Health, performance, and complete blood counts of newly received feedlot heifers in response to an oral drench of water and crude glycerin[1]

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INTRODUCTION

Newly received feedlot calves typically have suppressed DMI, partly because of stress associated with handling, transportation, comingling, and foreign environment. Reduced DMI could limit intake of dietary energy, thus limiting the supply of energy to support the immune system (Duff and Galyean, 2007) and predisposing feedlot receiving calves to diseases such as bovine respiratory disease. Crude glycerin, a liquid by-product from the biodiesel industry, is a "generally recognized as safe" feed ingredient for livestock (Sellers, 2008). Glycerin shifts rumen fermentation in favor of propionate production (Lopez et al., 2017), increases plasma glucose concentrations of dairy cattle (Linke, 2005), and has been used as a source of supplemental dietary energy in finishing cattle diets (Parsons et al., 2009).

Because newly received feedlot calves typically have low DMI, Carey et al. (2017) dissolved crude glycerin in drinking water to supply additional energy to endotoxin-challenged steers and reported a greater innate immune response when steers consumed ±420 g of crude glycerin daily via drinking water. We hypothesized that supplementing crude glycerin via an oral drench to calves upon arrival at the feedlot, as well as to calves warranting medical treatment during the study, will provide additional energy for active immunity, thereby altering morbidity and improving performance. The objective of this study was to evaluate the effects of an oral drench of crude glycerin on newly received feedlot calf health and performance.

MATERIALS AND METHODS

Animals and Facilities

All procedures were approved by the New Mexico State University Institutional Animal Care and Use Committee. A total of 719 heifer calves (British and British × Continental; 180 ± 3.5 kg) were transported 1,158 km (12 h on a truck) from Gonzalez, TX, to the Clayton Livestock Research Center in Clayton, NM. Calves were shipped in six truckloads with 119 to 120 calves per truckload. Cattle were housed in 48 soil-surfaced pens (12 × 35 m) with 14 to 15 calves per pen. All pens were equipped with automatic water fountains (CattleMaster 480; Ritchie Inc., Conrad, IA) and 11 m of feed bunk space. Calves were fed a receiving diet (Table 1) once daily at 0700 h, and feed

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Table 1. Composition of feedlot receiving diet

Item	DM basis
Ingredient, %	
Wet corn gluten feed[a]	60.0
Corn grain, cracked	17.0
Grass hay	15.0
Dried distillers grain	5.7
Limestone	2.0
Salt	0.20
Trace mineral premix[b]	0.04
Lasalocid feed additive[c]	+
Nutrient,[d]	
NE_m, Mcal/kg	2.16
NE_g, Mcal/kg	1.50
CP, %	19.9
ADF, %	12.7
K, %	1.42
Ca, %	1.11
P, %	0.80
Mg, %	0.39
S, %	0.35
Fe, mg/kg	156
Zn, mg/kg	88
Mn, mg/kg	42
Cu, mg/kg	12

[a]Sweet bran (Cargill Inc., Minneapolis, MN).

[b]Trace mineral premix (Beefmax 0510, Cargill Inc.).

[c]Bovatec 91 (Zoetis).

[d]Analyzed and calculated by SDK laboratories (Hutchinson, KS).

bunks were evaluated daily at 0630, 1230, and 1830 h for unconsumed feed. Feed delivery was adjusted throughout the study so that feed bunks contained trace amounts of feed to no feed at 0630 h each day.

Experimental Design and Treatments

The experiment was a randomized complete block design, with pens of cattle serving as the experimental unit. The experiment consisted of six blocks (each truckload) and four experimental treatments, with two replicated pens per treatment within each block. Therefore, there were 48 pens with a total of 12 pens per treatment. Within each block, calves were randomly allocated to one of eight pens, and pens were randomly assigned to one of four treatments.

Treatments were a control (**CON**) where calves did not receive an oral drench throughout the study, a water drench (**WATER**) where calves received 2 liters of drinking water, a low glycerin drench (**LOW-GLY**) where calves received 2 liters of a 200 g/L crude glycerin solution, and a high glycerin drench (**HIGH-GLY**) where calves received 2 liters of a 400 g/L crude glycerin solution. Calves received the oral drench treatments (WATER, LOW-GLY, and HIGH-GLY) at initial processing as well as when a calf in these groups showed signs of illness and warranted medical treatment. The crude glycerin (Westway Feed Products, Stratford, TX) contained 80% glycerol, and the LOW-GLY and HIGH-GLY treatments supplied calves with approximately 33% and 67% of their daily NEM requirements (NRC, 2000), respectively. Treatments were dispensed from a 1,200-liter horizontal leg tank (Norwesco Inc., St. Bonifacius, MN) attached with a transfer utility pump (1/12 HP, CountyLine, Delavan, WI) and a digital flow meter (Sotera Digital Display Meter; Fort Wayne, IN) to a hydration drench gun via 19-mm tubing.

