Co-product and Rumen Degradable Protein Supplementation of Beef Steers Fed Bahiagrass Forage

Jacqueline Wahrmund[1]
Matt Hersom

Growing beef cattle consuming bahiagrass hay require supplemental dietary crude protein to maintain performance and promote ADG. Supplements of dried distillers grains or soybeans hulls can may be useful supplements. Additional degradable protein may not be beneficial.

Summary

An experiment was conducted to evaluate the effects of feeding co-products with Optigen® II on animal performance and blood metabolites in growing beef calves. Angus steers were allowed ad libitum access to bahiagrass hay and were supplemented for 42 d via Calan gates. Treatments included 1) dried distillers grains; 2) dried distillers grains + Optigen; 3) soybean hulls; 4) soybean hulls + Optigen. Amounts of dried distillers grains and soybean hulls were formulated to be isonitrogenous. On d 42, there were no treatment differences for steer bodyweight (BW), average daily gain (ADG), or blood glucose concentrations. Across all days, steers offered only dried distillers grains had greater plasma urea nitrogen concentrations than steers offered soybean hulls. On d 14, 28, and 42, Optigen-supplemented steers had greater plasma urea nitrogen concentrations compared to those that were not. Beef cattle consuming bahiagrass hay require additional dietary crude protein to maintain performance and promote ADG. However, when sources of natural protein are fed, additional rumen degradable protein may not be necessary.

Introduction

Bahiagrass is the most common type of forage utilized in Florida (Chambliss and Sollenberger, 1991); however, cattle are not able to consume enough bahiagrass to meet their nutrient requirements at certain points of the production cycle. Therefore, supplementation programs must be developed to optimize beef cattle performance. Bahiagrass in Florida generally does not contain enough protein to meet growing cattle requirements. This makes growing calves particularly susceptible to protein deficiencies on low-quality forage-based diets, because they require high levels of protein to support tissue growth, are.

Dried distillers grains (DDG) are a co-product of the corn-derived ethanol fuel industry. As ethanol fuel production continues to increase in the United States, DDG will become more available to cattle producers for animal consumption. Dried distiller grains are high in crude protein (CP**)** but relatively low in rumen degradable protein (RDP; 31.6% CP, 27.9% RDP, as a % CP). Soybean hulls (SBH) are another co-product which are relatively low in total RDP (12.6% CP, 58% RDP, as a % CP). For growing cattle a small amount of additional RDP may optimize performance when added to co-product supplements. Optigen® II (Opt; Alltech, Inc., Nicholasville, KY) is a urea product which has slow-release properties that should result in N availability from urea that is better synchronized with the energy availability provided by forage or supplements. A trial was conducted to evaluate the use of DDG or SBH with or without additional RDP to background growing beef steers.

Materials and Methods

Animals and Diets

Fifty-six Angus steers were blocked by

bodyweight (BW; mean = 544 ± 57 lb) and randomly assigned to one of four treatments and one of seven pens. Treatments included: 1) DDG (2.62 lb of DM); 2) DDG+Opt (2.62 lb of DDG, 0.10 lb Optigen® II); 3) SBH (5.79 lb of DM); 4) SBH+Opt (5.79 lb of SBH, 0.10 lb Optigen® II). Basal supplements (DDG and SBH) were formulated to be isonitrogenous (0.80 lb CP); the addition of Optigen® II provided 0.10 lb of supplemental RDP. Steers were offered basal supplements daily beginning five d prior to the initiation of the experiment. Bahiagrass hay was offered in each pen, ad libitum, as large round bales. Fresh bales were offered each wk, and each bale was weighed and core-sampled for analysis of chemical composition. Steers were individually supplemented at approximately 0700 via a Calan gate system. Approximately 0.13 lb of a vitamin/mineral supplement was included in the daily supplements.

Sampling and Analysis

Steers were fed for 42 d, unshrunk BW were taken on two consecutive days at the initiation (d -1, 0) and termination of the trial (d 42, 43). Interim BW were obtained on d 14 and 28. The two-d mean of BW was utilized to determine initial and final BW and to determine ADG. Blood samples were collected for analysis of plasma urea nitrogen (PUN) and glucose concentrations. On each of the sampling dates, spot urine samples were obtained from steers and creatinine concentrations were determined. Creatinine concentrations were used to determine total daily urine output based on the principle that cattle excrete 883 µmol of creatinine •(kg $BW^{0.75}$)$^{-1}$•d^{-1} (Chen et al., 1992). Bodyweight measurements, blood, and urine samples were obtained approximately two h after supplements were offered.

