1977

Utilization of Aspen Trees as Ruminant Feed Component

L. D. Kamstra
South Dakota State University

M. Singh

J. Sharps

South Dakota State University
Brookings, South Dakota
Department of Animal Science
Agricultural Experiment Station

A.S. Series 77-15

Utilization of Aspen Trees as a Ruminant Feed Component

L. D. Kamstra, M. Singh and J. Sharps

Introduction

When traditional roughages are in short supply or high in price, other fibrous feed sources for ruminants should be considered if available at a competitive price. One such fibrous material shown to have potential as a ruminant feed is the aspen tree (Populus tremuloids Michx.) harvested in its entire form to include bark, leaves and trunk. The aspen tree is the most widespread tree species in North America and the least utilized. Estimates exceed 6 million acres of mature trees in an area which would include the Black Hills (58,000 acres), the Great Lakes region and the Rocky Mountain region. Since the tree responds to harvest by thirtyfold reproduction from the remaining stump and root, it becomes a highly renewable source of fiber. Previously, when aspen wood was properly supplemented to correct nutrient deficiencies such as protein, the final mixed ration was a satisfactory replacement for up to 80% alfalfa in growing rations for cattle (A.S. Series 76-19).

The objective of this experiment was to further explore the use of aspen as the roughage portion of both growing and finishing rations. An attempt was also made to determine if chicken manure could partially replace soybean meal as a protein supplement in a ration having aspen as a major component.

Materials and Methods

Approximately 50 tons of fresh aspen chips were provided by the South Dakota Department of Game, Fish and Parks from trees harvested in the grouse habitat study areas located in the Black Hills. The aspen chips were trucked (350 miles) to the Foundation Seed House located on the South Dakota State University campus for drying. Aspen chips were forced air-dried at a temperature of 38° C. to a moisture level which would provide for safe storage prior to ration formulation. Fresh aspen chips contained approximately 50% moisture and less than 10% moisture after 2 days of bin drying. Although aspen chips can be ground wet, drying appears to proceed more rapidly in the chip form. All aspen material used in these experiments was ground following the drying process using a portable hammer mill equipped with a 3/8-inch screen.

The six treatments (table 1) were (1) an all-concentrate ration, (2) a high roughage control composed of 93% alfalfa, (3) a high-concentrate ration with 15% alfalfa as roughage, (4) a high-concentrate ration with 15% aspen as roughage, (5) a 48% aspen-13% alfalfa ration without grain and 32% added soybean meal and (6) a 48% aspen-13% alfalfa ration without grain and 16% added soybean meal plus 16% chicken manure. All rations were prepared in meal form at the South Dakota State University feed mill. Ingredient composition is shown in table 1.

Table 1. Ration Composition and Treatments

Ingredients	Treatments 1 Concentrate	2 Control 93% alfalfa	3 Concentrate 15% alfalfa	4 Concentrate 15% aspen	5 48% aspen 13% alfalfa	6 48% aspen 13% alfalfa 16% chicken manure
Corn	86	--	73.5	67.0	--	--
Aspen	--	--	--	15.0	48.0	48.0
Alfalfa	--	93	15.0	--	13.0	13.0
Soybean oil meal (44% crude protein)	13	--	10.0	17.0	32.0	16.0
Chicken manure (26% crude protein)	--	--	--	--	--	16.0
Molasses	--	5.0	--	--	5.0	5.0
Trace minerals	0.5	1.0	0.5	0.5	1.0	1.0
Limestone	0.5	--	0.5	--	--	--
Dicalcium phosphate	--	1.0	0.5	0.5	1.0	1.0
Vitamin A	Sixty-seven grams/ton to supply 2000 IU per kg					
Estimated crude protein	12.60	13.95	12.53	12.84	16.00	13.15

Sixty Hereford steers weighing approximately 700 lb. were randomly allotted to 12 pens of five animals each. Each ration treatment was fed to two pens of steers or a total of ten animals per treatment. Animals were fed to a desired slaughter weight of about 1100 pounds. Animals were brought to full feed over a 2-week period starting with an initial feeding of 10 lb. per animal and increasing the feeding level daily. Animals were fed ad libitum once full feed was achieved. All animals received trace mineral salt and water free choice.