Management and Collections

Upon arrival (day 0), calves were immediately processed (initial processing) before access to water or feed. All animals were individually weighed (Daniels Bud Box System; Model AH-10; Ainsworth, NE), measured for rectal temperature (GLA M700; GLA Agricultural Electronics, San Luis Obispo, CA), and affixed with an individual, unique identification tag before being randomly assigned to a pen. Pens of calves were randomly allocated to one of four treatments. Calves received an oral (fenbendazole; Safe-guard; Merck Animal Health, Millsboro, DE) and injectable (doramectin; Dectomax; Zoetis, Parsippany, NJ) anthelmintic, a growth implant (100 mg of progesterone and 10-mg estradiol benzoate; Synovex-C; Zoetis), and tildipirosin antibiotic (Zuprevo; Merck Animal Health) as metaphylaxis. Calves also received a viral and bacterial vaccine (Vista Once and Vision 7 with Spur; Merck Animal Health) upon arrival. Whole blood (4.0-mL K2 EDTA Blood Collection Tubes; Becton, Dickinson and Co., Franklin Lakes, NJ) was collected via jugular venipuncture from five randomly selected calves per pen on days 0, 7, 21, and 42. Whole blood was later analyzed for complete blood count (**CBC**) at West Texas A&M University Animal Health Laboratory using an automated hemocytometer (Idexx, ProCyte DX Hematology Analyzer, Westbrook, ME).

Once processed, calves were placed into their designated pens where they had ad libitum access to water and a feedlot receiving diet (Table 1). On days 21 and 42, all calves were individually weighed and had their rectal temperatures recorded. Calves also received booster vaccines (Vista 5 and Vision 7; Merck Animal Health) on day 21.

Throughout the study, animal health was evaluated daily by implementing a 4-point scale method based on depression, anorexia, respiration, and temperature ("**DART**") as described by Oosthuysen et al. (2015). Calves with signs of morbidity based on the DART system were removed from their pens and further assessed to determine whether medical treatment was warranted. Calves warranted medical treatment if they scored 2 or above using a severity score of 0 (no signs) to 3 (severe signs) for any of the DART criteria, had a rectal temperature ≥40.5 °C, or had a loss or no BW gain since their previously recorded BW.

All cattle were on a 5-d moratorium after metaphylaxis (day 0), as well as after a calf received antibiotic treatment for illness, before being eligible for a subsequent antibiotic treatment. For the first antibiotic treatment, calves received a combination antibiotic of florfenicol and flunixin meglumine (Resflor Gold; Merck Animal Health) in addition to the animal's assigned oral drench treatment (CON, WATER, LOW-GLY, or HIGH-GLY). If a second medical treatment was warranted, calves received ceftiofur crystalline free acid (Excede; Zoetis) in addition to the animal's assigned oral drench treatment. Animals were removed from the study if a third medical treatment was warranted.

Statistical Analysis

Data were analyzed as a randomized complete block design using MIXED models (SAS Institute Inc., Cary, NC) for performance and CBC as continuous variables, and the GLIMMIX (SAS Institute Inc.) procedure for morbidity and mortality as binomial response variables. The model for CBC included day as repeated measures and interactions with treatments. Pens of cattle served as the experimental unit. Differences were considered significant when $P \leq 0.05$ and a tendency when $P \leq 0.10$.

RESULTS AND DISCUSSION

Performance and Calf Health

Calf BW and DMI did not differ ($P \geq 0.25$) among treatments (Table 2). Drench treatments also

Table 2. Effects of crude glycerin in an oral drench on performance and health of newly received feedlot calves

Item	Treatments*				SEM	*P* value
	CON	WATER	LOW-GLY	HIGH-GLY		
BW, kg						
Day 0	180	180	180	180	1.10	0.98
Day 21	194	195	191	194	1.76	0.25
Day 42	216	216	213	215	2.48	0.65
ADG, kg/d						
Days 0 to 21	0.67	0.72	0.53	0.68	0.07	0.12
Days 22 to 42	1.08	0.97	1.03	1.01	0.07	0.76
Days 0 to 42	0.87	0.84	0.78	0.84	0.05	0.54
DMI, kg/d						
Days 0 to 21	3.30	3.37	3.25	3.24	0.10	0.65
Days 22 to 42	5.04	4.73	5.04	4.97	0.16	0.38
Days 0 to 42	4.17	4.04	4.13	4.09	0.12	0.83
G:F						
Days 0 to 21	0.203[a]	0.215[a]	0.163[b]	0.209[a]	0.020	0.10
Days 22 to 42	0.214	0.205	0.199	0.202	0.010	0.76
Days 0 to 42	0.210	0.209	0.187	0.206	0.009	0.15
Morbidity†, %						
1st Treatment	27.1	26.3	27.1	23.1	5.33	0.80
2nd Treatment	7.26	6.11	10.06	10.61	2.30	0.37
Mortality‡, %						
Days 0 to 42	1.90	2.29	3.51	1.90	2.06	0.62

