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Association between feed efficiency and carcass and meat quality traits in Hereford steers

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Summary

The association between residual feed intake (RFI) and growth, carcass and meat quality traits were investigated using 233 Hereford steers. Individual feed intake, body liveweight, average daily gain and ultrasound measurements were recorded during 70-d post-weaning period to calculate RFI. Steers were categorized into high efficient (<0.5 SD below the RFI mean; 72), medium (mid ± 0.5 SD; 85), and low efficient steers (>0.5 SD above the RFI mean; 76). After the feed intake test, steers grazed on sorghum pasture and oat with corn supplementation during summer and autumn and winter, respectively, until achieving the slaughter weight (with back fat thickness 6.35 mm). During the finishing phase, the efficient steers had some lighter weights ($P<0.05$) at the start of finishing but achieved the same slaughter weight ($P<0.001$). Average daily gains during finishing were similar among efficiency groups. No differences were found among groups on ultrasound measures except a slight difference on UBFAT at pre-slaughter between medium and lower efficient ($P=0.009$). No differences were found among RFI groups for any carcass or meat quality traits. Phenotypic correlations with RFI were close to zero for all traits. These results suggest that increasing feed efficiency by RFI does not lead to unfavorable effect on finishing performance, carcass and meat quality. Larger dataset will allow the estimation of genetic correlation among these traits and the prediction of genetic correlated responses.

Keywords: Residual feed intake, beef cattle, growth, tenderness

Introduction

Improving feed efficiency in beef cattle may have a major economic impact since feeding explains more than 50 % of total production costs (Herd *et al.*, 2003). Residual feed intake (RFI), defined as the difference between actual and predicted feed intake is moderately heritable ($h^2= 0.29 – 0.46$) and genetically independent of growth rate and body weight in growing cattle (Herd and Bishop, 2000; Arthur *et al.*, 2001a,b).

Knowing the associations between RFI with other economically relevant traits is important

to evaluate the impact of including this trait in genetic improvement programs (Herd *et al.*, 2014). Many studies reported no associations between RFI and other relevant traits (Arthur *et al.*, 2001ab; Herd *et al.,* 2014) although, animals with lower RFI eat less feed and have a better feed efficiency.

The objective of this study was to investigate the associations between RFI and growth performance during the finishing period and carcass and meat quality traits of Hereford steers.

Material and methods

Data of 233 Hereford steers that were evaluated in post-weaning feed efficiency tests was analyzed. Post-weaning feed intake tests of 70 days were carried out at the Central de Pruebas Kiyú, San Jose, Uruguay in the springs 2014 and 2015, in agreement with the Beef Improvement Federation guidelines (BIF 2006) as described by Pravia *et al.*, (2015). Individual feed intakes were daily recorded using the Growsafe automated feeding system (Growsafe Sytems Ltd., Alberta, Canada) and adjusted by the percentage of dry matter to calculate the dry matter feed intake (DMFI). As proposed by Basarab *et al*. (2003), RFI was calculated as the residual (*e*) of the regression model used to predict DMFI:

$$DMFI = b0 + b1 \times MTMW + b2 \times ADG + b3 \times FAT + Test + e \quad (1)$$

where DMFI is the average dry matter feed intake, MTMW is the metabolic average weight, ADG is the average daily gain obtained by linear regression of weights recorded fortnightly during the test, FAT is ultrasound back fat at the end of test, b0 is the intercept and b1, b2 and b3 are the partial regression coefficients of each trait on DMFI and *e* represents the RFI.

Steers were classified into three RFI groups: “High Efficiency group” with 72 steers with RFI values 0.5 SD below the mean; “Low efficiency group” including 76 steers with RFI values 0.5 SD above the mean, and “Medium Efficiency group” with 85 steers with values in between. The RFI means of these were -0.77, 0.63 and -0.03, respectively ($P<0.001$).

After the feed efficiency tests, steers were managed together until slaughter. They grazed first on sorghum during 70 days in the summer and then on oat with corn supplement for 45 to 120 days, until slaughter. Supplementation consisted of 6 kg of chopped corn/day/animal. Animals were weighted every two weeks during the finishing and ultrasound measurements were recorded at the beginning of oat grazing and pre slaughter. Steers were slaughtered in four batches with an average liveweight of 520 kg, (minimum of 490 kg and 5 mm of subcutaneous fat cover) at Breed and Packers Uruguay.

Hot carcass weight (HCW) was recorded and ribeye area (REA, cm^2) and subcutaneous fat depth were measured between the 10^{th}-11^{th} ribs at quartering. The left “pistola” cut (hindquarter) was weighted and then deboned. The weights of seven primal cuts (Tenderloin, Striploin, Top Sirloin, Inside, Outside, Knuckle, and Tri-tip), fat trimming and total bone were recorded. Two-cm steaks from the *Longissumus dorsi* muscles were obtained, vacuum-packed individually and frozen at -20^{o} C for meat quality evaluation. After 5 days of aging at 2^{o}C, shear force was measured (kgF, Warner Bratzler model D2000- WB). Ultimate pH was recorded using a

pHmeter (Orion 210A). Instrumental meat color (colorimeter Konica Minolta CR 400) was measured on the *Longissimus dorsi* muscle after 5 d aging and 1 h blooming, recording the parameters L* (brightness), a* (redness) and b* (yellowness).

