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DIGESTIBILITY OF CHEMICALLY CURED RANGE FORAGE

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The digestibility of most range forages found throughout the intermountain west decreases quite rapidly with advancing maturity. Consequently, the performance of range cattle during late summer and fall is markedly reduced. Sneva (1964, 1966) has proposed a method of providing higher quality late season forage which entails growth arrestation of plants while they are high in nutritive value, through the application of paraquat 3/, a bipyridylium herbicide. This method of chemical curing has demonstrated a remarkable potential for retention of chemical composition of range forages. The purpose of the work reported in this paper was to compare the digestibility of range forages cured by chemical and natural means.

EXPERIMENTAL PROCEDURE

The digestibility of bluebunch wheatgrass (Agropyron spicatum) and cheatgrass (Bromus tectorum) cured naturally and chemically was studied in the artificial rumen. Digestibility determinations were conducted by in vivo and in vitro methods on crested wheatgrass (Agropyron desertorum) cured by natural and chemical means.

In Vitro Trials. Cheatgrass treated with 0 and 0.47 kg. paraquat per hectare on May 31 was sampled on June 1, June 11, and July 5. Duplicate in vitro cellulose digestibility determinations were conducted on all treatments from each of 4 replications. Bluebunch wheatgrass treated with 0 and 0.9 kg. paraquat per hectare on June 23 was sampled on June 23, July 26, August 26, and October 30. Duplicate in vitro cellulose digestibility determinations were conducted on all treatments from each of 2 replications. Crested wheatgrass treated with 0 and 0.9 kg. paraquat per hectare on June 2 was sampled on June 2 and July 1. Duplicate in vitro cellulose digestibility determinations were conducted on all treatments from each of 2 replications.

The respective level of paraquat used for each forage species was emulsified in water with a cationic surfactant and foliar applied to the grasses at total volumes of 93 to 375 liters per hectare.

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2/ Jointly operated by Oregon Agricultural Experiment Station and Crops Research Division ARS, USDA.
3/ Paraquat has not been cleared for use as described in this paper.

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A simplified *in vitro* procedure was used in which the innocula (strained rumen juice) were obtained from a rumen fistulated steer maintained on a ration of native meadow hay. Other details of the procedure were described by Wallace *et al.* (1965). Cellulose digestibility was determined after 24 hours fermentation on bluebunch wheatgrass samples and after 48 hours fermentation on cheatgrass and crested wheatgrass samples.

In Vivo Trials. Two *in vivo* trials were conducted with sheep to compare crested wheatgrass cured by natural and chemical means. For the first trial samples were taken from the same plots as those described under *in vitro* procedures for crested wheatgrass. For the second trial, two paraquat applications were made (June 10 and June 30) on separate plot areas. Untreated forage was sampled June 10, June 30, and August 20 while treated forage was sampled on June 30 from plots treated at the first application date and August 20 from plots treated at both application dates. Application rates were the same for each trial (0 and 0.9 kilograms per hectare). Aliquot samples were taken from forage harvested at the last date for each trial and hand separated to determine percentage of old and new growth forage present.

The samples were coarsely chopped (approximately 3 cm. lengths) prior to each digestion trial. Randomized block designs were used for both trials in which all experimental diets were fed to four Columbia wethers. The sheep were caged in digestion crates with open mesh floors to allow for total collection of excreta. During each trial the sheep were fed at about 115% of maintenance with the daily ration being fed in equal parts four times daily. Five-day preliminary and five-day collection periods were used in both trials. Digestibility values were determined for nitrogen, dry matter, and cellulose in both trials and, in addition, energy digestibility was determined in the second trial. Cellulose analyses were conducted according to Crampton and Maynard (1938) and gross energy was determined in an oxygen bomb calorimeter. The kjeldahl procedure was used for nitrogen determinations.

