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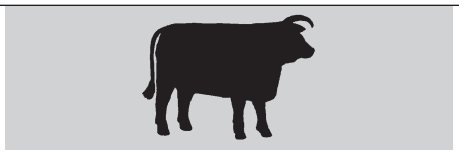

Effects of dietary glycerin on growth performance, carcass characteristics, and rumen metabolism of beef cattle[1]

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ABSTRACT

Our objectives were to determine the effects of replacing corn with glycerin on growth performance, carcass characteristics, ruminal metabolism, and fiber disappearance in beef cattle. In Exp. 1 heifers (initial BW = 242 ± 32 kg) were fed 1 of 3 treatments from d 1 to 85 (growing phase): (1) 0%, (2) 10%, or (3) 20% glycerin (DM basis). From d 86 to 167 (finishing phase), they were fed a common diet. During the growing phase, ADG and G:F decreased ($P \leq 0.01$) with increasing glycerin inclusion, but DMI was not different ($P = 0.84$). During the finishing phase, heifers fed 10% glycerin in the growing phase had increased ($P = 0.05$) final BW and HCW and the greatest (trend; $P = 0.09$) marbling scores. Treatment did not affect ($P > 0.15$) back fat, KPH, YG, or LM area. In Exp. 2 ruminally fistulated steers were fed 3 treatments in a replicated 3 × 3 Latin square: (1) 0%, (2) 8%, and (3) 16% glycerin (DM basis). Increasing dietary glycerin decreased (trend; $P = 0.06$) DMI. Glycerin inclusion did not affect mean ruminal pH ($P = 0.61$), 24-h in situ DM ($P = 0.38$) or NDF disappearance ($P = 0.51$). There was a glycerin × time interaction ($P = 0.05$) for acetate concentration. At 3 and 6 h after feeding, acetate was reduced with increasing glycerin. Mean propionate concentration ($P = 0.01$) increased, whereas mean acetate-to-propionate ratio ($P < 0.01$) and mean ruminal H_2S (linear; $P = 0.05$) decreased, with increasing glycerin. Fiber digestion was not increased in steers fed increasing glycerin. But, ruminal propionate was increased and marbling was greatest in heifers fed 10% glycerin.

Key words: beef cattle, by-product, glycerin

INTRODUCTION

By-products from grain processing, such as glycerin, distillers grains with solubles (**DDGS**), and wet brewers grains (**WBG**), can be used to meet protein and energy requirements of cattle. When corn is expensive, cattle producers and nutritionists may increase dietary inclusions of by-products, if economical. However, increasing inclusion of by-products in the diet decreases starch concentrations (Gunn et al., 2008), thus reducing the primary gluconeogenic substrate in feedlot cattle diets, potentially effecting dietary energy concentrations and carcass quality. One by-product that may counteract this negative effect of reduced gluconeogenic substrate availability is glycerin. Glycerin can be converted in the rumen to propionate (**Pr**), the precursor to glucose synthesis (Johns, 1953). Shifting the ruminal VFA profile toward Pr, and away from acetate (**Ac**) production, is a more energetically favorable pathway (Van Soest, 1994). In fact, Gunn et al. (2008) showed early-weaned calves fed 15% glycerin had increased ADG and marbling score when compared with calves fed 0% glycerin. Furthermore, Parsons et al. (2009) reported ADG and HCW were optimized in heifers fed glycerin at 2 to 8% dietary inclusion versus those fed greater inclusions. Because of the VFA shift to Pr, glycerin may also decrease available hydrogen ions (H^+) in the rumen (Van Soest, 1994). Available H^+ can combine with sulfates, that are reduced to sulfides in the rumen, forming hydrogen sulfide gas (H_2S) and increasing the risk for polioencephalomalacia (**PEM**) in cattle fed DDGS (Felix and Loerch, 2011). Furthermore, reduced pH can hinder fiber digestion by inhibiting fiber-digesting bacteria (Mould et al., 1983). Because pH is a measure of H^+ availability, a reduction in H^+ in cattle fed glycerin could

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increase ruminal pH, improving fiber digestibility.

Therefore, we hypothesized dietary glycerin would increase growth performance, increase ruminal pH, improve fiber digestion, and decrease ruminal H_2S concentrations. The objectives of these studies were to (1) determine the effects of 0, 10, and 20% dietary glycerin on feedlot cattle growth performance and carcass characteristics and (2) determine the effects of 0, 8, and 16% dietary glycerin on ruminal metabolism of beef steers fed by-products.

MATERIALS AND METHODS

All animal procedures were approved by the University of Illinois Institute of Animal Care and Use Committee and followed the guidelines recommended in the *Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching* (FASS, 2010). Experiments were conducted at the Beef Cattle and Sheep Field Laboratory in Urbana, Illinois.

