparent overlay grid technique (Burson, 2005), and subsequently converted to square centimeters. The BFT was measured using a vernier (cm). TMP was estimated with the following equation (Jiménez et al., 2006):

$$TMP = -32.4196 + (BW * 0.3949) + (UREA * 0.5007) - (UBFT * 1.66)$$

Where: TMP = Total meat produced, BW = Body weight, UREA = Rib eye area between the 12th and 13th rib by ultrasound, UBFT = Back fat thickness covering the *Longissimus dorsi* muscle between the 12th and 13th rib by ultrasound. With the values obtained yield percentage of TMP (YTMP) was calculated in relation to the animals dieted weight (DW), using the NRC Beef Cattle (2000).

$$\%YTMP = (TMP * 100) / DW$$

For the analysis of the data Minitab 15 (2007) software was used with a completely randomized design. The factors were genotype and slaughter weight. The response variables were YG, AYG, YTMP and TMP. The means were compared with Tukey's test (P<0.05). Simple regression analysis was performed and the correlation coefficient between UREA and UBFT vs. REA and BFT were obtained. Furthermore, the correlations between the BW of the animal, the HCW and carcass measurements were estimated. Furthermore several prediction equations for HCW were obtained with a stepwise multiple regression analysis, with UREA, UBFT and carcass measures as predictor variables, the goodness of fit was assessed with χ^2.

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \varepsilon_i$$

Where: Y_i = Hot carcass weight (HCW),

β_0 = Intercept

$\beta_1 X_1, \beta_2 X_2, \ldots \beta_n X_n$ = Carcass length and depth; Leg length, width, depth and perimeter; rib eye area and back fat thickness, ε_i = random error ~NID (0, σ^2)

Results and Discussion

The characteristics of the animals involved in this study are presented in Table 1, showing that the average values of the following variables were: slaughter weight 414 kg (varied from 313-506 kg), REA 76.02 cm^2, BFT 0.364 cm and YTMP 42.51%. UREA value was larger by one centimeter compared to REA, as well as BFT was larger ~ 0.05 cm than UBFT. This differs from the results reported by Greiner et al. (2003), who obtained differences of 0.7 cm for UREA and 0.01cm for UBFT, and the ones found by Jiménez et al. (2006) with values of 0.5 cm and 0.1cm, respectively.

In this regard, Hamlin et al. (1995) by repeated measurements over time reported UREA and UFBT 57.3 cm^2 and 0.65 cm respectively at eight months of age; however, following the three months, these estimates were higher than those presented in this research. In addition, it was noted that as age increases, the differences grow larger, because the growth rates of these measurements are very different. Crews and Kemp (2002) observed a higher UREA and UBFT in male and female animals. Furthermore, Bergen et al. (2005) with cattle with the same features at around 15 months of age found twice higher UREA than our results. These differences can be explained by the breeds and management conditions. In Brangus cattle, Waldner et al. (1992) found a higher UREA and UBFT at one and two year of age than those shown here. This is a beef specialized synthetic breed fed with a diet that ensures muscle growth. In tropical climate, Yokoo et al. (2008) at an average age of 18 months, reported similar UREA in Zebu Nelore breed bulls, but lower in female even though UBFT in both cases was lower than our findings. The differences in these values are mainly due to the genetic differences and the purpose of keeping the animals.

The correlation coefficient (r) between the REA (Fig. 1) and BFT (Fig. 2) was 0.81 and 0.51 (P<0.05) in different proportions to the measures taken on the carcass.

Table 2 shows the effect of genetic group and slaughter weight on YG, AYG and CC. It was observed that there was no statistical difference (P>0.05) in YG

Table 1: Descriptive statistics of carcass quality and yield of meat

Variable	N	Mean	Minimum	Maximum	SD
Body weight (kg)	37	414.05	313.00	506.00	50.29
REA (cm^2)	37	76.02	57.10	91.61	8.29
UREA (cm^2)	37	77.38	66.94	93.26	6.33
BFT (cm)	37	0.364	0.240	0.550	0.0084
UBFT (cm)	37	0.401	0.330	0.483	0.0041
YTMP (%)	37	42.51	41.23	42.09	0.662

UREA= rib eye area by ultrasound, UBFT = Back fat thickness by ultrasound. REA= rib eye area, BFT= Backfat thickness, YTMP= Yield of total meat produced, SD= Standard Deviation.

Table 2: Yield grade, commercial cuts and total meat produced from European Zebu crossed cattle carcasses at three slaughter weights

