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# COMPARISON OF FEED EFFICIENCY RANKINGS OF HEIFERS FED LOW AND HIGH ENERGY DENSE DIETS

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## Introduction

Concepts related to energy efficiency in cattle have been the basis for many research projects. Even though differences in individuals have long been recognized, little effort has been focused on the causes of the observed variations. The concept of residual feed intake was first introduced in 1963, and is calculated as the difference between actual feed intake by an animal and its expected feed intake based on body weight and growth rate. Residual feed intakes are phenotypically independent of the production traits used to calculate expected feed intake. Consequently, residual feed intake values can be useful in comparing individuals differing in level of production during a test period. These feed efficiency calculations have been shown to be a more accurate indicator of genetic variation in efficiency because they are independent of production traits. Thus, selection for improved residual feed intake makes it feasible to reduce feed intake without compromising growth performance. Hence, this trait could have great economic value to all segments of the beef industry. Energy density of cattle diets varies substantially and the selection for the ability to efficiently utilize high roughage diets does not guarantee efficient utilization of high grain diets. The objective of this study was to determine if energy density of the diet influences the ranking of cattle within a contemporary group and to determine if residual feed intake is influenced by changes in body composition and diet digestibility.

## Experimental Procedures

Twenty-six weaned, spring-born Angus-Hereford crossbred heifer calves were used in this experiment. No growth promoting implants or oral antibiotics were used during this experiment. Heifers were individually fed using Calan gate feeders. Feed offerings were made once daily and feed refusals were measured weekly. Composition of the diets from each feeding period can be found in Table 1. The low energy feeding period (Period 1) consisted of *ad libitum* amounts of chopped brome hay and 4.4 lb of supplement for 70 days. During the high energy feeding period (Period 2, also 70 days) heifers were fed approximately an 80% concentrate ration *ad libitum*. During both periods, heifers had *ad libitum* access to a commercial vitamin/mineral supplement (Ca = 12%, P = 12%, NaCl = 12%) and water. Body weight, ultrasound measurements, hip height, and feed disappearance were recorded and analyzed. Predicted daily dry matter intakes were estimated by using a linear regression model which included the average metabolic body weight of the feeding period, rate of gain, and changes in carcass composition (ΔBF = change in backfat, ΔMarb = change in marbling score) and height (ΔHt = change in hip height) as independent variables. The model for this regression analysis was: DM intake = $\beta_o + \beta_1$ average $BW^{0.75} + \beta_2$ ADG + $\beta_3$ ΔBF + $\beta_4$ ΔMarb + $\beta_5$ ΔHt + error. Residual Feed Intake values were calculated as the difference between the individual's actual and predicted dry matter feed intakes. Partial correlations were performed to determine significant relationships between feed efficiency traits, performance and body composition. Heifers were then ranked within each period (diet energy density) for residual feed intake. Spearman rank order procedure was then used to determine if the ranking orders for residual feed intake were similar between periods.

## Results and Discussion

For the first feeding period (low energy dense diet) heifers averaged 611 pounds at the beginning and achieved an average daily gain of 1.65 pounds (see Table 2). The average daily dry matter intake was 15.4 pounds. Therefore, heifers' average feed consumption was 2.30% of body weight with a feed to gain ratio of 9.33:1. Residual feed intake values ranged from -1.1 to 1.9 pounds with an average value of 0.0007 pounds. he average residual feed intake value should theoretically equal 0 because the actual average was calculated from within the contemporary group and not a general population. The range of residual feed intake values was approximately 19.5% in feed efficiency within the group of heifers when fed the high forage, low energy diet.

For the second feeding period (high energy diet), heifers averaged 760 pounds at the beginning and achieved an average daily gain of 2.61 pounds (see Table 2). Daily dry matter intake was 23.8 pounds. Therefore, average feed consumption was 2.8% of body weight with a feed to gain ratio of 9.14:1. Several of the heifers experienced bloat, which was attributed to not including ionophores in the diet. Because of the bloat, diet composition was adjusted by adding small increments of prairie hay to the diet. Therefore, diet energy concentrations were calculated on an individual basis. This could have affected the feed to gain ratio of some cattle. Again, by definition, the average residual feed intake of the heifers was 0. The range in residual feed intake values was approximately 11.72%, which appears to be less variable than the observed range in the first feeding period.

