INTAKE AND DIGESTIBILITY RESPONSE TO FORAGE KOCHIA (*KOCHIA PROSTRATA*) IN A LOW QUALITY FORAGE DIET[1]

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ABSTRACT: Forage kochia (*Kochia prostrata*), a half-shrub native to arid regions of central Eurasia, has potential to be a source of forage for the beef industry in the western U.S., but little is known about its nutritional value. Our objective was to evaluate intake and digestibility using different dietary ratios of forage kochia and tall wheatgrass (*Elytrigia elongata*). Four ruminally fistulated beef steers (mean initial BW = 348 kg) were allocated to four treatments in a 4 × 4 Latin square design. Treatments were: 100% wheatgrass (**0K**); 75% wheatgrass:25% kochia (**25K**); 50% wheatgrass:50% kochia (**50K**); and 25% wheatgrass:75% kochia diet (**75K**). Steers were fed twice daily at 110% of mean intake over the previous 5 d. Steers were allowed an 11 to 13 d adaptation period. Feed intake and fecal output were measured and sampled during the following 7 d. Immediately following that period, duplicate in-situ bags of wheatgrass or kochia were incubated in the rumen for 0, 2, 6, 12, 18, 24, 48, and 96 h. Data were analyzed in a Latin square-design in the MIXED procedure of SAS. Intake increased linearly ($P = 0.019$) as the amount of kochia increased in the diet. In vivo DM digestibility differed among treatments ($P = 0.014$), and tended ($P = 0.107$) to display a quadratic response, with maximum DM digestibility at 25K. In vivo NDF digestibility decreased linearly ($P = 0.012$) as the amount of kochia increased in the diet. In situ rate of DM and NDF digestion of wheatgrass samples increased ($P < 0.02$) as the amount of kochia increased in the diet. The in situ rate of DM digestion of kochia samples also increased ($P = 0.005$) as the amount of kochia increased in the diet. The in situ rate of NDF digestion for kochia samples tended to increase ($P = 0.056$) as the amount of kochia increased in the diet. Although fiber digestibility decreased as kochia was added to the diet, the steers were able to increase feed intake because of an increase in the rate of digestion of DM and NDF. Incorporating forage kochia into a low-quality grass diet improved nutrient utilization.

Key words: Beef cattle, forage utilization, forage kochia

Introduction

Forage kochia (*Kochia prostrata*) is a semi-evergreen half shrub that grows to a height of 0.3 to 0.9 m. It is native to the arid and semiarid regions of Central Eurasia (Keller and Bleak, 1974) and has adapted well to a variety of environmental conditions in the western United States. It is drought tolerant and capable of growing in areas receiving 12 to 50 cm of annual precipitation (ZoBell et al., 2003).

Potential uses of forage kochia include forage for livestock and wildlife (Gade and Provenza, 1986), food and cover for upland game birds (Stevens et al. 1985), ground cover on disturbed sites, greenstrips that reduce wildfire size and/or spread (Clements et al. 1997), and competition against the invasive annual weeds cheatgrass (*Bromus tectorum*), Russian thistle (*Salsola tragus*), medusahead (*Taeniatherum caput-medusae)*, and halogeton (*Halogeton glomeratus*).

Fall and winter grazing studies have been conducted on forage kochia (ZoBell et al., 2003; Koch and Asay, 2002) but nutritional value and the optimum amount of kochia in the diet that will be most beneficial to an animal has not been evaluated.

The objective of this study was to evaluate intake and digestibility responses by beef cattle to different dietary ratios of forage kochia and tall wheatgrass (*Elytrigia elongata*) straw.

Materials and Methods

Four ruminally fistulated beef steers (mean initial BW = 348 kg) were allocated to one of four treatments in a 4 × 4 Latin square design. The 4 treatments consisted of varying mixtures of tall wheatgrass straw and kochia mixed to provide diets of: 100% wheatgrass (0K); 75% wheatgrass:25% kochia (25K); 50% wheatgrass:50% kochia (50K); and 25% wheatgrass:75% kochia diet (75K) on an as-fed basis. The forage kochia was from an irrigated, pure stand with the intent of the seed being harvested but was instead harvested as hay at full maturity with the seed-heads attached for the purpose of this study. The tall wheatgrass straw was harvested in late fall from an irrigated, pure stand after seed had been harvested. Both forages were intended to mimic stockpiled forage used for winter grazing. The tall wheatgrass and kochia were chopped to an average length of 3 cm. Treatment diets were fed as mixed rations.

