Project Summary

Using Crude Glycerol, an Alternative Feedstuff from Biodiesel Production, as a Pre-harvest Carcass Influencer to Enhance Marbling and Meat Quality

Principal Investigator: M. Kerley, Ph.D.,
University of Missouri

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Background

The growth of bioenergy production in the U.S. has impacted animal agriculture production by increasing the costs of grains traditionally fed and increasing the supply of alternative feedstuffs (by-products) not previously available. One such by-product is crude glycerol or glycerin. Feeding glycerin, which would increase the glucose supply to the calf, would hypothetically be expected to increase intramuscular fat deposition, which requires glucose for its synthesis. If glycerin improves the animal's ability to increase marbling, then it would be expected that feeding glycerin would improve carcass quality grade, and subsequently carcass value and meat quality.

The objectives for this project were to:

1. Determine the effect of crude glycerol inclusion in the diet on carcass weight, yield grade and quality grade.
2. Determine the effect of crude glycerol inclusion on marbling score, intramuscular fat content and fatty acid composition.
3. Determine the effect of crude glycerol on water holding capacity of the muscle (meat).

Methodology

Source and age verified steer calves (n=480) were purchased after calves had been placed in an industry-approved 45-day preconditioning program. The calves weighed approximately 600 lbs at purchase. Six steers were placed in each pen, and four pens were assigned to each treatment. The diet fed to calves contained 0, 5, 10 or 20% glycerin in experiment 1 and 0, 5, 10, 12.5 and 15% glycerin in experiment 2, with glycerin replacing corn in the diet.

Steers were humanely harvested after reaching an average live weight of 537 $\pm$ 12 kg and an average 12th rib fat depth of 1.18 $\pm$ 0.13 cm. At harvest, carcass data was collected for each animal and parameters measured (hot carcass weight, yield grade, quality grade, backfat, marbling score and ribeye area) and statistically compared across treatments using means comparison and linear and quadratic contrasts. Steaks were pulled from carcasses of experiment 1 and analyzed (shear force, water-holding capacity, fat content, fatty acid profile, color) for differences among treatments.

In experiment 1, blood samples were collected to measure initial and final circulating triacylglyceride, glucose and glycerol levels. Meat quality measures of shear force tenderness and Hunter *L**, *a**, and *b** color measurements (over 7 day shelf storage) were made. *Longissimus dorsi* samples were collected and intramuscular fat was extracted and prepared for fatty acid profile determination by gas chromatography.

Findings

Inclusion of glycerin in the diet had a quadratic effect on yield grade and marbling in both experiments, with 10% inclusion yielding the greatest response compared to controls (Table 1 & Table 2). In experiment 2, hot carcass weight and backfat responded quadratically to glycerin inclusion, with the 10% level yielding the greatest response. In experiment 1, backfat followed the same trend numerically but the response was not statistically significant. From these data it was concluded that glycerol inclusion into the diet could have beneficial effects at the 10% level.

However, levels above 10% did not have any further benefit and 20% inclusion of glycerol in the diet could reduce carcass quality grade and value.

Table 1. Carcass measurements of beef calves fed diets with increasing crude glycerol content (Experiment 1)

	Diet (% crude glycerol)				
Measurement	0	5	10	20	SEM
Hot carcass weight (lbs)	702	709	697	690	19.6
Backfat (in)	0.47	0.44	0.62	0.43	0.051
Ribeye area (in^2)	11.0	11.1	10.9	11.7	0.39
Yield grade[1]	3.3	3.3	3.5	2.9	0.21
Marbling score[2]	522	503	562	458	27.4

[1]Quadratic, $P < 0.17$.
[2] Quadratic, $P < 0.10$.

Table 2. Carcass measurements of beef calves fed diets with increasing crude glycerol content (Experiment 2)

Diet (% crude glycerol)								
Measurement	0	5	10	12.5	15	SEM	Linea	Quadratic
Hot carcass weight (lbs)[1]	677	663	708	664	645	15.6	0.22	0.10
Quality grade[2]	4.3	4.6	4.8	4.6	4.1	0.46	0.79	0.27
Backfat (in)[3]	0.27	0.35	0.36	0.32	0.23	0.42	0.5	0.03
% Retail product	66.9	66.5	66.0	66.9	67.9	0.87	0.38	0.20
Ribeye area (in^2)	12.5	12.7	12.9	12.8	12.7	0.48	0.73	0.68
Yield grade[2]	2.2	2.3	2.4	2.2	1.9	0.21	0.30	0.11

[1]Quadratic, $P < 0.10$
[2]Standard = 1, low select = 2, average select = 3, high select = 4, low choice = 5, average choice = 6.
[3]Quadraatic, $P < 0.05$.

Statistical analysis revealed no differences for initial and final circulating triacylglycerides, glucose or glycerol across treatment groups. Total lipid percentage within the *longissimus* differed among treatment groups and measured 2.67, 3.68, 2.37 and 2.91% for 0, 5, 10 and 20% glycerol, respectively. No differences were observed for any saturated fatty acids within the *longissimus* among treatment groups. However, C14:1 means differed and measured 0.454, 0.757, 0.751 and 0.481% for 0, 5, 10 and 20%, respectively. Other changes occurred in poly-unsaturated fatty acids (PUFA) and were observed for C18:2N6, C20:2N6, C20:5N3 and C22:6N3. These changes tended to show increases with up to 10% glycerol inclusion and subsequent decreases at the 20% glycerol level. The biological significance of these changes is not yet clear. Overall, these data indicate that feeding up to 10% crude glycerol to finishing beef steers has no negative impact on certain blood lipid and energy parameters or meat quality measures related to color and lipid profile.

Implications

In the production of biodiesel, approximately 10% of the oil used is captured as the crude glycerol or glycerin by-product. The estimated production volumes of biodiesel in the U.S. will make crude glycerol a potentially important feedstuff. Research has shown that crude glycerol can replace corn in the diet of feedlot cattle up to 10% of the diet with no detriment to growth performance. This research now shows that carcass value or meat quality is not adversely affected by feeding crude glycerol. In two experiments conducted where glycerol inclusion was compared to a no-glycerol control diet carcass, marbling was improved at a 10% dietary glycerol level. Meat color, tenderness (shear force measurement) and pH was not affected by glycerol consumption. Feeding diets with 10% crude glycerol did increase the eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) levels in the meat, and increased the omega-3 to omega-6 fatty acid ratio. Crude glycerol can be used in cattle diets to replace corn and may have beneficial effects on carcass value and meat quality.

For more information contact:
National Cattlemen's Beef Association
9110 East Nichols Avenue
Centennial, Colorado 80112-3450
(303) 694-0305