Steers from treatments 1, 3 and 4 and pen 6 of treatment 5 were slaughtered after 126 days of feeding. The remaining animals were slaughtered at 182 days (treatments 2 and 5 and pen 5 of treatment 5).

Results and Discussion

Feedlot Performance

Results of feedlot performance for the 126- and 182-day feeding trials are shown in tables 2 and 3, respectively. All experimental rations were readily consumed in the meal form, although some difficulty was encountered with the 93% alfalfa ration (treatment 2) early in the feeding period. One animal was lost due to bloat and others showed distention. No further problems with bloat occurred after a portion of the ration was offered as long hay. Animals on this ration actually performed better than in the 1975 experiments when the same ration was offered in pellet form. However, frequent contamination with corn as batches of feed were prepared may have contributed to performance. Certain batches of feed contained as much as one-third corn contamination if concentrate rations were prepared just prior to the roughage rations. In general, the steers accepted all experimental rations quite well. Some sorting did occur with the 48% aspen ration if large chips of aspen occurred in the ration mixes. It was also noted an overall decreased consumption of as much as 18% occurred with the meal as compared to the pellet form of this ration. The meal form of the alfalfa ration, however, was more readily consumed than the pellet form. The ration containing chicken manure (treatment 6) attracted a large fly population which was somewhat disturbing to animals during ration consumption.

Table 2 summarizes feedlot performance after 126 days for all treatments. No difference in animal performance was noted between concentrate-fed animals due to roughage addition or type of roughage used. No difference was shown in rate of gain for animals fed roughage rations (treatments 2 and 5), but it would appear that the addition of chicken manure as a replacement for soybean meal depressed gains. The lower gains could have resulted from the lower total protein content of this ration as compared to the other roughage rations rather than an effect caused by addition of manure protein. The feed efficiency was significantly better with the aspen-soybean ration (treatment 5) than the alfalfa ration (treatment 2) for 126 days and was also favored after 182 days (table 3).

At 126 days, steers on treatments 1, 3 and 4 had reached or exceeded 1100 lb. and were slaughtered. The animals from treatment 5 averaged 1066 lb. at 126 days and were within 34 lb. of the desired 1100 lb. slaughter weight imposed by experimental design. This group of five animals was also slaughtered at 126 days to enable at least cursory comparison of carcass characteristics between high-concentrate fed animals and high-roughage fed animals at similar slaughter weights and length of feeding. Of special interest was a comparison of the taste panel scores between concentrate- and roughage-fed animals.

Table 2. Feedlot Performance as Affected by Different Rations--126 days[a]

	Treatments					
	1	2	3	4	5	6
	Concentrate	Control 93% alfalfa	Concentrate 15% alfalfa	Concentrate 15% aspen	48% aspen 13% alfalfa	48% aspen 13% alfalfa 16% chicken manure
Number of animals	10	10	10	10	10	10
Avg. init. filled wt., lb.	718	722	720	722	722	718
Avg. final filled wt., lb.	1176	1012	1166	1177	1030	952
Avg. init. shrunk wt., lb.	707	717	710	710	708	709
Avg. final shrunk wt., lb.	1148	--	1135	1140	1066[b]	--
Avg. daily gain, lb.						
31 days	3.42	1.71	3.48	4.10	3.45*	1.90
63 days	3.78	2.05	3.57	3.96	2.74	1.53
94 days	3.66	2.37	3.51	3.66	2.51	1.88
126 days	3.64	2.29	3.55	3.61	2.44	1.86
126 days (shrunk)	3.50	--	3.37	3.42	--	--
Avg. daily ration, lb.						
31 days	14.91	18.36	17.99	19.59	21.33	16.94
63 days	17.60	23.37	19.00	22.32	22.58	19.75
94 days	18.60	25.74	19.86	23.38	22.61	21.26
126 days	19.91	28.24	21.25	24.63	23.82	23.04
Feed/lb. gain, lb.						
31 days	4.49	10.78	5.17	4.78	6.26*	8.97*
63 days	4.67	11.47	5.32	5.63	8.24*	13.25
94 days	5.10	10.95	6.50	6.39	9.01	11.44
126 days (filled)	5.47	12.43	6.00	6.83	9.82*	12.42
126 days (shrunk)	5.72	--	6.34	7.24	--	--

