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Feed efficiency and its correlations with carcass traits measured by ultrasound in Nellore bulls

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ABSTRACT

Forty-six Nellore bulls were individually fed for 84 days and evaluated for residual feed intake (RFI) and feed conversion ratio (FCR) with the objective to correlate RFI_1 (usual), RFI_2 (adjusted for final rump fat thickness) and FCR with carcass composition traits measured by ultrasound and to verify differences between RFI groups (classified by standard deviation) in performance and carcass traits. Carcass traits were evaluated by ultrasound at the beginning and at the end of the test and the gain over the test period was calculated for ribeye area (REA), backfat thickness on the 12–13th ribs (BFT) and rump fat thickness on the *Biceps femoris* muscle (RFT). The RFI_1 was positively correlated ($P<0.05$) with the final RFT ($r=0.34$) and with the gain in RFT ($r=0.36$) and also there were differences ($P<0.05$) in these traits and also in dry matter intake (DMI) between groups, in which the most efficient animals had lower values of DMI, final RFT, and gain in RFT. For the RFI_2, there were no differences ($P>0.05$) between groups and neither were there significant correlations between those with the carcass traits, only for FCR, feed efficiency and DMI. FCR was correlated with the gain in REA and BFT ($r=-0.43$ and $r=-0.31$, respectively) and with the initial BFT ($r=0.31$). The positive correlation between residual feed intake and subcutaneous fat of Nellore bulls' may cause some concern, because with the selection of more efficient individuals (with negative RFI), carcasses which are too lean will be produced. Adjustments in the estimation of RFI including carcass traits may override this undesirable effect.

1. Introduction

Traditional genetic improvement programs that include weight gain as the main trait can compromise the feed efficiency of the beef cattle (Almeida, 2005). This happens because steers selected only by weight gain also increase their feed intake. Sometimes this increase in feed expenses will not be compensated by an increase in weight. Thus to improve livestock profitability, it is important to take into account feed efficiency traits when selecting steers.

Beef cattle feed efficiency is usually described by the gross feed efficiency (GFE) or the feed conversion ratio (FCR). These traits have limitations as selection criteria due to their correlations with live body weight and average daily gain. As a long-term concern, this could compromise the productive efficiency in grazing systems by over-increasing the female's mature size therefore increasing their nutritional requirements for maintenance. A feed efficiency trait that can be used and is not correlated with live body weight and average daily gain is the residual feed intake (RFI) that measures feed intake independent from mature size or growth (Arthur et al., 2001; Richardson and Herd, 2004).

Richardson et al. (2004) observed, in a unique selection generation of *Bos taurus* against RFI (higher efficiency), a

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reduction in carcass fat content in its progeny. It is necessary to investigate if this effect also occurs in *Bos indicus* cattle, mainly in the Nellore breed. Also, if a body composition adjustment in the RFI estimate can avoid any compromise in the performance or in the carcass traits.

According to Lanna and Almeida (2004) the lower subcutaneous fat deposition by the most efficient animals could be overdone by predicting feed intake not only by the body weight and average daily gain, but also by the body composition, which can be partly evaluated *in vivo* by ultrasound. The carcass traits obtained by ultrasound allow a better adjustment of the predicted intake and, consequently, more accurate RFI values (Almeida, 2005).

The objective of this study was to estimate the correlations between RFI (adjusted or non-adjusted to subcutaneous fat) and FCR with productive traits (average daily gain, daily feed intake, live body weight, and gross feed efficiency). In addition, to estimate the correlations of RFI and FCR with carcass traits (ribeye area, subcutaneous fat thickness over the 12th to the 13th ribs, and *Biceps femoris* muscle fat thickness). Furthermore for evaluating the possible differences across these traits for the RFI groups (high, medium, and low) in Nellore bulls.

