

Project Summary

Mechanism of Dietary Corn Oil Depression of Intramuscular Adipose and Muscle Accretion in Beef Cattle

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**Study Completed
May 2009**



Funded by The Beef Checkoff

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Background

The value of a beef carcass is a function of weight, quality grade and yield grade. Recently, the cattle feeding sector became concerned that distiller's grains, while valuable for producing carcass weight, may be causing higher yield grades and lower quality grades. The effect appeared inconsistent, which could be due to the challenge of data comparisons involving yield and quality grades as well as the variability in the composition of distiller's grains. This study used corn germ to allow researchers to focus on the oil fraction found in distiller's grains. Researchers suspected that the oil fraction was contributing to lower marbling scores. Distiller's grains also contain a large proportion of digestible fiber, which may also be antagonistic to development of marbling. This experiment was designed to evaluate the influence of oil and fiber independently. The focus was on how dietary corn oil (in germ) and fiber (from gluten feed and ear corn) affect metabolites and the endocrinology involved in depositing fat.

Methodology

Diets for finishing cattle were defined to include no (control) corn milling co-products, or to provide 2% (low) or 6% (high) added corn oil from corn germ. These levels of germ were fed in high-starch or high-fiber finishing diets. The higher fiber diets included substitution of chopped, high-moisture earlage and dried corn-gluten feed for rolled, high-moisture corn and dry, whole-shelled corn. These diets were evaluated in 144 steers with an initial body weight of 349 kg selected based upon uniformity of weight. To allot steers to treatments, steers were ranked by body weight and then sequentially assigned to high- or low-starch diets. Steers were then sorted by starch diet (high or low), ranked by body weight and randomly assigned to one of three germ levels. The process was repeated to assign steers to pen replicates.

Individual body weights were determined initially and at 28-day intervals during the study except during the last 25-day period. Revalor-S implants were administered to all steers during the day 28 weighing process. The feeding study duration was 137 days. Ultrasound measurements of ribeye area, ribfat depth and percent intramuscular fat (IMF) were acquired 77 and six days prior to harvest.

Blood samples for hormone and metabolite analysis were collected from steers at 96 and 131 days on feed. Individual steer identity was tracked through the harvest and grading process. For carcass composition comparisons, three steers from each pen were identified as nearest to the mean initial body weight. Carcasses from these steers were separated and anatomical reference points for 9-10-11 rib sections were marked on the left side of each carcass. These reference points were used to recover rib sections during fabrication 24 hours after grading.

An MRatio can be calculated as a means of comparing marbling to either preliminary yield grade or to total carcass fat (M_2 Ratio). The following equation was used:

$$\left[\frac{(\text{Obs Var}_1 - \text{Var}_1 \bar{x})}{\text{Var}_1 S_d} \right] - \left[\frac{(\text{Obs Var}_2 - \text{Var}_2 \bar{x})}{\text{Var}_2 S_d} \right]$$

The M₂Ratio reported used marbling and ribfat depth as variables 1 and 2, respectively. For M₂Ratio calculations, percent carcass fat derived from 9-10-11 rib sections was used as variable 2. A value of 0.0 signifies a ratio was not altered. Positive values indicate a favorable level of marbling to fatness. Negative M₂Ratio values indicate marbling depression has occurred.

Glucose (GLU), non-esterified fatty acids (NEFA), insulin (INS), plasma urea nitrogen (PUN), triglycerides (TG), cholesterol (CHOL), high-density lipoproteins (HDL) and low-density lipoproteins (LDL) were determined in plasma. The remaining lipoprotein fraction, which included very-low density lipoproteins (VLDL), intermediate density lipoproteins and chylomicrons, was calculated by subtracting the HDL and LDL fractions from the total CHOL.

