CARCASS CHARACTERISTICS AND BODY COMPOSITION OF LAMBS SELECTED FOR DIVERGENT RESIDUAL FEED INTAKE

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Impact Statement

This research is aimed at improving the existing knowledge of the physiological basis of variation in residual feed intake (RFI). A better understanding of the cause of RFI variation will assist producers in making informed selection decisions when breeding for improved efficiency.

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SUMMARY

The objective of this study was to evaluate differences in growth performance measures, carcass characteristics and quality, and body composition in lambs selected for high and low residual feed intake (RFI). Mixed-breed wether lambs (n = 65), approximately 4-mo-old, were placed on a 47-d feeding trial which was conducted to get an estimate of individual lamb intake. Residual feed intake, an efficiency measurement based upon the difference in actual feed intake and expected feed intake, was calculated for each lamb. Wethers with an RFI of one standard deviation greater (HIGH; less efficient; n = 6) or lower (LOW; more efficient; n = 6) than the mean RFI of the 65 wethers were used in the present study. Upon completion of the feeding trial, lambs were harvested and organ weights were collected immediately after slaughter. Carcass data was collected 24 hours after slaughter. Initial and final liveweights, as well as average daily gain (ADG) were not affected ($P > 0.05$) by RFI class. Back fat thickness (BF) and yield grade (YG) were greater ($P < 0.03$) in HIGH carcasses than in LOW lamb carcasses. No other carcass traits differed between RFI classes. Lung and trachea weights were heavier ($P < 0.03$) in LOW lamb carcasses than in HIGH lamb carcasses. Rumen weight was greater ($P < 0.005$) for LOW lambs than for HIGH lambs. Total GIT and total organ weights were greater ($P < 0.03$) for LOW lambs than in HIGH lambs. In growing lambs, selection for RFI seems to affect fat deposition and organ weights, although more research is necessary to understand the relationship between lung weight, RFI, and HCW.

Acknowledgements: The authors thank Philip Merta for his excellent technical assistance during the course of this study. This study was supported by the Montana Agric. Exp. Sta., and is a contributing project to Multistate Research Project, W2010, Integrated Approach to Enhance Efficiency of Feed Utilization in Beef Production Systems.

INTRODUCTION

The most costly resource in any livestock production system is the cost of feed (Moore et al., 2009). As feed prices continue to rise, selection for efficient animals that can gain more on less feed will become more economically important. Residual feed intake (RFI) has been suggested as the optimal selection trait for enhancing efficiency of production in beef cattle, since it has been reported to not be affected by growth or maturity of animals and instead reflects physiological differences between individual animals (Carstens and Kerley, 2009).

The physical causes of variation in RFI are not clear or completely understood. Richardson and Herd (2004) estimated that the cause of 27% of the variation in RFI cannot be explained. This can be problematic when using RFI as a selection tool, as our lack of understanding of what causes variation in RFI might lead to accidental selection of undesirable traits.

The objective of this study was to investigate patterns of variation in RFI and to determine if young wethers selected for extreme high or low RFI differed in performance traits and produced carcasses with different carcass characteristics and organ weights. Our hypothesis was that this selection process would not influence performance traits such as ADG, but would lead to carcasses with different carcass characteristics and organ weights.

PROCEDURES

Crossbred wethers (n = 65), approximately 4 mo of age, from the Montana State University flock were transported to the Fort Ellis Research Farm in Bozeman, MT. Following vaccination for enterotoxaemia and a 2-wk acclimation period, a 47-d RFI feeding trial was conducted. Due to space constraints, lambs were separated into two groups; group 1 (n = 45) and group 2 (n = 25). Lambs were brought into a barn twice daily, 12 h apart, and individually penned to allow unlimited access to an 80%:20% alfalfa:barley pelleted diet for 2 to 3 h. Feed was weighed prior to and after each feeding for calculating individual lamb intake. Lambs were penned in a drylot with unlimited access to water, but no access to forage. Wethers were weighed on two consecutive days to get an average weight at wk 1, 3, 4, and 6 after the adaptation period.

Daily intakes for each wether were used to calculate ADG. Statistical regression methods were used to calculate the initial and final BW, mid-test metabolic BW (MBW), and expected feed intake (EFI), and then to calculate RFI as actual dry matter intake (DMI) – EFI (Koch et al., 1963). Wethers with an RFI greater than (HIGH; less efficient; n = 6) and less than (LOW; more efficient; n = 6) one standard deviation of the mean of the 65 wethers were retained and moved to the Bozeman Agricultural Research and Teaching Farm (BARTF).

