Effect of Glycerol Level in Feedlot Finishing Diets on Animal Performance

V.L. Anderson and B.R. Ilse
NDSU Carrington Research Extension Center

Abstract

Yearling heifers (n = 132) were purchased from a commercial source and allotted by weight (initial wt. = 913.4 ± 33.4 lbs.) in a randomized complete block design and sorted into 16 identical pens (four pens per treatment). Treatments were 0, 6, 12, and 18 percent glycerol (DM basis) replacing dry-rolled corn and co-products in finishing diets (62 Mcal NEg/cwt). Diets met or exceeded NRC requirements for crude protein. Heifers were fed for 102 days and shipped to a commercial abattoir. Ribeye area, fat thickness over the 12th rib, KPH, and HCW were measured to calculate USDA yield grade and quality grades were recorded. A 3-inch portion of the shortloin was secured from each carcass, aged for 14 days at 39°F and cut into two steaks. One was used for Warner-Bratzler shear force (WBSF) evaluation and the other for sensory analysis of tenderness, juiciness, off-flavor, and flavor intensity. Dry matter intake linearly decreased over the entire feeding period with glycerol level (P = 0.05) as three of the four feeding periods showed either a quadratic or linear response. Gains were not affected by glycerol level (P > 0.26) during individual periods or overall and feed efficiency was also similar (P > 0.22) among treatments. From this feedlot trial, it appears that glycerol is a viable energy source in finishing cattle diets and can be used in diets with very low starch to support excellent gains and feed efficiency. Carcass data and taste panel response will be reported in a future paper.

Key words: glycerol, beef, feedlot

Introduction

The glycerol (or glycerine) supply may increase dramatically throughout the Northern Plains states and Canadian provinces with the development of the biodiesel industry. Approximately 10% of the original weight of the vegetable oil ends up as glycerol in the process to produce biodiesel. If glycerol can be used successfully as a feed, beef cattle are the largest potential year-round market outlet in North Dakota. A few research trials with dairy cattle support the use of glycerol as an energy source for ruminants, but no production feedlot research has been reported in the Northern Plains. Glycerol is currently used in some formulations of liquid feed products. This trial was designed to study the effects of glycerol in finishing rations on animal performance, carcass traits, tenderness, and taste panel response. This paper is a preliminary report and covers only the feedlot performance component of the experiment. Additional studies are planned using glycerol in post-weaning receiving diets.

Glycerol added to a totally-mixed ration in a truck-mounted mixer wagon.

Materials and Methods

One hundred thirty-two yearling feeder heifers were weighed, blocked by weight and randomly allotted within block to one of four ration treatments. There were four pens or replicates for each treatment utilizing 16 pens. The four treatments included glycerol in the ration at 0, 6, 12, or 18 percent of the diet DM. Feed grade glycerol (or glycerine) was provided by Westway Feed Products, Inc. Finishing diet formulations are presented in Table 1. The finishing diets were fed as totally-mixed ration and included wheat middlings, distillers grains, field peas, and decreasing levels of corn (60, 40, 20, and 0 percent, respectively) and a supplement that included an ionophore (Rumensin®; Elanco Animal Health, Indianapolis, IN), melangesterol acetate (MGA™; Pfizer Animal Health, Exton, PA), a vitamin premix, and a high-calcium, feedlot finishing mineral mix. The glycerol levels were increased in stepped increments as follows: all glycerol treatment groups were fed the 6 percent glycerol ration during the first 7 days of the trial; the 12 and 18 percent treatment groups were increased to 12 percent during the second week; and the 18 percent glycerol treatment pens were increased to the final glycerol level at the start of the third week.

Table 1. Finishing diets with increasing glycerol fed to yearling heifers.

