The Effects of Shredded Sugar Beets on Sheep Nutrient Metabolism

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IMPACT STATEMENT

The current research suggests that whole shredded sugar beets can replace barley up to 45% without having any deleterious effects on fiber or nitrogen digestion. Utilizing sugar beets may potentially provide greater economic returns for sugar beet producers, as well as decreasing feed costs for livestock producers.

SUMMARY

Non-harvested sugar beets represent an underutilized yet cost effective feedstuff for livestock producers in Montana. The objective of this study is to evaluate the effects of shredded sugar beets fed at increasing levels on sheep nutrient metabolism. Eight wethers were used in a 4 × 4 replicated Latin Square and allocated to one of four dietary treatments where sugar beets replaced 0% (0SB), 15% (15SB), 30% (30SB), or 45% (45SB) of barley on a DM basis. The digestibility of DM, NDF, ADF, and nitrogen were not affected ($P \geq 0.10$) by treatment. There was quadratic tendency observed for ADF digestibility ($P = 0.10$), with 0SB and 45SB wethers being greater than 15SB and 30SB wethers. Nitrogen concentration in fecal matter and serum were not affected by treatment ($P \geq 0.22$).

INTRODUCTION

Montana is a major producer of sugar beets in the Northern Great Plains (5th in the U.S.; USDA, 2015a), and excess or non-harvested sugar beets could provide a readily available alternative feedstuff for cattle and sheep producers. In Montana, during the 2014-2015 sugar beet harvest, approximately 45.2 million pounds of sugar beets were not harvested (USDA, 2015b).

Sugar beets are an excellent energy source (81% TDN; Lardy and Schafer, 2008), which can be complimentary to, or even replace traditional feedstuffs, such as barley or corn. Sugar beets differ due to the much higher moisture content (70-80% moisture; Lardy and Schafer, 2008) and how they store energy in the form of sugar rather than starch (12-20% sugar; Agribusiness Handbook, 2009). Numerous studies have observed the effects of sucrose on nutrient metabolism and the rumen environment (Broderick & Smith, 2001; Vallimont et al., 2004). Some studies have observed an increase in NDF digestibility when sugar beets replaced a high starch feed source (Huhtanen, 1988; Arrizon et al., 2012). Because rumen anaerobic fungi are capable of fermenting sugars such as sucrose and glucose, the sugar from sugar beets may be able to create a favorable rumen environment resulting in enhanced NDF digestibility (Emanuele, 2004).

Therefore, the objective of this study is to evaluate the effects of shredded sugar beets fed at increasing levels on sheep nutrient metabolism. We previously conducted a study that suggests sugar beets can replace barley up to 45% in the diet on a DM basis when fed to backgrounding steers (McGregor et al., 2016) without deleterious effects on performance. Based on the previous data, we hypothesize that when sheep are fed increasing levels of sugar beets (0, 15, 30, and 45% of DM), there will be no deleterious effects on fiber or nitrogen digestibility.

Table 1. Ingredient and nutritional composition of diets fed to growing wethers (DM basis).

	Dietary Treatment[1]			
Item	0SB	15SB	30SB	45SB
Ingredient, %				
Sugar beets[2]	—	15.00	30.00	45.00
MSU barley	45.00	30.00	15.00	—
Grass hay	46.00	41.00	36.90	32.80
Soybean meal	5.50	10.40	14.80	19.00
NaCl	0.25	0.25	0.25	0.25
Decoquinate	1.35	1.35	1.35	1.35
Calcium carbonate	1.00	1.10	0.85	0.75
Mineral premix	0.90	0.90	0.90	0.90
Nutritional Composition[4]				
DM, %	28.33	24.97	22.59	20.72
TDN, %	66.80	65.80	64.80	63.60
CP, %	15.80	15.70	15.40	15.10
Ca:P	2.30	2.50	2.40	2.47

[1]Diets (DM basis) were formulated for growing wethers according to NRC (2016). Treatments: **0SB)** 0% sugar beets, **15SB)** 15% sugar beets, **30SB)** 30% sugar beets, & **45SB)** 45% sugar beets.