RESULTS AND DISCUSSION

A summary of *in vitro* cellulose digestibility comparions between naturally cured and chemically cured cheatgrass, bluebunch wheatgrass, and crested wheatgrass is presented in Table 1. From the first to the last sampling date there was a reduction in precent cellulose digestion of untreated forage from cheatgrass, bluebunch wheatgrass, and crested wheatgrass of 25.9, 3.4, and 9.8, respectively, compared to reductions of 18.4, 0.2, and 4.9 for araquat-treated forage of these same species. The smaller reduction in bluebunch wheatgrass was due to the later application of paraquat (Table 1). *In vitro* cellulose digestibility in chemically cured forage was higher ($P < .05$) than that cured naturally with all three species when sampled approximately one month after chemical application. However, when bluebunch wheatgrass was sampled at 2 months and again at 4 months following chemical application the digestibility differences between control and treated forage was not significant. A possible explanation for lack of significance here was that the unusual amount of late summer rain may have stimulated enough regrowth in both control and treated forage to mask existing differences.

Results of the first *in vivo* digestion trial with crested wheatgrass where only one application date (June 2) and one later sampling date (July 1) were

Table 1. *In vitro* cellulose digestibility of range forage cured naturally and chemically

Species	Paraquat treatment Appl date	Paraquat treatment Level	Sampling date	Cellulose digestion a/ Control forage	Cellulose digestion a/ Treated forage
		(kg./ha.)		%	%
Cheatgrass	May 31	0.47	June 1	70.4	71.2
			June 11	56.1	60.8*
			July 5	44.5	52.8*
Bluebunch wheatgrass	June 23	0.90	June 23	54.1	53.1
			July 26	48.3	56.5*
			Aug. 26	52.1	52.3
			Oct. 30	50.7	52.9
Crested wheatgrass	June 2	0.90	June 2	79.5	79.5
			July 1	69.7	74.6*

a/ Cellulose digestibility determined after 24 hours fermentation on bluebunch wheatgrass and 48 hours fermentation on cheatgrass and crested wheatgrass samples.

* Significantly higher ($P < 0.05$) than control forage.

involved are shown in Table 2. Dry matter digestion one month after chemical application was the same in forage treated at 0 or 0.9 kilograms of Paraquat per hectare, however, cellulose and nitrogen digestion values were higher ($P < .05$) in chemically cured forage. On July 1, the treated forage contained 7.5% regrowth material which probably contributed to the higher cellulose and nitrogen digestibility at this date than at the time of chemical application.

Table 2. *In vivo* digestibility on crested wheatgrass cured naturally and chemically (Trial 1)

Nutrient	Apparent digestion on date of treatment b/ (June 2)	Apparent digestion on July 1 a/ Control forage	Apparent digestion on July 1 a/ Treated forage
	%	%	%
Dry matter	57.3	53.0	52.9
Cellulose	65.5	59.3	70.4*
Nitrogen	52.3	50.9	59.0*

a/ Treated forage contained 7.5% regrowth on July 1 according to hand separation of aliquot samples.

b/ Plots treated with 0 and 0.9 kg. paraquat per hectare on June 2

* significantly higher ($P < 0.05$) than control forage

The second *in vivo* digestion trial with crested wheatgrass is summarized in Table 3. This trial was conducted to evaluate paraquat-treated forage (applied June 10) and untreated forage sampled on June 30 and to compare, on August 20, forage treated on June 10 or June 30 with untreated forage.

Table 3. *In vivo* digestibility of crested wheatgrass cured naturally and chemically (Trial 2)

Sampling date	Paraquat treatment		Apparent digestion coefficients a/			
	Appl. date	Level	Dry matter	Cellulose	Gross energy	Nitrogen
		kg./ha.	%	%	%	%
June 10	---	0	63.5[a]	71.8[a]	65.2[a]	63.9[a]
June 30	---	0	58.9[b]	64.0[b]	61.0[b]	57.8[bc]
	June 10	0.9	57.5[b]	73.2[a]	60.1[b]	61.9[ab]
Aug. 20 b/	---	0	48.5[c]	52.8[c]	50.0[c]	40.9[d]
	June 10	0.9	52.6[d]	64.8[b]	55.9[d]	58.2[bc]
	June 30	0.9	51.3[d]	66.7[b]	54.2[d]	54.4[c]

a/ Apparent digestion coefficients represent mean values established from 4 trials with each sample. Means with same superscript letters are not significantly different ($P < 0.05$).

b/ On August 20, regrowth forage in treated samples amounted to 43% and 8% for that treated on June 10 and June 30, respectively.