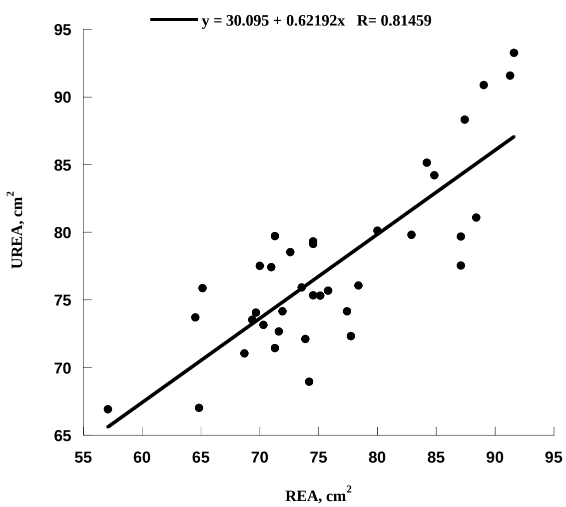
Variable	YG		CC, %	AYG		CC, %	TMP (kg)		YTMP (%)	
	Mean±SEM			Mean±SEM			Mean±SEM		Mean±SEM	
Ho/Z	1.1^a	0.07	52-54	2.4^a	0.06	50-52	168.8^a	1.2	42.4^a	0.12
BS/Z	0.9^a	0.11	52-54	2.7^a	0.10	50-52	169.8^a	1.5	42.7^a	0.17
Slaughter weight										
<400 (kg)	0.9^a	0.10	52-54	2.6^a	0.09	50-52	145.3^c	5.1	42.3^a	0.16
401-450 (kg)	1.2^a	0.10	52-54	2.4^a	0.09	50-52	171.9^b	5.1	42.3^a	0.16
>451 (kg)	1.0^a	0.12	52-54	2.7^a	0.11	50-52	196.4^a	5.1	43.0^b	0.16

Different letters within column are statistically different (P≤0.05). Means were compared by the Tukey method.CC= Commercial cuts; YG= Yield Grade; AYG= Adjusted Yield Grade; SEM= Standard Error of the Mean

Table 3: Correlations between variables obtained from the carcass

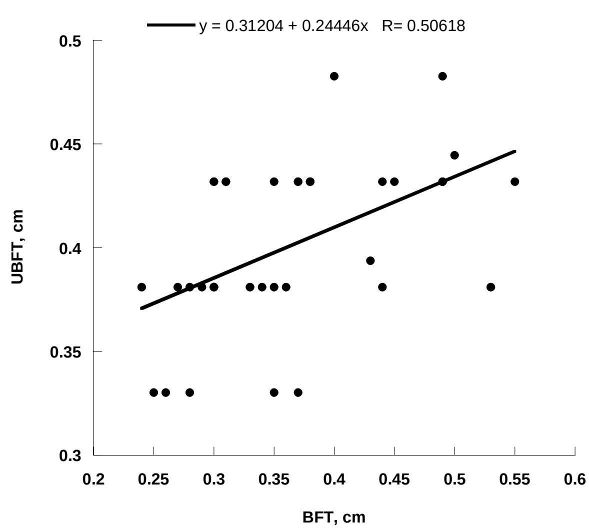
	HCW	UREA	UBFT	CL	CW	LL	LW	LD
UREA	0.472							
UBFT	0.757	0.653						
CL	0.925	0.456	0.746					
CW	0.850	0.375	0.618	0.810				
LL	0.565	0.128*	0.505	0.571	0.540			
LW	0.525	0.049*	0.178*	0.465	0.475	0.633		
LD	0.629	0.257*	0.554	0.516	0.434	0.384	0.318*	
LP	0.749	0.148*	0.384	0.701	0.736	0.652	0.732	0.379

*(P>0.05); HCW= Hot carcass weight; UREA= rib eye area by ultrasound; UBFT = Backfat thickness by ultrasound. CL= Carcass long; CW= Carcass width; LL= Leg length; LW=leg width; LD= leg deep; LP= Leg perimeter.



r^2=0.6636, r=0.8146 (P<0.05)

Fig. 1: Correlation between UREA and REA



r^2=0.2562, r=0.5062 (P<0.05)

Fig. 2: Correlation between UBFT and BFT

for animals finished on grazing. López et al. (2002) found similar YG 1.6 and 2.0 in Charollais and Beefmaster in feedlot bulls respectively.

The TMP estimated values according to the equation established by Jiménez et al. (2006) are presented in Table 2, no significant difference (P>0.05) was observed between genetic groups for YTMP showing no effect on beef production on grazing system. It was notable that there was a difference (P<0.05) between the three different ranges of slaughter weight, and increased production of meat was obtained after the animal reached 450 kg. Jiménez et al. (2006) observed a TMP of 183.9 kg in animals with an average weight of 461.7 kg, a lower production than the one achieved in this research.

The correlations between the variables measured on the carcass (Table 3) show that there is a strong relationship (P<0.05) of CL and CW, UBFT, LP and finally, LD, so all these variables can contribute to the establishment of a prediction equation to estimate the weight of the hot carcass. It is observed that most of the variables are correlated with each other, but it is not the case of UREA, which is shown to be independent of other variables.

An equation for the estimation of HCW from carcass measurement was established, where a value of r^2 = 0.92 was obtained, that is, the predictor variables CL, CW and LP explain 92% of the variability of the HCW.

$$HCW\,(kg) = -338 + 2.48(CL) + 2.30(CW) + 2.79(LP)$$

The χ^2 test proved that there is no significant difference (P>0.05) between the estimated value from the equation obtained and the observed value on the carcass; therefore, this equation can be used to estimate the HCW of crossbreds Ho/Z and BS/Z on pasture.

Conclusion

The research indicated that ultrasound can be used to estimate the rib eye area and back fat thickness which further helped to produce an equation to determine the Total Meat Produced and the Adjusted Yield Grade in two breeds of bull kept on grazing in the tropics for meat supply. Further, no productive difference was found in the carcass of both types of bulls. Additionally, animals weighing >451 kg had the best performance in term of Total Meat Produced and yield of total meat produced. Lastly, an equation was also obtained to estimate the weight of the hot carcass without the use of a scale.

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