[a] Treatment 3 (concentrate-alfalfa) and treatment 4 (concentrate-aspen) are compared with concentrate control and treatment 5 (48% aspen-13% alfalfa) and treatment 6 (48% aspen-16% chicken manure) against alfalfa control at the 5% level of significance.

[b] Average weight of five animals (pen 6).

* Significantly different ($P<.05$).

Table 3. Feedlot Performance As Affected by Different Rations--182 days--for Treatments 2, 5 (lot 5) and 6

	Treatments		
	2	5	6
	Control 93% alfalfa	48% aspen 13% alfalfa	48% aspen 13% alfalfa 16% chicken manure
Number of animals	10	5	10
Avg. init. filled wt., lb.	722	722	718
Avg. final filled, wt., lb.	1091	1041	975
Avg. init. shrunk wt., lb.	717	708	709
Avg. final shrunk wt., lb.	1054	1022	959
Avg. daily gain, lb.			
154 days	2.11	1.88	1.67
182 days	2.02	1.76	1.41
182 days (shrunk)	1.89	1.73	1.37
Avg. daily ration, lb.			
154 days	30.09	22.81	24.19
182 days	31.15	23.14	24.94
Feed/lb. gain, lb.			
154 days	14.25	12.13	14.55
182 days	15.50	13.17	17.77
182 days (shrunk)	16.55	13.43	18.32

Carcass Data

Carcass data and taste panel evaluation for the 35 animals slaughtered after 126 days and the 25 animals slaughtered after 182-day growing period are shown in tables 4 and 5, respectively. Slaughtering half of the cattle fed 48% aspen-13% alfalfa-32% soybean meal ration at each date enabled comparison of slaughter data with cattle fed the highest aspen ration with both concentrates and roughages by taste panel. Animals from all treatment groups had carcass grading within the range of standard to choice minus. Dressing percent was lower for the animals fed rations containing aspen than those fed the alfalfa control. Animals fed the roughage control ration (treatment 2) had more kidney fat than those fed the aspen rations (treatments 5 and 6). No significant differences were noted between marbling scores, dressing percent, rib eye area, color, maturity, flavor, juiciness, drip loss or volatile gas loss. As could be expected, the number of abscessed livers and livers condemned was higher for animals on concentrate rations.

Steaks from animals fed ration 5 had less cooking loss than the steaks of animals fed the alfalfa ration (table 6). Steaks from the ration 5 group were more tender than the meat from animals fed either the corn or alfalfa rations. Mechanical shear also confirmed that the steaks from animals fed ration 5 were more tender than steaks from animals fed either the corn or alfalfa rations (table 6). Percent cooking losses were lower for meat from animals on ration 5 as compared to the steaks produced on the other rations.