[2]Sugar beets were coarse ground with a flail chopper designed for woody biomass, to reduce choking hazard.

PROCEDURES

All procedures were approved by the animal care and use committee of Montana State University (#2016-AA09).

A 4 × 4 replicated Latin Square design was used to evaluate the effects of four diets varying in sugar beet concentration on the nutrient metabolism of wethers. Dietary treatments (Table 1) were; 1) 0% sugar beets (**0SB**), 2) 15% sugar beets (**15SB**), 3) 30% sugar beets (**30SB**), and 4) 45% sugar beets (**45SB**). Sugar beets directly replaced barley on a DM basis. All dietary treatments were formulated to meet or exceed the nutrient requirements of growing wethers (NRC, 2007). Each experimental period was 20 d in length with 4 d between periods (d 1 to 5; to remove wethers from metabolism crates). All wethers were kept in a single pen with ad libitum access to hay and water d 1 to 5. On d 5 wethers were assigned to a dietary treatment and placed in metabolism crates in a temperature controlled enclosed room for a 10-d adaptation period to metabolism crates and diets. These wethers were on a 12 h light, 12 h dark schedule. Each treatment was fed as a TMR at 3% of each wethers initial BW (as fed).

Total mixed ration (TMR) samples were collected d 15 through d 19 and ort samples were collected d 16 through d 20. Ort and TMR samples were dried in a 60°C forced air drying oven for 48-h for DM analysis. Total fecal output was collected and weighed on d 16 through d 20 with 7.5% of the total fecal sample collected, weighed, and placed in a 60°C forced air drying oven for 96-h for DM analysis. On d 16 through d 20, total urine output was collected. Sufficient 6 *N* HCl (100 mL) was added daily to urinals to maintain urine pH < 3. A 25% subsample of the total urine weight was collected and composited by individual lamb.

Blood samples were collected on d 15 through d 19, 4 hours post-prandially via jugular venipuncture into 16 × 100 mm blood collection tubes (no. 367988; BD Vacutainer, Franklin Lakes, NJ) and refrigerated (4°C) for 2.5 h.

Data were analyzed as a replicated Latin Square, with lamb serving as the experimental unit. Nutrient metabolism data were analyzed using the MIXED procedure of SAS (SAS 9.4; SAS Inst. Inc., Cary, NC).

RESULTS AND DISCUSSION

The nutrient metabolism results are presented in Table 2. Initial body weights, by design, did not differ (P = 1.00) between treatments. Daily DMI was not affected by treatment ($P \geq 0.30$). The intake of NDF was affected quadratically by treatment (P = 0.04), with the greatest being 0SB and the least being 15SB wethers. The intake of ADF demonstrated a quadratic tendency (P = 0.09), with the greatest being for 45SB and the least being 15SB. These results contrast with Huhtanen (1988), where both NDF intake and ADF intake were greater when sugar beet pulp replaced barley in a silage based diet for cattle. There was a cubic effect for daily nitrogen intake (P = 0.02) where nitrogen intake was greatest in the 30SB wethers and 15SB had the least nitrogen intake.

Dry matter digestibility was not affected by treatment ($P \geq 0.25$). Results from the current study agree with Vallimont et al. (2004) that reported no effects on DM digestibility when corn starch was replaced with sucrose in vitro. In contrast, Huhtanen (1988) demonstrated a decrease in DM digestibility when sugar beet pulp replaced barley in a silage based diet.

Table 2. Nutrient metabolism characteristics of growing wethers fed increasing concentrations of sugar beets in the diet.