Weekly hay samples were collected from each pen and composited for analysis of chemical composition. Hay and supplement total digestible nutrients (TDN) concentrations were determined using the equation (Fike et al., 2002):

%TDN = [(% IVDMD * 0.59) + 32.2] * organic matter concentration.

Because hay was fed as large round bales within each pen, mean daily hay dry matter intake (DMI) was calculated using the NRC (2000) equation:

$SBW = 13.91 * RE^{0.9116} * EQSBW^{-0.6837}$

where:

SBW = shrunk body weight

RE = retained energy

EQSBW = equivalent shrunk body weight,

assuming a 4% shrink, and that RE is equal to net energy for gain (NE_g).

Statistical analysis.

The experiment was designed as a completely randomized design, with supplement treatment as the fixed effect (Littell et al., 2006), steer within treatment as the random effect and individual steer was the experimental unit. Data were analyzed using the Mixed procedure of SAS v9.1. Means were calculated using least squares means, and means were separated using the P-diff option when the overall F-value was <0.10.

Results

Steer performance and intake.

At the initiation of the trial, steer BW averaged 521 lb (Table 1), with no differences (*P*=0.97) among treatments. No differences were observed in ADG during any two-wk sampling period (*P*>0.14). While the addition of Optigen® II had no effect on overall ADG (*P*=0.30), steers offered SBH gained approximately 0.15 lb/d more (*P*=0.05) compared to steers offered DDG.

The changes observed in steer BW from d 0 to 14 were approximately 2.4 times greater compared to the period between d 14 and 28. The dramatic decline in ADG between the first two collection periods was likely due to compensatory gain observed during the first 14 d. Two wk prior to the initiation of the trial, steers consumed a restricted diet consisting of only limited amounts of a grain-based feed with molasses. The purpose of this diet was to induce hunger to enhance the steers' willingness to learn to use the Calan gates. During the two wk training period, steer BW gain was minimal, with some steers losing BW. The ADG of all

steers was 0.20 lb/d during the three weeks prior to d 0. The ADG from d -22 to 14 (restriction through compensation) was nearly equal to the BW gains observed through the remainder of the trial (d 14 – 42) for each treatment, indicating that the steers likely compensated for the lack of BW gain during the period of feed restriction.

Forty-two day estimated mean daily hay DMI (Table 1) was calculated based on shrunk BW gain and net energy values of the feedstuffs. Based on the estimations, co-product type affected voluntary hay DMI (P<0.001), but not the addition of Optigen® II (P=0.62). Steers consuming DDG or DDG+Opt had 62% greater (P<0.05) estimated daily hay DMI compared to steers offered SBH or SBH+Opt. The differences in estimated mean hay DMI resulted in 18% greater (P<0.001) total DMI for steers consuming the DDG supplements compared to steers receiving SBH. The addition of Optigen® II had no effect (P=0.52) on total DMI.

The decreased DMI observed for steers consuming the SBH treatments may be a result of the greater amount of supplement offered compared to DDG treatments. Supplements were formulated to contain equal amounts of CP. Dried distillers grains have a greater concentration of CP compared to SBH, and as a result, steers in the SBH treatment were offered 3.17 lb/d more supplement compared to steers in the DDG treatment. However, the steers offered the DDG treatment consumed an estimated mean of 6.0 lb/d more hay; therefore, not all of the differences in hay intake between supplement types were the result of substitution effects. Supplements were formulated to contain equal concentrations of CP, and therefore, equal concentrations of N. However, the greater hay DMI observed in steers consuming DDG resulted in 40% greater (P<0.001) N intake for DDG-supplemented steers compared to SBH-supplemented steers (Table 1). Similarly, steers offered DDG+Opt consumed 35% greater (P<0.001) amounts of N/d compared to steers offered SBH+Opt.

