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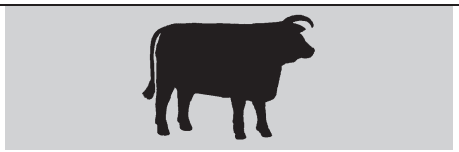

Effects of barley-based diets with 3 different rumen-degradable protein balances on performance and carcass characteristics of feedlot steers

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ABSTRACT

The objective of this experiment was to determine the effect of varying the dietary degradable protein balance (DPB) on finishing cattle performance. Crossbred yearling steers (n = 300; BW = 460 ± 26 kg) were allotted to 12 pens (25 steers/pen) and fed barley grain-based finishing diets with negative DPB (−12 g/kg of DM), neutral DPB (0 g/kg of DM), or positive DPB (14 g/kg of DM). The diet with negative DPB contained 88.3% barley grain and 4.7% barley silage. For the neutral and positive DPB diets, 11 and 22% of dietary barley grain, respectively, was replaced by wheat-based dried distillers grains with solubles. Increasing DPB in the diet increased the concentration of most nutrients linearly (P < 0.05), except for starch, which linearly (P < 0.05) decreased. With increasing DPB, the extent of rumen degradability decreased (P < 0.05) for OM (73.9 to 69.5%) and CP (74.3 to 68.6%), but not (P > 0.05) starch (88.3 ± 1.36%), whereas protein supply in the small intestine (78.8 to 91.2 g/kg of DM) increased (P < 0.05). Over the 131-d finishing period, DMI (11.6 ± 0.20 kg/d), ADG (1.8 ± 0.01 kg/d), G:F (0.16 ± 0.01), BW (677.8 ± 0.58 kg), HCW (397.5 ± 3.40 kg), DP (58.6 ± 0.47%), QG, and YG were similar (P > 0.05) among treatments. In conclusion, when diets were formulated to meet or exceed nutrient requirements for targeted performance, changing dietary DPB from −12 to 14 g/kg had no major effect on animal performance and carcass characteristics.

Key words: barley, finishing cattle, performance and carcass quality, rumen degradable protein balance, wheat-based dried distillers grains with solubles

INTRODUCTION

Barley (*Hordeum vulgare* L.) has traditionally been the mainstay of the western Canadian feedlot industry (Koenig and Beauchemin, 2005), with feedlot diets containing up to 90% barley grain (DM basis) (Beliveau and McKinnon, 2008). However, barley has an extremely high rumen degradation rate for both protein and starch, which can lead to acidosis and a shortage of ammonia-N for optimal microbial protein synthesis in the rumen (Yu et al., 2003; Damiran and Yu, 2012; Damiran et al., 2012). Calculating the rumen-degradable protein balance (**DPB**) based on 2 protein evaluation systems (Tamminga et al., 1994; NRC 2001; Yu et al., 2003) revealed that replacing barley grain with wheat-based distillers dried grains with solubles (**wDDGS**) increased the ratio between nitrogen and energy supply in the rumen, with an optimum wDDGS inclusion level

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of approximately 25% (Damiran et al., 2012). Due to expansion of the bioethanol industry in North America, inclusion of wDDGS in feedlot diets has become a viable alternative to barley grain (Nuez-Ortín and Yu, 2009; Damiran et al., 2012). We hypothesized that diets with different rumen-available protein-to-energy ratios would affect animal performance and carcass characteristics of finishing cattle. The objective of the current experiment was to determine the effects of diets with negative, neutral, or positive DPB, by substituting wDDGS for barley grain, on animal performance and carcass traits of finishing cattle.

MATERIALS AND METHODS

Feeding Animal Management

Three hundred crossbred yearling steers (460 ± 26 kg) were provided by Pound-Maker Agventures Ltd. (Lanigan, SK, Canada) and shipped to the University of Saskatchewan Beef Cattle Research Unit (Saskatoon, SK, Canada) for the current experiment. The animals were cared for according to guidelines of the Canadian Council on Animal Care (2009). At the beginning of the experiment, steers were vaccinated against clostridial diseases with Covexin 8 (Schering-Plough Animal Health, Kirkland, Quebec, Canada), *Pasteurella hemolytica* and *Histophilus somni* with Somnu-star Ph (Novartis, Mississauga, Ontario), and infectious bovine rhinotracheitis virus, bovine viral diarrhea virus (type 1 and 2), *Parainfluenza* type 3 virus, and bovine respiratory syncytial virus with Biostar, Starvac 4 Plus (Novartis), and implanted with a TBA-estradiol combination implant (Synovax Choice; Wyeth Animal Health, Guelph, Ontario, Canada). All steers were stratified from lightest to heaviest BW (unshrunk), and assigned randomly within strata to 1 of 12 pens (25 steers/pen); each pen was assigned randomly to 1 of the 3 treatments.