Wethers were transported to Big Timber, MT and processed following standard industry procedures. Organ weights were taken immediately after slaughter. Gastrointestinal tracts (GIT) of each wether were emptied, transported back to Montana State University, and weighed 24 to 48 h later.

Following a 24-h chill, carcasses were transported back to the Meat Laboratory at Montana State University, where carcass data (back fat thickness, rib-eye area, maturity, leg score, conformation, flank streaking, and quality grade) were collected by a trained meat evaluator. Yield grade (YG) was calculated with the following equation: YG= [10*back fat thickness (in)] + 0.4.

RESULTS AND DISCUSSION

Initial live weight, final live weight, and ADG did not differ ($P > 0.05$) between HIGH and LOW RFI lambs. HIGH wethers were 64 lbs at the start of the study and 99 lbs at the end; LOW wethers were 68 lbs at the start and 101 lbs at the end. Both groups gained 0.6 lbs/day. Carcass characteristics other than BF and YG were not affected ($P < 0.03$) by RFI class (Table 1). HIGH wethers produced carcasses with more BF and higher YG. As YG is calculated based upon BF, it was not surprising that both of these values were significant. It is important to note that these lambs were on feed for a fixed period and were not “finished” prior to processing. This resulted in carcasses that were smaller than industry average, and it is possible that if these wethers had been fed longer, the results might have been different

Prior research has also reported that inefficient sheep (Redden et al., 2013; Perry et al, 1997) and cattle (Perry et al., 1997) deposit more BF. This was expected to also be true for our study; however, it is interesting that this excess fat was already deposited at a young age, in sheep that would not have been finished enough for slaughter in a commercial setting. This may indicate that whatever is causing inefficiency begins to have physical effects at a young age, and might be something that has been accidentally selected for when selecting for efficient animals.

HIGH and LOW wethers had different total organ and total GIT weights ($P < 0.03$; Table 2). LOW RFI wethers had heavier ($P < 0.03$) lungs and heavier ($P < 0.005$) rumens than HIGH RFI wethers. It was expected that rumen weights in efficient sheep would be lighter, not heavier. It is possible that heavier rumen weight in efficient wethers is related to a greater surface area of the rumen, which would allow for increased nutrient absorption, but more investigation is required to determine this. More research is necessary on the relationship between lung weight and RFI class, as this is another scenario where selection for efficient animals might be changing more physical characteristics than expected.

This research suggests that we still do not fully understand the effect of RFI on carcass composition and quality, and that more research is necessary. It is important to fully understand what is physically changing in animals with different RFI classifications in order to help producers select for efficient animals that will help save money on feed, without negatively impacting physical and production characteristics.

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Table 1. Carcass characteristics and quality of wethers from divergent RFI classes

	RFI Classification		
Item	HIGH	LOW	*P*-value
Hot carcass wt, lb	46.2	45.8	0.90
Backfat thickness, in	0.23[a]	0.13[b]	0.03
Ribeye area, in^2	2.3	2.2	0.87
Leg Score [1]	9.3	9.3	1.00
Maturity [2]	1.67	1.8	0.55
Conformation[1]	9.3	9.3	1.00
Flank Streaking [3]	225	245	0.75
Quality Grade[1]	9.3	9.2	0.88
Yield Grade [4]	2.65[a]	1.73[b]	0.03

[1]Utility = 7, High Good = 9, Low Choice = 10, Average Choice = 11, High Choice = 12.
[2]A^{00} to A^{33} = 1, A^{34} to A^{67}=2.
[3]Practically devoid = 100-199, Traces = 200-299, slight = 300-399, small = 400-499.
[4]YG= [10*back fat thickness (in)] + 0.4
[a,b] Means within a row with different superscripts differ ($P \leq 0.05$).

Table 2. Viscera weights (lb) from carcasses from HIGH and LOW RFI wethers

	RFI Classification		
Weight, lb	HIGH	LOW	*P*-value
Heart	0.77	0.82	0.67
Intestine	3.76	4.19	0.13
Kidney	0.40	0.35	0.33
Liver	1.97	2.03	0.71
Lungs and trachea	1.27[a]	1.44[b]	0.03
Rumen	3.12[a]	3.67[b]	0.005
Spleen	0.15	0.16	0.75
Total GI Tract [1]	6.89[a]	7.86[b]	0.03
Total Viscera [2]	11.46[a]	12.67[b]	0.03

[1]Rumen weight + intestine weight.
[2]Heart weight + kidney weight + liver weight + spleen weight + total GI tract weight.
[a,b] Means within a row with different superscripts differ ($P \leq 0.05$).