Twenty days following the first application of paraquat the digestibility of dry matter and gross energy was essentially the same in treated and non-treated forage but the apparent digestibility of both cellulose and nitrogen was higher ($P < 0.05$) in treated forage. The digestibility of all nutrients studied was greater ($P < 0.05$) in chemically treated forage than in control forage when sampled at 71 days (August 20) following the date of first paraquat application. Forage treated at the second application date (June 30) and sampled on August 20 was higher ($P < 0.05$) in digestibility of all nutrients than control forage sampled the same date. When harvested on August 20 the differences in dibestibility of forage treated on June 10 or June 30 were not significant. Control forage showed a significant decline ($P < 0.01$) in digestibility of each nutrient with each later sampling date which corresponds to earlier findings at this Station (Raleigh and Wallace 1965). Regrowth material present in treated forage harvested on August 20 amounted to 43% and 8% for forage treated at the first and second application dates, respectively.

The chemical composition of crested wheatgrass samples fed in the second *in vivo* trial are shown in Table 4. Cellulose content of non-treated forage showed a slight increase with each later harvest date while that of treated forage exhibited a considerably more rapid increase especially at the first

sampling date following chemical application. Gross energy content of control forage increased slightly during June, then appeared to level off, while in treated forage the gross energy content remained constant during June and showed a slight decline when sampled in August. Crude protein levels were considerably higher in chemically cured forage as opposed to control forage at both the June 30 and August 20 sampling dates. Sneva (1966) has reported extensive data concerning the effects of chemical curing on nutrient composition, chemical residue, forage yield, and other related factors.

Table 4. Chemical composition of crested wheatgrass cured naturally and chemically on a dry matter basis

Sampling date	Paraquat treatment		Chemical composition		
	Appl. date	Level	Cellulose	Gross energy	Crude protein
		kg./ha.	%	kcal./kg.	%
June 10	----	0	28.1	4252	8.7
June 30	----	0	29.2	4300	7.2
	June 10	0.9	32.6	4258	9.4
August 20	----	0	30.1	4297	4.8
	June 10	0.9	29.8	4223	8.2
	June 30	0.9	35.1	4225	7.8

Results of digestion trials summarized in this paper along with nutrient composition data reported by Sneva (1964 and 1966) indicate that favorable animal response could be expected from grazing or feeding chemically cured forages. There is, however, a need for further investigation regarding the effect of chemical curing on intake, most appropriate stage of maturity for chemical application, and losses of chemically cured forage due to weathering, trampling, etc.

Observations made to date at this Station indicate that chemically cured forage is as acceptable or more acceptable to cattle and sheep than forage cured naturally. In short term preference trails involving harvested herbage of Whitmar wheatgrass, Siberian wheatgrass, and crested wheatgrass, chemically cured herbage appeared considerably more acceptable to sheep than that cured by natural means.

SUMMARY

The digestibility of various range grasses, in which growth arrestation was accomplished through application of paraquat, a bipyridylium herbicide, was studied *in vitro* and *in vivo*. Crested wheatgrass, cheatgrass, and bluebunch wheatgrass sprayed with paraquat during the head to flower stage and sampled subsequently had higher *in vitro* cellulose digestibility values than non-treated herbage of these species harvested at the same dates.

Two *in vivo* digestion trials were also conducted with sheep to compare crested wheatgrass cured by natural and chemical means. In the first trial, dry matter digestion one month after chemical application was the same in treated and non-treated forage, however, cellulose and nitrogen digestion was significantly higher in treated forage. In the second trial, two paraquat application dates were used. Twenty days following the first application, the digestibility of cellulose and nitrogen was significantly higher in treated samples as opposed to control samples while the digestibility of dry matter and gross energy was essentially the same in treated and non-treated samples. The digestibility of all nutrients studied was significantly higher in chemically cured forage than in naturally cured forage when sampled at 71 days following the first application date or 51 days following the second application date.

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