

Evaluation of Sorghum Silage as an Alternative Forage in Growing and Finishing Diets on Steer Performance, Carcass Characteristics, and Nutrient Digestibility

A.S. Leaflet R3138

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Summary and Implications

Overall trial performance indicates that sorghum silage-fed steers consume less feed but maintain similar growth and carcass composition when compared to steers fed grass hay. Similar performance by steers despite additional post-extraction sorghum silage partially replacing cracked corn, the primary energy source in the diet, suggests the feeding value of sorghum silage is equivalent to or better than the average quality hay used in this study. Further research is needed to quantify the energy/feeding value of this post-ethanol extraction sorghum silage in growing and finishing feedlot diets.

Introduction

Roughage is required in ruminant diets because of its importance for proper health and function of the rumen. A high forage diet typical of those fed during the growing phase in the U.S. beef industry commonly consists of higher quality forages which provide significant amount of nutrients for growing cattle. However, cattle fed high concentrate finishing diets still have a requirement for a minimum amount of physically effective fiber in the diet to allow for proper rumen function. In recent years there has been increasing interest in the use of alternative agriculture commodities for the production of bio-fuels through various extraction processes. Post-processing residues may then hold value for use in animal production as by-product feeds. The objective of this study was to evaluate the use of post-ethanol extraction sorghum silage as an alternative forage in growing and finishing feedlot diets.

Materials and Methods

Seventy-two Angus-cross steers were purchased from a single source and transported to the Iowa State University research feedlot. Steers were fed a receiving diet for 7 d. Prior to the trial, forages were analyzed for nutrient composition. The nutrient profile of sorghum silage included: 8.7% CP, 57.6% NDF, 40.5% ADF, and 2.5% ether extract (EE). The hay used in this trial was predominately bromegrass with some red clover. The nutrient profile of the hay fed was: 13.3% CP, 63.3% NDF, 42.9% ADF, and 3.0% EE. At initiation of the trial, steers were implanted with Component TE-IS, individual weights

were taken on two consecutive days and steers were blocked by initial BW (396 ± 23.7 kg) into pens (6 steers/pen and 6 pens/treatment). Pens within block were randomly assigned to growing phase diets including 40% hay (DM basis) control diet (CON) or a 40% sorghum-silage (DM basis) diet (SS); fed for 56 d. A sub-sample of steers were selected to be housed in GrowSafe-equipped pens for the determination of apparent total tract digestibility. All steers were transitioned to finishing diets using three step-up diets from d 56 through d 76. At initiation of finishing steers received a Component TE-S implant and offered corn-based finishing diets for 56 days. During the finishing phase diets were balanced to offer 6% eNDF to the diet from each forage source, with forage displacing corn in the diets. Additional BW were collected on d 28, 55, 56, 76, 77, and 105. Final body weights were collected on consecutive days prior to harvest with carcass data collected after a 48 hr chill.

Sample Collection. Diet components and total mixed rations were sampled weekly to determine DM content. To determine diet total tract digestibility during the growing phase, titanium dioxide, an indigestible marker, was offered at approximately $10 \text{ g}^{-1} \cdot \text{steer}^{-1} \cdot \text{day}^{-1}$ for 14 d and fecal samples were collected on day 42 and 43. Total mixed ration samples were collected on d 0, 7, and 14 of the titanium dioxide feeding period. Diet and fecal samples were analyzed for DM, OM, NDF, ADF, CP, and EE.

Statistical Analysis. Live animal performance and carcass data were analyzed using the MIXED procedure of SAS (SAS Inst. Inc., Cary, NC) as a randomized complete block design with the fixed effects of treatment and block. Pen served as the experimental unit for BW, DMI, ADG, G:F, and carcass data analysis ($n = 6$ per treatment). For nutrient digestibility data determined using steers fed in GrowSafe equipped-bunks steer was the experimental unit ($n = 12$ per treatment). Data reported are LSMeans and SEM. Significance was declared at $P \leq 0.05$ and tendencies from $0.05 < P \leq 0.10$.

Results

Live steer performance and carcass characteristics. Steer performance results are presented in **Table 1**. During the growing period (d 0 to 56) there were no differences noted in DMI or ADG ($P \geq 0.19$); however, there was a difference in F:G ($P = 0.05$), with SS-fed steers having better feed conversion than CON-fed steers. During the finishing phase (d 77 to 133) SS-fed steers consumed less DM ($P = 0.008$)

than controls, but there were no differences observed in ADG, F:G, or final BW ($P \geq 0.15$). Overall performance for the duration of the trial (d 0 to 133), showed no differences for DMI, ADG, or F:G between diets ($P \geq 0.12$). Similarly, carcass characteristic data (**Table 2**) were not affected by treatment as no differences were noted in HCW, DP, BF, KPH, REA, YG, marbling score, and QG.

