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Increased Dietary Energy in Limit-fed Diets Does Not Affect Immune Function, Inflammation, or Stress, but Health Status Does

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Abstract

Objectives: Measure effects of limit-feeding high-energy diets on the immune system, stress, and inflammation as well as differences in these parameters between healthy and sick animals under the dietary conditions.

Study Description: Heifers from 4 dietary treatments were used to study the effects of limit-feeding and increased dietary energy on immune function, inflammation (indicated by elevated levels of haptoglobin), stress, and differences in these parameters between healthy and morbid animals consuming the different diets.

The Bottom Line: Limit-feeding high-energy diets does not negatively affect immune function, cause stress, or promote inflammation, and morbid animals have significantly higher haptoglobin levels.

Keywords

Stocker cattle, limit-feeding, health

Authors

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Increased Dietary Energy in Limit-fed Diets Does Not Affect Immune Function, Inflammation, or Stress, but Health Status Does

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Introduction

Inflammation, stress levels, and overall suppression of the immune system have been documented in cattle experiencing complications from ruminal acidosis. Subacute and acute ruminal acidosis are most often caused by excessive fermentation of readily fermentable carbohydrates, the most common being starch. Metabolic and pathological issues associated with acidosis have limited the inclusion of starch in receiving diet formulation thereby limiting dietary energy in most cases. The use of by-products in limit-fed diets have made it possible to increase energy beyond a typical receiving/growing ration providing better performance. The specific effects such a feeding strategy may have on the overall health of the animal have not been extensively studied, to our knowledge.

Experimental Procedures

A total of 354 crossbred heifers (body weight = 478 lb ± 9) were purchased at auction markets in Alabama and Tennessee, assembled at an order buyer's facility in Dickson, TN, then shipped 675 mi to the Kansas State University Beef Stocker Unit, Manhattan, KS, over a 10-day period from May 24 to June 3, 2016. The heifers were used in a randomized complete block design to analyze the effects of 4 energy levels and intakes of fibrous by-product-based diets on health and performance of stocker cattle in a 55-day receiving and growing study. Calves were blocked by load (4), stratified by individual arrival weight within load and assigned to pens containing 11 or 12 heifers. Pens within each block were randomly assigned to 1 of 4 treatments that equaled 8 pens/treatment for a total of 32 pens. Experimental diets were formulated to provide 45, 50, 55, or 60 Mcal net energy for gain/100 lb dry matter and were offered for ad libitum intake (45/100), 95 (50/95), 90 (55/90), or 85% (60/85) of ad libitum intakes (Table 1). All diets were formulated to contain 40% wet corn gluten feed (Sweet Bran; Cargill Animal Nutrition, Blair, NE) on a dry matter basis.

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Thirty-two animals from each dietary treatment (4 from each pen) were randomly selected after arrival (day -1) and bled via a tail vein to serve as a subset for analysis of antibody production toward vaccines and the acute phase protein haptoglobin. Blood was collected via a tail vein on days 0, 14, and 27 using venipuncture. Samples were shipped to the Kansas State University Veterinary Diagnostic Laboratory, Manhattan, KS, and analyzed for antibody titers for bovine viral diarrhea I and II and infectious bovine rhinotracheitis as well as haptoglobin. Animals removed from the pen according to the protocol for illness were also bled via a tail vein and the blood sample handled identically to the samples taken from the subset of cattle. In addition, a predetermined random order of animals from each pen was generated on day 0 that served as a means to select a healthy control animal from each pen to obtain a blood sample following the same protocol to use for pairwise comparisons. Animals that became morbid were permanently removed from the list of healthy candidates and therefore could never serve as a "healthy" animal for comparison. Two randomly selected animals from each pen (16/dietary treatment) were also used to determine fecal cortisol metabolite as a means of quantifying stress levels. Fecal grab samples were obtained from the rectum of each of the selected animals on days 0 and 14 of processing. Samples were labeled by individual animal identification number and immediately frozen at -20°C for analysis. All fecal samples were shipped to the K-State Veterinary Diagnostic Laboratory to determine fecal cortisol metabolite concentrations.

Results and Discussion

Serological results from the subset of cattle sampled from each treatment are in Table 2. There were no diet or diet × day interactions for titer level production toward viruses, haptoglobin, or fecal cortisol metabolite excretion ($P \geq 0.23$ and $P \geq 0.21$, respectively). Haptoglobin increased for all dietary treatments between days 0 and 14 and decreased from days 14 to 27 (quadratic, $P < 0.01$). Titer levels for the viruses increased linearly from days 0 to 27 ($P < 0.0001$) and fecal cortisol metabolite was higher on arrival than on day 14, most likely due to stress of procurement and transport ($P < 0.01$).

Dietary treatment or the interaction of dietary treatment and health status had no effect on any of the parameters measured. Haptoglobin was higher overall in morbid animals compared to healthy animals as a result of increased inflammation with morbidity (Figure 1; $P < 0.05$). Titer levels for bovine viral diarrhea I and infectious bovine rhinotracheitis were higher in healthy animals compared to morbid pen mates ($P < 0.05$). Bovine viral diarrhea II titers were not affected by health status ($P > 0.10$).