Table 4. Carcass Characteristics and Taste Panel Evaluation As Affected by Different Rations--126 Days

	Treatments			
	1	3	4	5
	Concen-trate	Concen-trate 15% alfalfa	Concen-trate 15% aspen	48% aspen 13% alfalfa
Hot carcass wt., lb.	700.8	694.2	687.4	546.4
Dressing percent	59.5	59.6	58.4	51.2
Carcass grade	choice-	good+	good+	standard+
Marbling score	4.7	4.3	4.9	3.0
Abscessed livers	4	4	3	--
Number of livers condemned	3	2	2	--
Rib eye area, sq. in.	11.4	12.1	11.4	10.8
Maturity	24	24	24	24
Color	5.1	5.1	5.5	4.8
Firmness	4.7	4.4	4.8	4.2
Kidney fat, %	3.0	2.8	2.8	1.6
Taste panel evaluation[b]				
Tenderness	3.9	3.7	3.3	2.7
Flavor	3.0	3.1	2.9	2.9
Juiciness	4.0	3.9	3.7	3.4

[a] Five animals only.
[b] Scored on a scale of 1 to 8 with lower values being more desirable.

Table 5. Carcass Characteristics and Taste Panel Evaluation As Affected by Different Rations--182 Days

	Treatments		
	2[a]	5[b]	6
	Control 93% alfalfa	48% aspen 13% alfalfa	48% aspen 13% alfalfa 16% chicken manure
Hot carcass wt., lb.	591.1	552.4	504.3
Dressing percent	54.17	53.08	51.74
Carcass grade	good-	good-	standard
Marbling score	3.6	3.8	3.05
Abscessed livers	2	--	--
Numbers of livers condemned	2	--	--
Rib eye area, sq. in.	10.17	10.34	10.38
Maturity	23.7	24.0	23.8
Color	5	5	4.8
Firmness	6	6	5.8
Kidney fat, %	1.9	1.6	1.4
Taste panel evaluation[c]			
Tenderness	3.7	2.6	3.6
Flavor	3.2	2.9	3.0
Juiciness	3.9	3.5	4.0

[a] Ten animals.
[b] Five animals only.
[c] Scored on a scale of 1 to 8 with lower values being more desirable.

Table 6. Shear Test and Percent Volatile Gas and Cooking Losses
126 and 182 Days

	Treatments					
	1	2	3	4	5	6
	Concen-trate	Control 93% alfalfa	Concen-trate 15% alfalfa	Concen-trate 15% aspen	48% aspen 13% alfalfa	48% aspen 13% alfalfa 16% chicken manure
Volatile gas loss, %	22.4	25.1	24.6	22.0	20.3	22.7
Cooking loss, %	27.1	29.6	28.4	26.4	25.1	29.4
Shear (lb./1 inch section)	16.0	13.8	14.6	12.9	11.4	14.3

Summary and Conclusions

Steers were used to determine the value of aspen material as a component of a high-energy ration replacing alfalfa as the roughage portion, as a component of a growing ration in which soybean meal was used to correct protein deficiency, and as a component of a growing ration in which soybean meal as well as chicken manure were used to correct the protein deficiency of aspen material.

All rations were fed in the form of a meal. Two of the 1976 rations (93% alfalfa and 48% aspen-32% soybean meal) were fed during 1975 as a pellet with little difference in performance by the cattle fed aspen other than depressed feed intake for the meal form. The animals fed the alfalfa ration performed better when the ration was presented as a meal except bloat was more of a problem. Roughage addition or type of roughage did not affect the performance of concentrate-fed animals or appreciably alter carcass characteristics. Feedlot performance was poor for chicken manure-fed animals as compared to those fed the alfalfa ration which served as a control for the roughage-type rations. Steaks from animals fed the 48% aspen-soybean meal ration had lower cooking losses and higher tenderness scores than steaks from animals fed either corn or alfalfa.

Aspen wood contains an appreciable amount of fiber carbohydrate which can provide energy for ruminants. It must be realized that aspen has certain nutrient deficiencies which must be corrected. If nutritional deficiencies such as protein, vitamin A and phosphorus can be corrected without excessive cost, aspen rations should become competitive with similar traditional rations. Aspen will probably have the greatest potential as a major component of maintenance-type rations. Development of aspen-containing maintenance rations are being studied at the present time and the results will be reported at a later date.