Gain:feed (Table 1) was calculated using mean estimated daily hay DMI and amount of supplement offered. Co-product type affected (P<0.001) gain efficiency, while the addition of Optigen® II did not (P=0.34). Steers offered DDG-based supplements had a mean gain efficiency of 0.10, however, steers offered SBH-based supplements had mean gain efficiency of 0.13. Thus, steers consuming supplements containing SBH were approximately 25% more efficient at converting feed to BW compared to steers offered DDG based supplements. The differences in gain efficiency were mainly driven by the differences observed in hay DMI.

Physiological response

As a result of the five-d acclimation period prior to d 0, differences were observed in initial steer PUN concentrations (Table 2). Plasma urea nitrogen concentrations of steers consuming the SBH and SBH-based supplement treatments were 45% less (P<0.001) than steers consuming DDG-based supplement treatments on d 0. Optigen® II was first included in the supplements on d 0; therefore, resulting in greater (P=0.05) initial PUN concentration in steers offered Optigen. On d 14, the steers consuming DDG-based supplements continued to have greater (P<0.001) PUN concentrations compared to steers consuming SBH-based supplements. Additionally, the inclusion of Optigen® II increased steer PUN concentrations by 31% (P<0.001) when included in supplements containing DDG and by 84% in supplements containing SBH (P<0.001). On d 28, the inclusion of Optigen® II increased steer PUN concentrations by 28.2% in DDG supplements and by 38.0% in SBH supplements (P<0.001) compared to steers not offered Optigen® II. Steers consuming DDG+Opt maintained the greatest PUN concentrations, and steers offered only SBH had the lowest PUN concentrations. On d 42, steer PUN concentrations were greatest (P<0.001) in steers offered DDG+Opt, followed by the steers on the DDG and SBH+Opt treatments, which were not different (P>0.10), followed by SBH-supplemented steers.

The greater level of N intake observed in steers offered DDG likely contributed to greater PUN concentrations compared to SBH. Plasma urea nitrogen concentrations above 12 mg/dL are associated with adequate dietary CP, and

consequently, may indicate a potential for performance improvement through energy supplementation (Hammond et al., 1993). Therefore, steers offered the DDG+Opt treatment may have exhibited improved performance with additional dietary energy. Additionally, Hammond et al. (1993) stated that cattle with PUN concentrations below 9 mg/dL are most likely to respond to protein supplementation when maintained on a subtropical forage-based diet. The steers offered the SBH supplement were the only group of steers that consistently had PUN concentrations below 9 mg/dL, indicating that these steers may have benefited from additional protein supplementation.

Plasma glucose concentrations (Table 2) were not different (P=0.59) among supplement treatments or Optigen (P=0.92) on any of the four sampling dates. Mean glucose concentration during the experiment was 68.34 mg/dL. While there were differences (P=0.06) in estimated total TDN intake (Table 1), only about 1.32 lb/d separated the group of steers that consumed the greatest amount of TDN compared to those that consumed the least. These differences were likely not sufficient to elicit any changes in plasma glucose concentrations.

As a result of the acclimation period prior to d 0, treatment differences as a result of co-product supplementation (P<0.001) were observed in initial daily urinary N excretion (Table 2). The addition of Optigen® II had no effect (P=0.12) on initial urinary N excretion. However, steers consuming DDG and DDG+Opt excreted 56.2 g N/d more (P<0.001) compared to steers consuming SBH and SBH+Opt on d 0. On d 14, Optigen had no effect (P=0.80) on urinary N excretion, steers offered DDG excreted approximately 63% greater (P=0.05) amounts of urinary N compared to steers offered the SBH treatments. On d 28, co-product type and addition of Optigen affected urinary-N excretion (P=0.001 and 0.01, respectively). No treatment differences (P>0.38) were observed for urinary N excretion on d 42.

Similar to PUN concentrations, urinary-N excretion appears to have been related to calculated mean daily N intake. Throughout most of the experiment, urinary-N excretion was greater for steers consuming DDG supplements compared to steers consuming SBH. The addition of Optigen® II to the supplements of beef steers generally did not affect urinary-N excretion. This may suggest that despite the additional dietary N, Optigen® II did not increase urinary-N excretion, possibly resulting in greater N retention.