	Treatment, % Glycerol			
	0%	6%	12%	18%
Item	- - - - - - - - - - Percent, DM basis- - - - - - - - - -			
Corn, dry-rolled	59.39	39.10	19.33	0.00
Field pea, dry-rolled	12.03	11.88	11.76	11.59
Wheat middlings	4.84	12.44	19.81	27.07
Mod Distillers grains w/solubles	13.38	19.84	26.07	32.23
Glycerol	0.00	6.56	12.87	19.07
Straw, chopped	8.66	8.50	8.42	8.22
Calcium carbonate	0.62	0.61	0.63	0.67
Ionophore/MGA Suppl	1.08	1.07	1.11	1.15
Dry Matter, %	82.57	80.08	77.84	75.73
NEg, Mcal/lb	64.24	64.06	63.82	63.62
Crude Protein, %	13.10	14.64	16.13	17.59
Calcium, %	0.40	0.41	0.43	0.47
Phosphorous, %	0.35	0.40	0.44	0.47
Potassium, %	0.60	0.66	0.71	0.77

Individual animals were weighed at the start of the trial and at 28-day intervals during periods 1, 2, and 3, but period 4 was only 18 days long and terminated when all the heifers were shipped to market. Heifers were fed once daily to appetite based on morning bunk readings, with feed recorded daily and summarized for each weigh period. Diets were assembled and mixed by treatment batch and distributed to respective pens in a three-auger, truck-mounted Knight LA-9 mixer wagon equipped with a digital scale. Pens were equipped with fenceline automatic water fountains and fenceline concrete bunks with a minimum of two feet per head. The average daily DMI, gain, and feed efficiency were calculated for each pen for each weigh period. The statistical analysis was conducted for each weigh period and for the entire 102 days on feed. All heifers were marketed at the same time when visual appraisal of the animals suggested a minimum of 0.4 inches of backfat and 60 percent would grade USDA Choice. Heifers were transported to a commercial abattoir (Tyson Fresh Meats, Dakota City, NE) for harvest. Carcasses were evaluated after a 48-hour chill and data will be reported in a future paper. Final live weight was calculated from HCW using a constant dressing percent of approximately 63 percent and 3 percent shrink.

Statistical Analysis

Data were analyzed using SAS software with mixed-model procedures. Pen was the experimental unit. Significance, a term associated with a real vs. chance effects of the treatments tested, is stated as occurring when ($P < 0.10$) or when treatment effects have a 90 percent or greater chance of being caused by the imposed treatment(s). Contrast comparisons were conducted on glycerol vs. no glycerol, and linear and quadratic effects of glycerol level.

Animal Care and Management

This project was approved by the NDSU Institutional Animal Care and Use Committee and all animals were managed according the Guidelines for the Care and Use of Agricultural Animals in Agriculture Research and Teaching (FASS, 1999).

Results and Discussion

Average weights of heifers (Table 2) were not different overall (P > 0.22). Initial weight was 913.4 ± 33.9 lbs. Final weights averaged 1316.0 ± 46.8 lbs. Dry matter intake (Table 3) responded linearly (P = 0.06) to glycerol level over the entire feeding period with varying responses during the four feeding periods. During period 1 glycerol levels were ramped up at weekly intervals, intake appeared to be negatively affected by treatment with a P value for the linear contrast of (P = 0.06) indicating potentially reduced intake for the higher levels of glycerol, however, gains were not affected. A quadratic response was observed during period 2 (P = 0.04) with greater intake on the 6 and 12 percent glycerol diets. During period 3, a linear decrease in DMI with increasing glycerol level was observed (P = 0.04) but in period 4, treatment did not affect DMI. Even though overall DMI was affected by treatment, ADG (Table 4) was consistent and not significantly different (P > 0.26) during any weigh period or overall. Daily gains averaged 3.92 ± .21lbs. for all treatments during the entire feeding period. Feed efficiency (Tables 5 and 6) was not affected by treatment.

Table 2. Live weight of heifers fed increasing levels of glycerol in finishing diets.

	% Glycerol						Contrasts		
Item	0	6	12	18	St.Err	P-Value	Glyc vs. None	Linear	Quadratic
Initial Wt., lb.	909.03	920.43	916.98	906.50	33.91	0.75	0.65	0.81	0.31
Period 1, lb.	1018.45	1027.43	1022.95	1011.07	36.36	0.56	0.83	0.49	0.23
Period 2, lb.	1131.63	1147.85	1146.20	1126.40	39.17	0.22	0.38	0.64	0.05
Period 3, lb.	1249.25	1257.25	1257.85	1237.27	38.27	0.39	0.89	0.40	0.15
Final, Wt., lb.	1312.74	1321.72	1329.80	1299.55	46.80	0.48	0.79	0.62	0.18
HCW	802.94	808.43	813.38	794.87	28.63	0.48	0.79	0.62	0.18

Table 3. Dry matter intake of heifers fed increasing levels of glycerol in finishing diets.