2. Material and methods

2.1. Animals and facilities

The trial was conducted in Guapirama, in the north of Paraná State (south of Brazil), between December 22nd and March 16th, 2009 in an experimental feedlot with 15 m long × 2 m wide individual pens. Forty-six Nellore bulls were evaluated, coming from 10 different breeders with an average starting age of 22 ± 2 months and live body weight of 409 ± 49 kg, and all were registered in Associação Brasileira dos Criadores de Zebu (ABCZ).

2.2. Experimental diet and management

All young bulls were adapted by grazing *Panicum maximum* pasture for 45 days to avoid eventual compensatory effects from original farms. Subsequently, these animals were housed in the experimental feedlot, and were allowed to adapt to the diets and facility for 14 days.

The bulls were individually fed twice a day with a total mixed ratio diet (Table 1) with 70% total digestible nutrients (%TDN) estimated by the Weiss et al. (1992) equation and 15.2% crude protein. Sugarcane silage and concentrate were added to the 50:50 proportion, on a dry matter (DM) basis. No feed additives or hormonal implants were used.

The chemical composition of the sugarcane silage and feed refusals was obtained by weekly samples that were analyzed in the Laboratório de Nutrição Animal of Universidade Federal do Paraná (UFPR). Daily sub-samples of the silage and feed refusals were collected and at the end of each week those sub-samples were homogenized to obtain the weekly sample. Table 2 shows the average silage chemical composition during the 12-week experiment. The diet average dry matter was 34.37 ± 5.55%DM.

2.3. Data collection

All bulls were weighed five times on days 0, 21, 42, 63, and 84 of the experimental feedlot period, after being deprived of feed (but not water) by 16 h. The average daily gain (ADG) was measured by linear regression of individual BW measurements on day of trial.

The observed dry matter intake (DMI_{obs}) was obtained through the subtraction of the daily feed offered minus the daily feed refusals (both DM-adjusted). Residual feed intake (RFI_1) was calculated as the difference between actual and predicted feed intake by regressing DMI on mid-test $BW^{0.75}$ and ADG (Koch et al., 1963) using the REG procedure of SAS, whereas RFI_2 also included ultrasound fat thickness over the *Biceps femoris* muscle at the end of trial (RFTf). The model for predicting DMI of the RFI_1 was:

$$DMI_{est} = 0.15463 + \left(0.07619 \times BW^{0.75}\right) + (0.85989 \times ADG) \quad \left(R^2 = 0.56\right)$$

For the RFI_2 the equation to get the DMI_{est} was:

$$DMI_{est} = 0.16748 + \left(0.06749 \times BW^{0.75}\right) + (0.82585 \times ADG) + (0.15305 \times RFTf) \quad \left(R^2 = 0.62\right)$$

After determining the RFI, young bulls were classified into high (less efficient; >0.5 SD above the mean), medium (mid; ±0.5 SD from the mean), and low (more efficient;

Table 1
Ingredient composition of the experimental diet.

Ingredients	% (DM)
Sugarcane silage	50.00
Corn grain cracked	20.22
Soybean meal 49%	20.43
Wheat meal	7.37
Limestone	1.26
Sodium chloride (NaCl)	0.40
Dicalcium phosphate	0.10
Premix mineral[a]	0.22

[a] Mineral premix: P = 14 (g/kg); Ca = 45 (g/kg); Mg = 3 (g/kg); S = 16 (g/kg); Na = 10 (g/kg); Zn = 530 (mg/kg); Cu = 160 (mg/kg); Mg = 140 (mg/kg); Co = 16 (mg/kg); I = 50 (mg/kg); Se = 5 (mg/kg).

Table 2
Chemical composition of sugarcane silage.

Nutrient	%
Dry matter	25.52
Crude protein (% DM)	8.48
Ether extract (% DM)	1.12
Ash (% DM)	4.31
Acid detergent fiber (% DM)	44.52
Neutral detergent fiber (% DM)	69.97
Total digestible nutrients (%)	70.00
Digestible energy (Mcal/kg)[a]	3.09
Metabolizable energy (Mcal/kg)[a]	2.67
Calcium (% DM)	0.27
Phosphorus (% DM)	0.12

[a] NRC (2001).