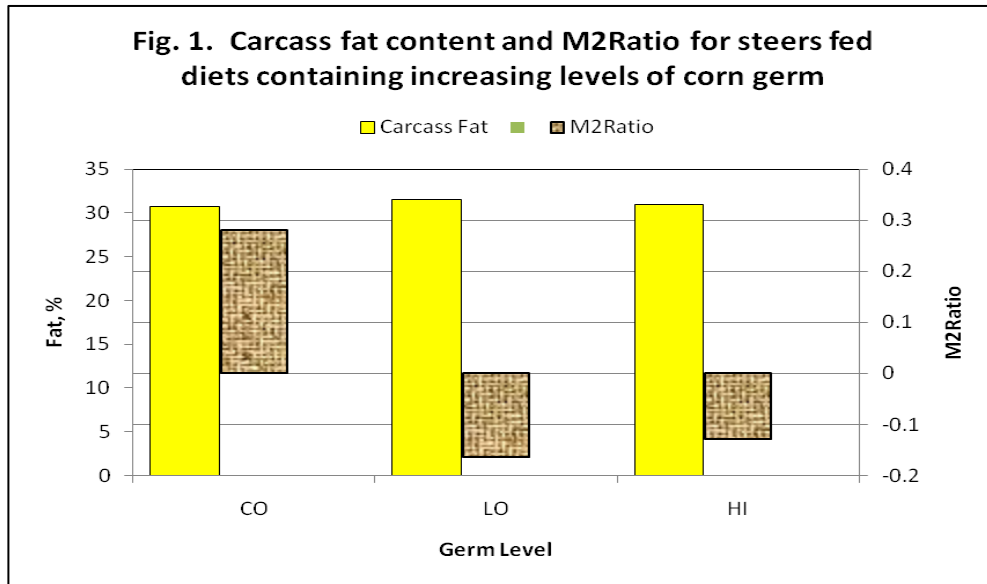
To evaluate plasma hormone and metabolite concentrations relative to the ability of cattle to deposit intramuscular versus subcutaneous adipose tissue, cattle were separated based on their M₂Ratio. The M₂Ratio was used to identify 24 steers to be used as sera donors for satellite cell cultures. These included the three or four highest and lowest M₂Ratios within each level of germ. Satellite cells used were isolated previously from the *Longissimus dorsi* muscle of a young, growing, high-energy-fed heifer.

Findings

Fiber has less net energy (NE) than starch, and the tabular NE values were 62 and 57 Mcal/cwt. for control and higher-fiber diets, respectively. Predictably, the higher fiber diets resulted in 5% higher dry matter intake (DMI), 10% lower average daily gain (ADG) and 14% poorer efficiency. The only carcass trait affected ($P < 0.01$) was hot carcass weight (HCW) with weights of 832 lb and 801 lb, respectively. Fiber levels did not alter blood glucose, insulin or lipids. Improved performance has been observed when feeding distiller's grains. The fiber aspect of the current experiment suggests that the fiber fraction of distiller's grains is not the source of this response and that the fiber level does not alter carcass fatness or fat distributions.

Adding oil to the diet via germ increases the energy density. In this study, this had little effect on live animal production traits, except that the high germ inclusion caused lower ADG. The HCW differed ($P < 0.05$) due to germ level with values of 816 lb, 823 lb and 810 lb for control, low and high germ diets, respectively. Germ also reduced marbling ($P < 0.05$) while having no effect on ribfat thickness. The most pronounced effect on marbling occurred on the low germ diet.

Feeding germ resulted in negative M₂Ratio values ($P < 0.10$). Figure 1 illustrates carcass fat content and corresponding M₂Ratios for the three levels of germ in this study. Feeding the low level of germ also caused a slight increase in blood glucose levels (63 vs. 68 mg/dl; $P < 0.05$). When germ was fed, blood lipids increased dramatically ($P < 0.01$). TGs, HDLs, LDLs, VLDLs and NEFAs all increased ($P < 0.05$) with increasing dietary germ. The relationship between this shift in lipid metabolism and the causes for the shift and accumulation of IMF could be investigated further.



Serum from a sub-population of cattle with the highest (1.32) and lowest (-1.40) M₂Ratios was used in satellite cell cultures. Within this sub-population, serum obtained at 41 days prior to harvest supported higher differentiation and proliferation rates than serum collected at harvest. Increasing dietary germ caused a reduction in mitogenic activity supported by the serum from the early serum collection date. The higher M₂Ratio serum caused responses indicative of being stimulatory of muscle growth. This is especially interesting since the carcasses from these cattle had similar ribeye areas and HCW, but had more marbling.

Implications

This project shed light on new concepts to pursue as the industry strives to improve quality grades in beef carcasses. Dietary oil causes dramatic shifts in blood lipid profiles that have not been previously considered when studying IMF accretion. Besides diet, those steers that produced more highly marbled carcasses had substantially different serum lipid profile responses than steers producing less marbled carcasses. Serum from high-marbling steers provided more growth stimulation to satellite cells involved in muscle growth. This is in contrast to the perceived antagonisms between muscle growth and IMF accretion. These observations will be useful in ongoing efforts to solve the puzzle of utilizing diet, management and genetics to improve beef quality grades.

For more information contact:

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