*Treatments were a CON where calves did not receive an oral drench throughout the study, a WATER where calves received 2 liters of drinking water, a LOW-GLY where calves received 2 liters of a 200 g/L crude glycerin solution, and a HIGH-GLY where calves received 2 liters of a 400 g/L crude glycerin solution. Calves received the oral drench treatments (WATER, LOW-GLY, and HIGH-GLY) at initial processing as well as when a calf in these groups showed signs of illness and warranted medical treatment. There were 12 pens per treatment and 14 to 15 animals per pen.

†Percentage of calves receiving a first and second medical treatment during the 42-d study.

‡Percentage of calves that died during the 42-d study.

[a,b]Means within a row with different superscript letters differ ($P \leq 0.10$).

did not alter ($P \geq 0.15$) ADG and G:F of calves from days 0 to 42 and from days 22 to 42 (Table 2). From days 0 to 21, G:F tended to be lower ($P = 0.10$) for calves receiving LOW-GLY than CON, WATER, and HIGH-GLY, in part due to the numerically lower ADG of calves receiving LOW-GLY during the first 21 d. Lower G:F for calves receiving LOW-GLY compared with CON, WATER, and HIGH-GLY could be due to a decrease in ruminal degradation of dietary nutrients. Lopez et al. (2017) observed a decrease in ruminal DM degradation rate when crude glycerin (420 g/d) was supplemented via drinking water to endotoxin-challenged steers. These results are also consistent with Ciriaco et al. (2015), who observed a linear decrease in the in situ DM degradation rate of hay when steers were provided up to 1.1 kg/d of crude glycerin. The tendency for greater G:F among calves receiving HIGH-GLY vs. LOW-GLY may be attributed to an increase in energy supply that potentially offset the negative effects of glycerin on ruminal degradation. Linke (2005)

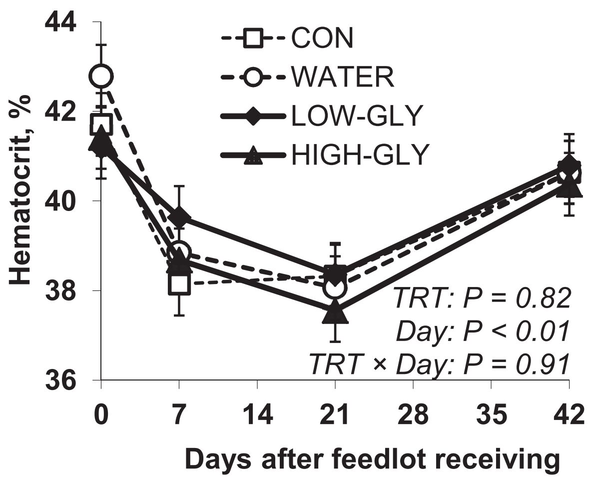

Figure 1. Blood hematocrit percentages of newly received feedlot heifers in response no oral drench (CON), a WATER (2 liters of drinking water), a LOW-GLY (2 liters of a 200 g/L crude glycerin solution), and a HIGH-GLY (2 liters of a 400 g/L crude glycerin solution) at initial processing and when medical treatment was warranted.

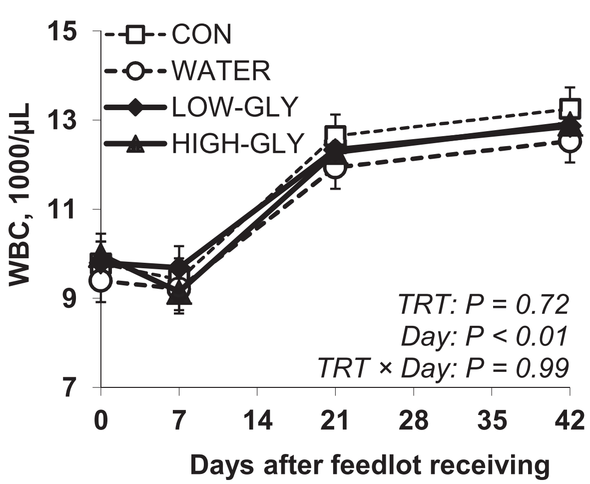

Figure 2. Total WBC count of newly received feedlot heifers in response no oral drench (CON), WATER (2 liters of drinking water), LOW-GLY (2 liters of a 200 g/L crude glycerin solution), and a HIGH-GLY (2 liters of a 400 g/L crude glycerin solution) at initial processing and when medical treatment was warranted.