Finishing Diet Management

The ingredients of the diets that differ in DPB are presented in Table 1. All 3 diets were formulated to meet or exceed NRC requirements (NRC, 1996) for CP, energy, minerals, and fat-soluble vitamins. Dietary treatments included (1) negative DPB (**−DPB**; −12 g/kg of DM); (2) neutral DPB (**0 DPB**; 0 g/kg of DM); and (3) positive DPB (**+DPB**; 14 g/kg of DM) and were calculated according to Tamminga et al. (1994) and Yu et al. (2003; Table 1). The −DPB diet is commonly fed to beef finishing cattle in western Canada (Koenig and Beauchemin, 2005; Beliveau and McKinnon, 2008). To generate the 0 DPB and +DPB treatments, 13.0 and 25% of total barley grain in the −DPB diet was replaced by wDDGS. The barley grain was purchased from commercial sources. The wDDGS (parental wheat cultivar AC Andrew) was obtained from Terra Grains (Belle Plaine, SK, Canada). The barley silage (cultivar AC Rosser) was grown at the University of Saskatchewan and stored in a bunker silo. Supplement pellets (Table 1) were purchased from Federated Co-op Ltd. (Saskatoon, SK, Canada). Supplement pellet B was used for 0 DPB and +DPB diets and pellet A in the –DPB diet (Table 1). Supplement pellet A is a typical mineral and vitamin supplement used in conventional barley-based feedlot diets. Supplement pellet B was identical to supplement pellet A except urea was replaced with ground barley. Each diet was formulated to supply 33 mg/kg of DM monensin. The calcium-to-phosphorus ratio was maintained at 1.5:1 (NRC, 1996) by supplementing with limestone at 40 g/steer per day (15 g of calcium/steer) and 80 g/steer per day (30 g of calcium/steer) in TMR of the 0 DPB and +DPB diets, respectively.

The DPB represents the balance between potential microbial protein synthesis based on RDP and potential microbial protein synthesis based on energy extracted during anaerobic fermentation of OM in the rumen (Tamminga et al., 1994). The DPB in the rumen is critical to achieve efficient synthesis of the microbial protein, which ultimately contributes to the postruminal pool of true protein

Table 1. Ingredient composition of the experimental diets

Item (% of DM, unless otherwise noted)	Diet[1]		
	−DPB	0 DPB	+DPB
Barley silage	4.7	4.7	4.7
Barley	88.3	76.9	66.2
Supplement pellet A[2]	7.0		
Supplement pellet B[3]		7.0	7.0
wDDGS[4]		11.4	22.1
Limestone (g/steer per day)		40.0	80.0

[1]Diets were formulated to have negative (−DPB; −12 g/kg), neutral (0 DPB; ~0 g/kg), and positive (+DPB; 14 g/kg) degradable protein balances (DPB; g/kg of DM; Tamminga et al., 1994; Yu et al., 2003).

[2]Supplement pellet A was formulated to supply dietary DM of 20.0% CP; 2.30% crude fat; 4.30% ADF; 12.4% NDF; 1.7% ash; 50.8% TDN; 8.1% Ca; 0.24% P; 0.53% Mg; 0.31% K; 0.14% S; and 1.64% Na; and supplementary monensin, 420.0 mg/kg; Co, 4.8 mg/kg; Cu, 184.7 mg/kg; I, 16.6 mg/kg; Fe, 90.2 mg/kg; Mn, 500.8 mg/kg; Se, 1.4 mg/kg; Zn, 543.6 mg/kg; NE_m, 1.24 Mcal/kg; NE_g. 0.85 Mcal/kg; vitamin A, 30,000 IU/kg; and vitamin D_3, 5,000 IU/kg of supplement.

[3]Supplement Pellet B was formulated similar to supplement Pellet A except for the following specifications: 7.3% CP, 13.3% NDF, 1.32 Mcal/kg of NE_m and 0.90 Mcal/kg of NE_g.

[4]wDDGS = wheat-based dried distillers grains with solubles.