Implications

Increased dietary energy from wet corn gluten feed in limit-fed receiving diets does not increase stress, inflammation as measured by haptoglobin, or immune function measured by titer levels to significant industry viruses. However, morbid animals demonstrated increased haptoglobin and decreased titers compared to healthy pen mates, independent of dietary treatment.

Table 1. Experimental diets

	Diets[1]			
Ingredient, % dry matter	45/100	50/95	55/90	60/85
Alfalfa	22.50	17.00	12.00	6.50
Prairie hay	22.50	17.00	12.00	6.50
Dry rolled corn	8.57	19.08	28.50	38.82
Wet corn gluten feed[2]	40.00	40.00	40.00	40.00
Supplement[3]	6.43	6.92	7.50	8.18

[1]Treatment diets offered based on dry matter intake of 45/100 treatment intake that was offered for ad libitum intake. First number = Mcal net energy for gain/100 lb dry matter. Second number = % of 45/100 treatment offered on dry matter basis.
[2]Cargill Animal Nutrition, Blair, NE.
[3]Supplement pellet was formulated to contain (dry matter basis) 10% crude protein, 8.0% calcium, 0.24% phosphorus, 5.0% salt, 0.55% potassium, 0.25% magnesium, 1.67% fat, 8.03% acid detergent fiber, and as 367 mg/kg lasalocid (Bovatec; Zoetis, Parsippany, NJ).

Table 2. Effects of intake and energy level on haptoglobin and titer levels over time

	Diet[1]				Standard error of mean[2]	P-value[3]		
Item	45/100	50/95	55/90	60/85		Diet	Day	Diet × day
Number of pens	8	8	8	8				
Number of animals	29	32	29	29				
Haptoglobin, mg/dL[c]						0.26	<0.01	0.64
Day 0	15.2	13.3	25.8	13.8	6.8			
Day 14	35.8	19.3	32.5	27.2	9.5			
Day 27	22.1	19.8	21.5	19.6	5.9			
Infectious bovine rhinotracheitis, titer level[b,d]						0.62	<0.01	0.94
Day 0	0.3	1.0	0.5	0.3	0.6			
Day 14	11.6	16.6	8.2	10.7	5.1			
Day 27	15.7	19.1	17.3	14.4	5.9			
Bovine viral diarrhea I, titer level[b,c]								
Day 0	1.7	2.9	1.2	1.6	1.1	0.89	<0.01	0.99
Day 14	48.6	51.7	46.5	40.8	20.1			
Day 27	286.2	303.1	284.7	257.9	121.6			
Bovine viral diarrhea II, titer level[b]						0.92	<0.01	0.99
Day 0	3.0	2.8	1.9	2.4	2.8			
Day 14	20.6	18.4	12.5	24.4	15.0			
Day 27	55.7	75.4	45.3	68.4	44.5			

[1]Treatment diets offered based on dry matter intake of 45/100 treatment intake that was offered for ad libitum intake. First number = Mcal net energy for gain/100 lb dry matter. Second number = % of 45/100 treatment offered on dry matter basis.
[2]Largest value between treatments is reported.
[3]Fixed effects of dietary treatment, day, and dietary treatment × day interaction.
[a]Linear effect of day (P<0.01).
[b]Linear effect of day (P<0.0001).
[c]Quadratic effect of day (P<0.01). mg/DL = milligram/deciliter.
[d]Quadratic effect of day (P<0.0001).

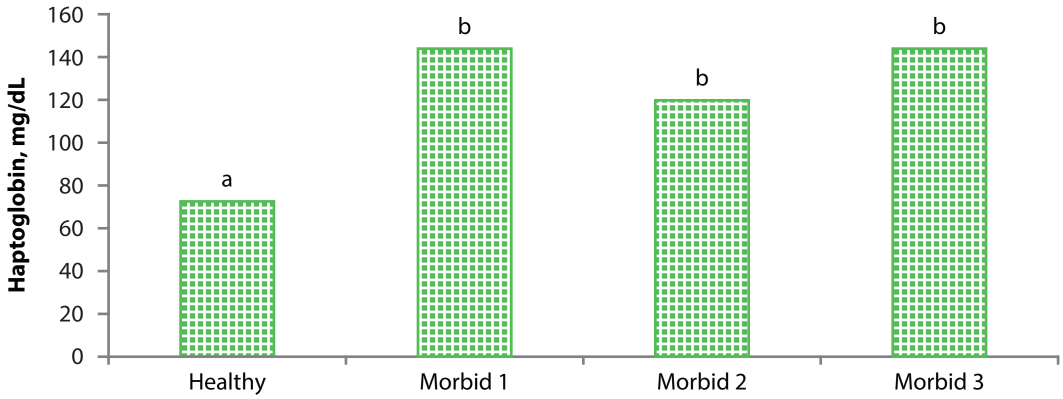

Figure 1. Effects of health status on haptoglobin concentrations.
Healthy = healthy pen mate pulled with sick animal for pairwise comparisons (standard error = 11). Morbid 1 = first pull for illness (standard error = 13). Morbid 2 = second pull for illness (standard error = 23). Morbid 3 = third pull for illness (standard error = 31).
[a,b]Unlike superscripts above bars in chart differ ($P<0.05$).