	Dietary Treatment[1]					Orthogonal Contrasts[3]		
Item	0SB	15SB	30SB	45SB	SEM[2]	Linear	Quadratic	Cubic
Initial BW, lb	80.80	80.80	80.80	80.80	0.00	1.00	1.00	1.00
Daily DMI, g/lb BW	13.21	11.80	12.71	13.80	2.51	0.61	0.30	0.68
Daily NDF intake, g/lb BW	5.66	4.34	4.76	5.05	0.85	0.41	0.04	0.27
Daily ADF intake, g/lb BW	3.54	2.70	3.12	3.23	0.60	0.68	0.09	0.20
Daily nitrogen intake, g/lb BW	0.31	0.29	0.41	0.34	0.07	0.10	0.33	0.02
Total tract digestibility, %								
DM	70.34	67.23	71.29	71.4	0.20	0.44	0.44	0.25
NDF	57.07	50.70	52.71	53.41	35.02	0.57	0.33	0.54
ADF	51.64	40.41	48.64	50.58	39.11	0.77	0.10	0.14
Nitrogen	74.83	72.66	74.95	72.22	1.88	0.37	0.85	0.19
Daily nitrogen excretion, g/lb BW								
Fecal	2.98	2.79	2.89	3.41	0.32	0.36	0.29	0.92
Urine	5.55	5.58	5.46	6.54	0.46	0.18	0.27	0.51
Serum urea nitrogen, mg/dL	5.65	5.03	4.39	4.87	0.53	0.22	0.31	0.63
Nitrogen balance, g/lb	0.07	0.06	0.13	0.06	0.05	0.63	0.24	0.04

[1]Dietary treatments were: 0SB: control diet with no added sugar beets; 15SB: 15% sugar beets substituted for barley; 30SB: 30% sugar beets substituted for barley; and 45SB: 45% sugar beets substituted for barley on a DM basis.
[2]Greatest SEM presented (n = 8).
[3]*P*-value for linear, quadratic, and cubic effects of increasing sugar beet concentration in the diet.

There was no treatment effect on NDF digestibility ($P \geq 0.33$), however there was a quadratic tendency for ADF digestibility ($P = 0.10$) with the lowest value for 15SB (40.41%) and the highest value for 0SB (51.64%). Our results differ from those observed by Arrizon et al. (2012) that reported increased NDF digestibility when dried shredded sugar beets replaced steam flaked corn. The results of the current study also differ from results observed by Huhtanen (1988) who observed an increase in NDF and ADF digestibility when sugar beet pulp replaced barley in a silage based diet.

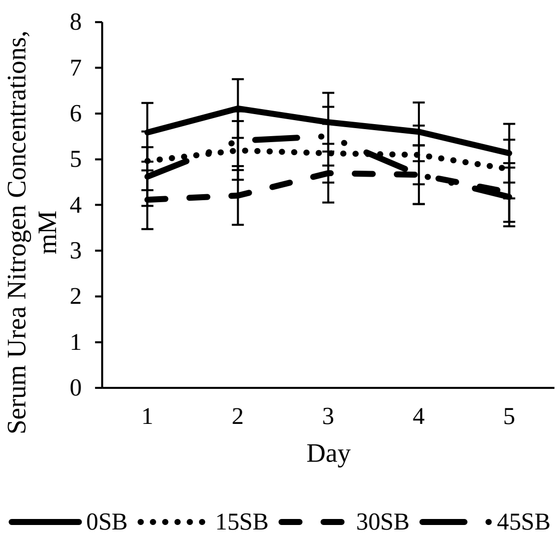

Figure 1. Effects of increasing sugar beet concentrations on serum urea nitrogen concentrations. Treatment x day: $P = 0.95$; Day: $P = 0.11$; and treatment: $P = 0.42$.

Nitrogen digestibility, fecal nitrogen excretion, and SUN were not affected by treatment ($P \geq 0.19$). There was no treatment × day interaction ($P = 0.95$; Figure 1) for SUN concentrations. These results agree with the results from Vallimont et al., (2004) where replacing corn starch with sucrose in vitro also had no effect on nitrogen digestibility.

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