The SBH treatments were the most effective, as these steers exhibited the greatest feed efficiency. Supplemental RDP did not affect steer performance. While Optigen® II addition increased PUN concentrations to more desirable levels in SBH diets, it did not affect performance.

Literature Cited

Chambliss and Sollenberger. 1991. Pages 74-80 in Proc. 40th Florida Beef Cattle Short Course.

Chen et al. 1992. Anim. Prod. 55:185.

Fike et al. 2002. J. Dairy Sci. 85:866.

Hammond et al. 1993. In: Proc. XVII Int. Grassl. Congr. p 1989.

Littell et al. 2006. SAS System for Mixed Models. 2nd ed.

NRC. 2000. Nutrient requirements of beef cattle. 7th rev. ed.

[1] Jacqueline Wahrmund, Former Graduate Student, Matt Hersom, Assistant Professor, UF-IFAS, Department of Animal Sciences, Gainesville, FL.

Table 1. Effect of co-product source and Optigen® II supplementation on steer bodyweight (BW), BW gain and intake.

Item	Treatment[a]				SEM[b]	*P*-Value	
	DDG	DDG+Opt	SBH	SBH+Opt		Co-product	Optigen
Initial BW, lb	522	522	524	515	15.6	0.88	0.71
BW gain, lb/d							
d 0 – 14	2.80	3.00	2.91	3.19	0.22	0.46	0.29
d 14 – 28	0.99	1.01	1.54	1.34	0.31	0.14	0.78
d 28 – 42	1.74	1.67	1.45	1.81	0.24	0.77	0.54
d 0 - 42	1.85	1.89	1.96	2.07	0.09	0.05	0.30
Mean hay DMI, lb/d	15.5[d]	15.9[d]	9.5[e]	9.8[e]	0.64	<0.001	0.62
Total DMI, lb/d	18.1[d]	18.6[d]	15.4[e]	15.7[e]	0.64	<0.001	0.52
N Intake, g/d[c]	165.65[d]	188.05[e]	118.02[f]	139.37[g]	3.93	<0.001	<0.001
TDN Intake, lb/d[c]	11.6[de]	11.8[d]	10.5[f]	10.7[ef]	0.39	0.007	0.62
Gain:Feed, lb:lb	0.10[d]	0.10[d]	0.12[e]	0.13[e]	0.003	<0.001	0.34

[a] Least square means; Treatment: DDG, dried distillers grains; DDG+Opt, dried distillers grains plus Optigen® II, SBH, soybean hulls; SBH+Opt, soybean hulls plus Optigen® II.

[b] Standard error of the mean, n=56.

[c] Estimated total dietary intake (hay and supplement).

Table 2. Effect of co-product source and Optigen® II supplementation on steer plasma metabolite concentrations and daily urinary excretion.

Item	Treatment[a]				SEM[b]	*P*-Value	
	DDG	DDG+Opt	SBH	SBH+Opt		Co-product	Optigen
PUN[c], mg/dL							
d 0	10.17	11.49	4.06	5.67	0.72	<0.001	0.05
d 14	10.70	14.02	5.51	10.12	0.82	<0.001	<0.001
d 28	10.69	13.70	6.17	8.51	0.67	<0.001	<0.001
d 42	10.35	13.43	7.87	10.30	0.66	<0.001	<0.001
Mean glucose, mg/dL	70.59	67.20	65.87	69.70	2.16	0.59	0.92
Urinary N, g/d							
d 0	102.11	125.41	53.40	61.64	10.37	<0.001	0.12
d 14	162.11	144.62	77.74	110.33	33.70	0.05	0.80
d 28	130.67	180.40	92.93	118.32	15.20	0.001	0.01
d 42	113.01	110.05	112.77	141.78	22.32	0.38	0.47

[a] Least square means; Treatment: DDG, dried distillers grains; DDG+Opt, dried distillers grains plus Optigen® II, SBH, soybean hulls; SBH+Opt, soybean hulls plus Optigen® II.

[b] Standard error of the mean; n=56 for PUN and glucose, n=19, 23, 27, 22 for days 0, 14, 28, 42, respectively for urinary N.

[c] Plasma urea nitrogen.