Statistical Analysis

The associations between RFI and other traits were evaluated by the comparison of the average performance of RFI groups and by phenotypic correlations. Least square means for the RFI groups were calculated using GLM (SAS Inst. Inc., Cary, NC) based on a model that included year of slaughter (2015, 2016), origin of animals (12) and RFI group as categorical fixed effects. The interaction of RFI group*year was not significant (P>0.1) Date of slaughter was also included as an effect in the model for carcass and meat quality traits. Phenotypic correlations were computed using PROC CORR of the SAS Inst. Inc., Cary, NC..

Results and discussion

A small difference in liveweight (P<0.05) was found between the extremes groups during the growing periods at sorghum and at begging of oat pasture, but there were no differences at final weight (Table 1). No differences on ADG at sorghum or oat grazing were observed among RFI groups, or in days to achieve the slaughter weight. The UBFAT of High-efficiency steers did not differ from medium or low-efficiency steers. Some authors found that inefficient animals (high RFI values) had significantly greater fat depth of subcutaneous rib (Herd *et al.*, 2014, Basarab *et al.*, 2003), but our results did not indicate a clear trend. All phenotypic correlations between RFI and different live weights and ADG were close to 0, in agreement with the studies that reported no associations between RFI and liveweight and ADG (Basarab *et al.,* 2003).

Table 1. Effect of residual feed intake group on growing and finishing performance on pasture

	LS MEANS for Efficiency group					
	High (low RFI)	Medium	Low (high RFI)	RFI_group P value	r_p with RFI	
Start weight_Sorgum (kg)	331[a]	340[ab]	346[b]	0.021	0.06	ns
Start weight_Oat (kg)	415[a]	425[ab]	432[b]	0.022	0.08	ns
Final weight_Oat (kg)	522	529	532	0.119	0.07	ns
Sorgum ADG (kg/d)	0.91	0.94	0.94	0.258	0.07	ns
Oat ADG (kg/d)	0.83	0.84	0.82	0.697	-0.03	ns
Days to slaughter (days)	231	224	223	0.287	-0.04	ns
UBFAT pre slaug. (mm)	6.33 [ab]	5.69 [a]	6.54 [b]	0.009	0.01	ns

r_p Phenotypic correlation with RFI; ns P value>0.1

No statistically significant differences were found among RFI groups for any of the carcass traits (Table 2) and meat quality traits (P>0.05) (Table 3). Herd *et al.* (2014) found a small difference in tenderness at 5 days of ageing, in favor of less efficient animals, but this difference disappeared after 7 days of ageing. Baker *et al.* (2006) did not find difference in L*and a*

between RFI groups in pure Angus steers, although steaks from high RFI steers had greater (P=0.02) b* values compared with those from low and mid RFI steers.

Phenotypic correlations between all traits and RFI were close to 0 (P>0.1; Table 2), which suggest that there is no association between RFI with any carcass traits as found by other authors (Basarab *et al.*, 2015).

Table 2. Effect of residual feed intake group on carcass traits

	LS MEANS for Efficiency group					
Variables	High (low RFI)	Medium	Low (high RFI)	RFI_group P value	r_p with RFI	
HCW (kg)	268	271	270	0.611	0.06	ns
Fat cover (mm)	8.9	8.9	9.6	0.335	0.07	ns
REA (cm^2)	60.4	60.3	61.3	0.541	-0.10	ns
Pistola cut (kg)	56.6	56.9	57.4	0.250	0.04	ns
7 primal cuts (kg)	32.0	32.4	32.1	0.446	0.02	ns
Total Fat trimming (kg)	3.7	3.7	3.9	0.109	0.01	ns
Bones (kg)	13.3	13.7	14.5	0.057	0.02	ns

r_p Phenotypic correlation with RFI; ns P value>0.1

Table 3. Effect of residual feed intake group on meat quality traits

	LS MEANS for Efficiency group			
	High	Medium	Low	RFI_group P value
WB Shear force 5d (kgF)	4.17	4.01	4.02	0.357
L* (brightness)	36.44	36.42	36.36	0.976
a* (redness)	20.68	20.77	20.94	0.727
b* (yellowness)	9.71	9.62	9.63	0.939
Ultimate pH	5.66	5.65	5.64	0.735
Intramuscular fat content (%)	3.11	3.40	3.33	0.303

Conclusions

This study suggests that improving feed efficiency by selecting by RFI will not have adverse phenotypic effects on finishing performance carcass and meat quality. Nevertheless, estimates of genetic correlations would be necessary to evaluate the genetic correlated responses as consequences of selecting for improving RFI.

The small trend of lighter liveweights of high-efficiency steer during growing and finishing period should be study in depth and considered in future studies to avoid antagonistic

effects on sexual maturity of replacement heifers.

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