Growing period nutrient digestibility. Diet nutrient digestibility data are presented in **Table 3**. Digestibility of DM and starch were similar between diets ($P = 0.19$); however, sorghum silage-fed steers tended ($P = 0.09$) to have improved OM digestibility. Digestibility of NDF was increased in steers fed SS ($P = 0.02$) compared with CON-fed steers; however, ADF digestibility was decreased by approximately 14% in steers fed the SS diet ($P < 0.0001$) compared with controls. Calculated by the difference in NDF and ADF fractions of the diet, steers receiving the SS diet had approximately 18% greater digestibility of the hemicellulose fraction of fiber ($P < 0.0001$). Cellulose

digestibility was greater in SS-fed steers with approximately 7% ($P = 0.03$) advantage over CON-fed steers. Digestibility of CP was 3% greater for steers fed SS in comparison to CON-fed steers ($P = 0.001$). Ether extract digestibility follows a similar trend with SS-fed cattle having approximately 7% greater digestibility than CON-fed cattle ($P < 0.0001$).

Under the conditions of this study, overall steer performance and carcass characteristics were similar across dietary treatments. However, digestibility of NDF, hemicellulose, CP, EE and starch was improved in steers fed the SS diet. In conclusion, dependent on geographic location of processing facilities, this post-ethanol extraction sorghum silage provides opportunity to producers as an alternative forage source.

Acknowledgements

The authors wish to thank the farm staff at the Iowa State University Beef Nutrition Research Farm and members of the Hansen lab.

Table 1. Effect of post-extraction sorghum silage inclusion in feedlot diets on BW, average daily gain, and feed efficiency of yearling beef steers.

	CON ¹	SS ²	SEM	P – value
Pens (n)	6	6		
Live performance ³				
Growing period ⁵				
DMI, lbs/d	24.8	25.1	0.572	0.66
ADG, lbs/d	3.37	3.68	0.146	0.19
F:G	7.38	6.84	0.149	0.05
Finishing period ⁶				
DMI, lbs/d	33.7	30.8	0.476	0.008
ADG, lbs/d	4.64	4.38	0.111	0.15
F:G	7.27	7.08	0.155	0.42
Overall (d 0-133)				
DMI, lbs/d	29.0	27.8	0.462	0.12
ADG, lbs/d	4.01	3.92	0.084	0.48
F:G	7.30	7.16	0.067	0.19

¹ CON: Mixed grass hay was roughage source.

² SS: Sorghum silage was roughage source.

³ A 4% pencil shrink was applied to live body weights.

⁴ For analysis of initial BW block was not included in the model.

⁵ Growing period: d 0 to 56 of trial.

⁶ Finishing period: d 77 to 133 of trial.

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Table 2. Evaluation of sorghum silage as a replacement for medium quality hay on carcass characteristics of beef steers.

	CON ¹	SS ²	SEM	<i>P</i> - value
Pens (<i>n</i>)	6	6		
HCW, lbs	873	874	7.1	0.91
Dressing percent	62.1	62.6	0.261	0.23
12 th - rib fat, in	0.61	0.65	0.030	0.40
KPH ³ , %	2.62	2.65	0.060	0.71
REA ⁴ , in ²	13.6	13.6	0.233	1.0
Yield grade	3.51	3.62	0.060	0.25
Marbling score ⁵	479	480	13.63	0.97
Quality grade ⁶	3.50	3.33	0.218	0.61

¹ CON: Mixed grass hay was roughage source.

² SS: Sorghum silage was roughage source.

³KPH: Kidney, pelvic, heart fat.

⁴ REA: Ribeye area.

⁵ Marbling scores: slight: 300, small: 400, modest: 500.

⁶ Quality grade: 2: Select⁺, 3: Choice⁻, 4: Choice.

Table 3. Effect of post-extraction sorghum silage inclusion in growing diets on diet nutrient digestibility (d 28- 42) in beef feedlot steers.

	CON ¹	SS ²	SEM	<i>P</i> - value
Steers (<i>n</i>)	12	12		
Nutrient digestibility, %				
DM	76.7	78.1	0.73	0.19
OM	78.1	80.2	0.81	0.09
NDF	70.5	73.1	0.71	0.02
Hemicellulose	64.6	82.4	0.82	< 0.0001
ADF	74.1	60.0	0.78	< 0.0001
CP	74.0	77.2	0.60	0.001
Starch	93.2	94.2	1.01	0.26
Ether extract	84.0	91.1	0.71	< 0.0001

¹ CON: Mixed grass hay was roughage source.

² SS: Sorghum silage was roughage source.