Exp. 1

Animals and Diets. Thirty-six crossbred heifers (initial BW = 242 ± 32 kg) were housed in feedlot barns constructed of wood frames with ribbed metal roofs and siding on the north, west, and east sides. The south sides were covered with 1.27 × 1.27 cm mesh wire bird screen and had retractable curtains. Each 4.9 × 4.9 m pen had rubber-coated (1.9 cm thick), slatted concrete floors. Heifers were stratified by BW and randomly allotted to 6 pens to equalize initial BW across pens. Heifers were fed 1 of 3 dietary treatments for 85 d (during the growing phase): (1) 0%, (2) 10%, or (3) 20% glycerin inclusion (DM basis). The remainder of the diets contained 20% husklage, 50% WBG, and 10% supplement, and glycerin replaced corn in the diet (Table 1). Diets were mixed in a wagon (Knight Reel Auggie 3130; Kuhn Agricultural Machinery, Brodhead, WI), and heifers were fed once daily for ad libitum intakes. Heifers were fed the treatment diets for 85 d, during the growing phase, and individual intakes were recorded using the GrowSafe Feeding System (GrowSafe Systems Ltd., Airdrie, AB, Canada). On d 86, the beginning of the finishing phase, all heifers were fed a common finishing diet from concrete bunks for the remainder of the trial (167 d). Heifers were weighed on 2 consecutive days at the beginning of the trial, at diet switch, and at the end of the trial to determine initial, final growing phase, and final average BW, respectively. When heifers were deemed finished by visual appraisal (targeting approximately 1 cm of back fat), they were weighed and then shipped 296 km to be slaughtered at a commercial slaughter facility, where standard carcass data were collected via camera imaging.

Husklage (ensiled corn husks, cobs, and seed derived from seed-corn processing), WBG, supplement, and corn samples were collected every 2 wk throughout the course of the trial. Feed samples were analyzed for 105°C DM, and rations were adjusted based on DM. Individual ingredient samples were composited over the course of the trial, freeze-dried (12 L of FreezeZone, Labconco, Kansas City, MO), and ground with a Wiley mill (Thomas Scientific, Swedesboro, NJ) through a 2-mm screen. Nutrient composition was analyzed using the composited individual feed ingredients, and then the nutrient composition of the diets was calculated using those values. Freeze-dried samples were analyzed for DM (24 h at 105°C), NDF and ADF (using Ankom Technology methods 5 and 6, respectively; Ankom[200] Fiber Analyzer, Ankom Technology,

Table 1. Composition of diets fed to heifers on a DM basis in Exp. 1

	% Glycerin inclusion			
Item	0	10	20	Finishing diet
Ingredient composition, % DM				
Dry-rolled corn	20	10	0	50
Wet brewers grains[1]	50	50	50	20
Husklage[2]	20	20	20	20
Glycerin[3]	0	10	20	—
Supplement[4]	10	10	10	10
Analyzed composition, % DM				
NDF	34.53	33.58	32.62	22.96
ADF	17.21	16.83	16.46	10.87
CP	21.24	20.33	19.42	13.84
Fat	6.11	5.73	5.35	4.55
Calculated values[5]				
NE_m, Mcal/d	2.17	2.14	1.89	—
NE_g, Mcal/d	1.49	1.46	1.26	—

[1]Anheuser Busch Co. (St. Louis, MO); analyzed values: CP: 33.70%, NDF: 4.70%, ether extract: 12.40%, DM: 28.20%.

[2]Husklage is ensiled corn shucks derived from seed-corn processing. Analyzed vales: CP: 9.63%, NDF: 42.00%, ether extract: 2.43%, DM: 36.00%.

[3]Glycerin source: Archer Daniels Midland (Decatur, IL), purity 99.9%.

[4]Supplement contained (% DM basis) 75.353% ground corn, 22.718% limestone, 0.909% dairy trace mineral mix [included 5% Mg as MgO and $MgSO_4$, 10% S as S_8, prilled, 7.5% K as KCl_2, 2% Fe as $FeSO_4$, 3% Zn as $ZnSO_4$ and Availa-4 (Zinpro Performance Minerals; Zinpro Corp., Eden Prairie, MN), 3% Mn as $MnSO_4$ and Availa-4, 5,000 mg/kg Cu as $CuSO_4$ and Availa-4, 250 mg/kg I as $Ca(IO_3)_2$, 40 mg/kg Co as Availa-4, 150 mg/kg Se as Na_2SeO_3, 2,203 KIU vitamin A/kg as retinyl acetate, 661 KIU vitamin D_3/kg as cholecalciferol, and 22,026 IU vitamin E/kg as DL-α-tocopheryl acetate], 0.154% Rumensin 90 (Elanco, Greenfield, IN), 0.100% Tylosin 40 (Elanco), and 0.766% fat.

[5]Back calculated off of performance data based on NRC (1996) equations.