Neither the Pearson nor the Spearman rank correlation coefficients were significant (P>0.80) between the residual feed intake values from the low energy and high energy diets (see Table 3). Correlation coefficients generally explain the proportion of the total variability of one value that is accounted for by another variable. The Pearson correlation coefficient assesses the linear association between two variables while the Spearman rank correlation coefficient indicates if the heifers remained in the same order (rank) between the first and second feeding periods.

## Implications

Cattle producers wishing to use residual feed intake values in selection criteria to improve feed efficiency need to carefully consider what diet type best reflects their production environments.

**Table 1. Nutrient Profiles of Diet Components for Low Energy Diet (Periods 1) and High Energy Diet (Period 2)**

| | Period 1 | | Period 2 | |
|---|---|---|---|---|
| Nutrients[a, b] | Supplement | Hay | Concentrate | Hay |
| Amount fed, kg/d | 2.03 | *Ad libitum* | 8.55 | 2.5 |
| Dry matter, % | 91.75 | 92.13 | 87.63 | 91.51 |
| Crude protein, % | 21.04 | 7.48 | 10.80 | 8.77 |
| Crude fiber, % | 26.95 | | 11.025 | |
| $NE_g$, Mcal/ kg | 0.37 | 0.25 | 0.615 | 0.26 |
| $NE_m$, Mcal/ kg | 0.70 | 0.58 | 0.94 | 0.59 |
| Total digestible nutrients (TDN) | 62.78 | 53.82 | 81.25 | 54.76 |
| Fat (EE) | 1.63 | | 3.785 | |
| Ash, % | 6.84 | | 3.375 | |
| Acid detergent fiber (ADF), % | | 44.41 | | 43.21 |
| Neutral detergent fiber (NDF), % | | 68.01 | | 68.32 |

[a]Nutrients expresses as percent on a dry-matter basis.
[b]Nutrient content based on lab analysis performed by SDK Laboratories, Inc., Hutchinson, KS.

**Table 2. Phenotypic Correlations Between Performance Traits and Residual Feed Intake During the Low Energy, Forage-based Feeding Period**

| Trait | Average Value | Correlation Coefficient with Residual Feed Intake |
|---|---|---|
| Starting weight, lb | 611 | -0.005 |
| Ending weight, lb | 726 | -0.004 |
| Birthdate, Julian | 61 | -0.35 * |
| Gain | | |
| Daily gain, lb | 1.66 | 0.001 |
| Hip height, inches | 2.4 | 0.003 |
| Backfat, inches | 0.001 | -0.0006 |
| Marbling[a] | 0.11 | -0.0004 |
| Dry matter intake, lb/day | 15.4 | 0.70 *** |
| Residual feed intake, lb/day | 0.0007 | 1.00 |

[a]Marbling score scale: 4.0 = Slight 00, 5.0 = Small 00, etc.; therefore, each 1.0 gain equals a gain of one marbling score.
*P<0.05.
**P<0.01.
***P<0.001.

**Table 3. Phenotypic Correlations of Measures of Feed Efficiency and Performance Traits During High Energy, Concentrate-based Feeding Period**

| Trait | Amount | Correlation Coefficient with Residual Feed Intake |
|---|---|---|
| Starting weight, lb | 760 | -0.00007 |
| Ending weight, lb | 942 | -0.0002 |
| Birthdate, julian | 61 | -0.21 |
| Gain | | |
| Daily gain, lb | 2.61 | -0.0002 |
| Hip height, inches | 2.1 | -0.0001 |
| Backfat, inches | 0.11 | -0.00007 |
| Marbling[a] | 0.40 | 0.00002 |
| Dry matter intake, lb/day | 23.8 | 0.49 ** |
| Residual feed intake, lb/day | 0.0 | 1.00 |

[a]Marbling score scale: 4.0 = Slight 00, 5.0 = Small 00, etc., therefore each 1.0 gain equals a gain of one marbling score.
*P < 0.05.
**P < 0.01.
***P < 0.001.

**Table 3. The Correlation Coefficients Between Residual Feed Intake of Heifers Fed Either Low or High Energy Dense Diets**

| | Pearson Coefficient | Spearman Rank Coefficient |
|---|---|---|
| $R^2$ value | -0.049 | 0.051 |
| P value | 0.81 | 0.81 |