Steers were housed in individual metabolism crates (2.4 x 1.1 m) located inside a shed that was enclosed on three sides and was open facing the south. Steers were allowed free access to water and a trace-mineralized salt block (Table 1). Steers were fed twice daily at 0700 and 1900. Orts were collected and weighed daily before the morning feeding. Steers were then offered 110% of mean intake over the previous 5 d. The experimental protocol was approved by the Institutional Animal Care and Use Committee at Utah State University.

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Experimental periods were 24 to 26 d, with 11 to 13 d of adaptation. Period 1 consisted of a 13-d period to allow steers to adjust to their respective treatments. Period 2 adaptation was reduced to 12 d and periods 3 and 4 were reduced to 11 d because of a limited supply of forage kochia. The following 7-d period was used to measure feed intake and fecal output. Individual feed, mixed diet, and orts samples were collected during this period. Total feces voided were collected in tubs and weighed twice daily at 0700 and 1900. A representative 2% subsample (wet weight) was obtained each time feces were weighed. The subsample was immediately weighed and dried at 60ºC in a forced-air oven until no more weight loss.

Feed, diet and ort samples were dried at 60ºC to obtain partial DM. Feed, diet, orts and fecal samples were then ground in a Wiley mill to pass a 1-mm screen. Feed, diet, orts and fecal samples were composited within steer and period.

Samples of wheatgrass and kochia that were representative of the feed used during each period were ground in a Wiley mill to pass a 2-mm screen for in situ procedures. Duplicate 5 g samples of each were weighed into 10 × 20 cm nylon bags (Ankom, Fairport, NY) with a 50 ± 15μm pore size, and heat-sealed using an impulse sealer (model MP-8; Midwest Pacific from Ankom, Fairport, NY) for each time point and each animal. Samples for each time point were placed in 36 × 42 cm polyester mesh bags to ensure similar location within the rumen and to assist in retrieval. Bags were placed in reverse order to allow 0 (never placed in the rumen), 2, 6, 12, 18, 24, 48, and 96 h of fermentation. Bags for 96 h were placed into the rumen of each animal on the day of the last fecal collections. All bags were removed simultaneously at 0 h and placed immediately into an ice-water bath to stop microbial activity. Bags were then immediately rinsed in a Kenmore heavy-duty, top-loading washing machine (Sears, Roebuck, and Co., Chicago, IL) for 10 cold-water rinse cycles. Each rinse cycle consisted of a one-minute agitation and a two-minute spin per rinse. The 0-h time bags were treated identically to the rest of the samples except for not being placed in the rumen. After rinsing, the bags were dried at 105º C for 48 h and then weighed to determine rate of DM digestion.

Laboratory Analysis. All samples were dried overnight at 105ºC to determine DM (AOAC, 1996). Feed and diet samples were analyzed for ADF content and feed, diet, and fecal samples were analyzed for NDF content using procedures modified for use in an Ankom 200 Fiber Analyzer (Ankom Technology, Fairport, NY). In situ residues were also analyzed for NDF content. Feed and diet samples were analyzed for N content with the combustion method (AOAC, 1996) using a N analyzer (Leco, St. Joseph, MI) and nitrogen was multiplied by 6.25 to determine CP.

Statistical analyses. The nonlinear regression procedure of SAS (PROC NLIN, SAS Institute, Cary, NC) was used with the in situ residue data to calculate ruminal rate of disappearance of DM and NDF. DM intake and extent and rate of digestion of DM and NDF were analyzed using the MIXED procedure of SAS in a Latin square-repeated measure design. The model included period, treatment, and steer. Steer was designated a random effect and treatment was designated a repeated measure. Linear and quadratic polynomial contrasts were constructed to evaluate the influence of increasing levels of forage kochia in the diet.

Results and Discussion

Chemical composition of wheatgrass and kochia are reported in Table 2. The low CP and high fiber of the wheatgrass typified a low-quality, dormant forage available for winter grazing. The CP level of kochia reported in this study was similar to levels that have been reported for fall and winter grazing by ZoBell et al. (2003) and Koch and Asay (2002), but slightly higher than that reported for the same period by Schauer et al. (2004). However, fiber values were lower than that reported by ZoBell et al. (2003) and Koch and Asay (2002). Differences could be due to different maturities at time of harvest or growing conditions that contributed to differences in plant stature and structural components.