	% Glycerol						Conrtasts		
Item	0	6	12	18	St.Err	P-Value	Glyc vs. None	Linear	Quadratic
Period 1, lb.	28.70	27.95	28.52	27.13	0.71	0.12	0.13	0.06	0.49
Period 2, lb.	26.82	28.16	27.20	25.59	0.79	0.10	0.84	0.13	0.04
Period 3, lb.	28.65	28.17	27.59	26.04	0.80	0.17	0.16	0.04	0.52
Period 4, lb.	28.35	27.38	27.43	25.70	1.36	0.50	0.30	0.17	0.76
Overall, lb.	28.11	27.97	27.71	26.16	0.80	0.18	0.28	0.06	0.29

Table 4. Average daily gain of heifers fed increasing levels of glycerol in finishing diets.

	% Glycerol						Contrasts		
Item	0	6	12	18	St.Err	P-Value	Glyc vs. None	Linear	Quadratic
Period 1, lb.	3.91	3.83	3.79	3.73	0.29	0.98	0.71	0.67	0.96
Period 2, lb.	4.04	4.30	4.40	4.12	0.27	0.67	0.40	0.75	0.26
Period 3, lb.	4.20	3.90	3.99	3.96	0.20	0.74	0.30	0.49	0.51
Period 4, lb.	3.53	3.58	4.00	3.46	0.59	0.81	0.77	0.91	0.51
Overall, lb.	3.92	3.90	4.04	3.82	0.21	0.77	0.99	0.82	0.51

Table 5. Gain per unit DMI of heifers fed increasing levels of glycerol in finishing diets.

	% Glycerol						Contrasts		
Item	0	6	12	18	St.Err	P-Value	Glyc vs. None	Linear	Quadratic
Period 1, lb.	0.14	0.14	0.13	0.14	0.01	0.97	0.80	0.95	0.67
Period 2, lb.	0.15	0.15	0.16	0.16	0.01	0.85	0.62	0.48	0.90
Period 3, lb.	0.15	0.14	0.15	0.15	0.01	0.73	0.86	0.58	0.37
Period 4, lb.	0.13	0.13	0.15	0.13	0.02	0.77	0.61	0.65	0.56
Overall, lb	0.14	0.14	0.15	0.15	0.00	0.20	0.41	0.13	1.00

Table 6. Feed intake (DM) per pound of gain for heifers fed increasing levels of glycerol in finishing diets.

	% Glycerol						Contrasts		
Item	0	6	12	18	St.Err	P-Value	Glyc vs. None	Linear	Quadratic
Period 1, lb.	7.46	7.36	7.67	7.35	0.45	0.95	1.00	1.00	0.82
Period 2, lb.	6.73	6.59	6.22	6.33	0.43	0.76	0.44	0.37	0.75
Period 3, lb.	6.90	7.21	6.93	6.66	0.35	0.70	0.93	0.51	0.39
Period 4, lb.	8.14	7.95	6.92	9.55	1.33	0.47	1.00	0.54	0.24
Overall, lb	7.17	7.20	6.87	6.94	0.24	0.48	0.42	0.22	0.92

Conclusions and Significance

The results of this study suggest that glycerol is an excellent energy source for finishing diets up to 18 percent of dry matter intake. The fact that corn decreased from 60 percent of the diet to 0 percent while glycerol increased, along with the co-products wheat midds and distillers grains indicates that high co-product diets can be competitive with corn-based diets. The protein content of the diet increased with co-product level, with potential for excess protein to be metabolized as an energy source.

Glycerol was handled as a liquid even though the lab analysis reports it at 85 percent dry matter. Feed-grade glycerol, a three-carbon alcohol, has high viscosity and does not flow well in colder temperatures, essentially below freezing. The viscosity decreases and the flow properties improve when water is added to the product. Adding up to 50 percent water will improve flow properties down to approximately -30°F. This practice is necessary if glycerol is to be used as a single ingredient throughout the winter feeding period. Ration adjustments must be made to account for the change in dry matter content. ◆

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