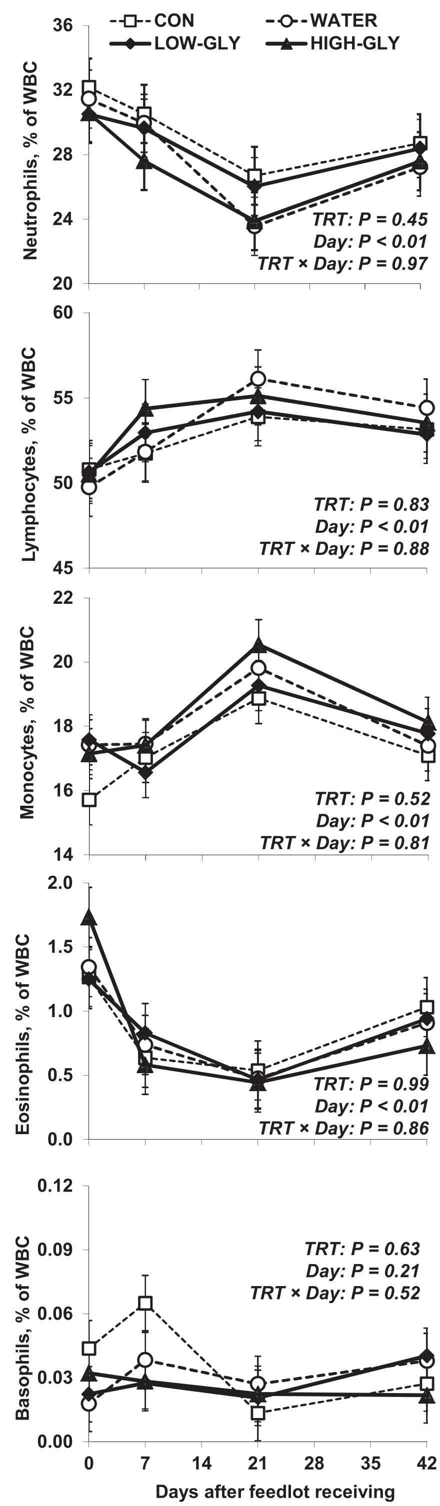

Figure 3. Differential percentages of neutrophils, lymphocytes, monocytes, eosinophils, and basophils of newly received feedlot heifers in response no oral drench (CON), a WATER (2 liters of drinking water), a LOW-GLY (2 liters of a 200 g/L crude glycerin solution), and a HIGH-GLY (2 liters of a 400 g/L crude glycerin solution) at initial processing and when medical treatment was warranted.

observed greater plasma glucose concentrations 3 h after dairy cows were drenched with a solution of 1-kg glycerol and 1-liter water compared with cows receiving no glycerol. Glycerin is mostly fermented to propionate in the rumen (Lee et al., 2011). Due to its glucogenic properties, we hypothesized that supplementing glycerin would improve calf health by improving energy status. However, calf morbidity and mortality (Table 2) were not different ($P \geq 0.37$) among treatments. This may have been due to the limited application of the experimental treatments (once at initial processing and if medical treatment was warranted) and (or) perhaps due to sample size limitations for binomial outcomes.

Calf Blood Parameters

No treatment × day ($P \geq 0.52$) and treatment ($P \geq 0.45$) effects occurred for hematocrit percentages and CBC. Hematocrit percentages (Fig. 1) were greatest on day 0 and decreased from days 0 to 21, then increased from days 21 to 42 ($P < 0.01$). Elevated hematocrit percentages on day 0 indicate that calves were dehydrated upon arrival at the feedlot; these percentages are greater than reference hematocrit percentages (23% to 33%; UC Davis Veterinary Medicine, 2011; Cornell University College of Veterinary Medicine, 2014) for hydrated cattle. A decrease in hematocrit percentages from days 0 to 7 is indicative of improved hydration status. Total white blood cell (**WBC**) counts (Fig. 2) were less on days 0 and 7 than days 21 and 42 ($P < 0.01$). As a percentage of total WBC, neutrophils and eosinophils (Fig. 3) decreased from days 0 to 21 and then increased from days 21 to 42 ($P < 0.01$). Lymphocyte and monocyte proportions of total WBC increased from days 0 to 21, then tended to decrease from days 21 to 42 ($P < 0.01$). Increased total WBC on days 21 and 42 could suggest an overall improvement in the immune status of calves, or less infection in calves at these later times.

Conclusions

These results indicate that supplementing crude glycerin as an oral drench to newly received feedlot calves at initial processing and upon diagnosis of illness does not affect calf performance, health, and CBC. Further research is warranted to evaluate effects of alternative crude glycerin application techniques, such as multiple crude glycerin drench applications and (or) supplementation of crude glycerin via drinking water, on feedlot receiving calf health.

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