Dry matter intake expressed on a percentage of BW basis increased linearly as the amount of kochia increased in the diet (Table 3).

In vivo DM digestibility tended to display a quadratic response (Table 3). Maximum DM digestibility occurred at 25K. In vivo NDF digestibility decreased linearly as the amount of kochia increased in the diet.

The in situ rate of DM and NDF digestion of wheatgrass increased linearly as the amount of kochia increased in the diet (Table 4). The rate of DM digestion of kochia increased linearly and the rate of NDF digestion for kochia samples tended to increase as the amount of kochia increased in the diet. The incremental increases in kochia caused increased rate and extent of digestion of the wheatgrass, indicating that kochia caused a positive associative effect to occur.

Forage intake is often positively related to rate and extent of digestion in the rumen (Forbes, 1996). The rate of digestion increased as kochia was added to the diets with a concomitant rise in intake. The rise in intake is further evidence of a positive associative effect resulting from addition of kochia to the diet.

Forage kochia has been considered a potential source of forage that has the ability to increase CP supplied to livestock in the winter grazing period (Welch and Davis, 1984; ZoBell et al., 2003). Besides that, forage kochia also increased digestibility of low quality forage in this study. Incorporation of forage kochia in grass stands intended for winter grazing has the potential to improve livestock performance and decrease supplementation costs. ZoBell et al. (2003) showed that cattle grazing a mixed stand of forage kochia and crested wheatgrass (*Agropyron desertorum*) during winter were able to select a diet that was higher in nutritional value than the average of available forage. In a grazing situation in which forage kochia is available, livestock will have the opportunity to choose the best ratio of forage kochia to other available forage. Alternatively, livestock producers with pure grass stands can use these results to determine the amount of forage kochia that should be interseeded for an optimum combination.

Implications

Although extent of fiber digestion decreased as kochia was added to the diet, the steers were able to increase feed intake because of an increase in the rate of digestion of DM and NDF. Incorporating forage kochia into a low-quality grass diet improved nutrient utilization. Based on the results reported herein, forage kochia should be interseeded into existing grass stands to achieve a 25 to 50% proportion of the available DM as kochia to optimize the combination of rate and extent of diet digestion and intake.

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Table 1. Composition of trace-mineralized salt block [a]

Item	Concentration
Salt (NaCl) minimum	95.5 %
Salt (NaCl) maximum	98.5 %
Zinc (Zn) minimum	3,500 ppm
Iron (Fe) minimum	2,000 ppm
Manganese (Mn) minimum	1,800 ppm
Copper (Cu) minimum	280 ppm
Copper (Cu) maximum	420 ppm
Iodine (I) minimum	100 ppm
Cobalt (Co) minimum	60 ppm

[a] Ingredients: salt, zinc oxide, ferrous carbonate, manganous oxide, magnesium oxide, copper oxide, calcium iodate, cobalt carbonate, red iron oxide for color.

Table 2. Chemical composition of tall wheatgrass and forage kochia used in diets

Item	Wheatgrass	Kochia
DM, %	94.1	93.6
	------ % of DM ------	
CP	3.6	9.6
NDF	77.7	53.8
ADF	50.6	32.2

Table 3. Least squares mean responses for intake and extent of digestion to dietary level of forage kochia

	Kochia, % as fed					Contrasts	
Item	0	25	50	75	SE	Linear	Quadratic
DM intake, %BW	0.975	1.666	1.881	2.324	0.098	0.02	0.28
DM Digestibility, %	51.29	53.67	50.73	52.17	0.355	0.78	0.11
NDF Digestibility, %	55.0	55.7	49.6	46.8	1.25	0.01	0.24

Table 4. Least squares mean responses for in situ rate of digestion of DM and NDF of tall wheatgrass and forage kochia

	Kochia, % as fed					Contrasts	
Item	0	25	50	75	SE	Linear	Quadratic
Tall wheatgrass							
DM rate, % h^{-1}	1.11	2.55	1.87	2.52	0.225	0.02	0.15
NDF rate, % h^{-1}	1.07	2.56	2.11	2.92	0.208	0.002	0.18
Forage kochia							
DM rate, % h^{-1}	8.1	10.3	14.1	17.5	2.37	0.005	0.73
NDF rate, % h^{-1}	4.5	7.4	11.9	19.3	1.77	0.06	0.27