Digestibility of Three Oat Cultivars and Mill Oats by Lambs

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Many factors influence the selection of grains to be used for livestock feeding such as price, production yields, nutrient content, animal requirements and management practices. Of these, alterations in the nutrient contents appears to be the most effective method of increasing all or specific nutrient concentrations in grains and the effects of grain mixtures depend upon the grain in question. Much emphasis in recent years has been placed on increasing specific nutrient densities within a feed grain.

Recent development of several varieties of high protein oats has stimulated interest in the overall feeding performance and potential protein sparing effects these new varieties might provide. A major drawback to these new oat varieties is a marked decrease in production yields of the high protein varieties versus superior yields of lower protein types. Current literature contains no data as to the digestibility of these new high protein oat varieties by ruminant animals.

"Mill" oats is a byproduct of the grain industry and considerable amounts can become available for livestock feeding at a relatively low cost. The "mill" oats used in this study weighed 29 pounds per bushel and did not appear moldy.

The purpose of these studies was to evaluate the digestibility of two high protein oat and a lower protein oat variety as compared to a corn-soybean meal control ration and to assess the digestibility of a sample of "mill" oats.

Materials and Methods

The ration composition is presented in table 1. Utilizing sunflower hulls, control and oat rations were formulated to be isofibrous at 20 per cent acid detergent fiber. Mill oats were substituted for cultivated oats pound for pound into the oat ration.

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The authors express their appreciation to Dr. William Slanger for his help in statistical analysis of the data.

Four mature crossbred wethers were confined to individual metabolism cages during each test period. During rest periods, the wethers were housed in an open pen with free access to alfalfa pellets and fresh water. Each lamb was fed in sequence one of the four rations, once a day, for 10 days each, according to a 4×4 Latin square design, and allowed free access to fresh water at all times. The last 7 days of each trial served as a collection period with total daily fecal collections from each lamb individually bulked and frozen at $-10°C$ until the end of the period.

TABLE 1. Ration Composition (%)

	TREATMENT				
Ingredients	Control	Dal	Froker	Hudson	"Mill" oats
Corn	41.1	--	--	--	--
Soybean oil Meal	27.0	--	--	--	--
Dal oats	--	72.6	--	--	--
Froker oats	--	--	72.6	--	--
Hudson oats	--	--	--	72.6	--
"Mill" oats	--	--	--	--	72.6
Sunflower hulls	31.5	27.8	27.0	27.0	27.0
Vitamin/mineral premix	0.4	0.4	0.4	0.4	0.4
Total	100.0	100.0	100.0	100.0	100.0

[1]Vitamin/mineral premix provides the following in a pound of ration: Vitamin A, 1600 IU; Vitamin D_3, 160 IU; Riboflavin, 1.60 mg; Niaciin, 12.80 mg; d-Pantothenic acid, 4.80 mg; Calcium d-Pantotinale, 5.22 mg; Choline Chloride, 32.00 mg; Choline 27.17 mg, Vitamin B_{12}, 0.13 mg; Ethoxyquin 20 mg.

Ration samples were obtained at the initiation of each trial. Composite fecal samples and ration samples were dried in forced air ovens at 42°C and analyzed for selected components. At the conclusion of trial four, all four wethers were fed a ration formulated with "mill" oats substituted for cultivated oats. Ration and fecal samples were handled in an identical manner to the previous four trials.

Coefficients of Digestion were calculated by the conventional method using the equation:

$$\text{Coefficient of Digestion} = 100 - 100\left(\frac{\text{weight of nutrient in feces}}{\text{weight of nutrient in feed}}\right)$$

To aid in the interpretation of data the following statistical measures were used: analysis of variance (Snedecor and Cochran, 1967) and Duncan's Multiple Range Test.

Results and Discussion

Selected chemical analysis of the rations is presented in table 2. Dry matter content of the rations were approximately equivalent as were total ash content, although, the "mill" oat ration was slightly higher in total ash due to their higher percentage of hull. Acid detergent fiber (ADF) was not significantly different ($P<.05$) between the control and cultivated oat rations or among the oat varieties themselves owning to isofibrous ration formulation. The "mill" oat ration was considerably higher in ADF content which would be anticipated due to a greater proportion of hull to groat.

TABLE 2. Selected Chemical Analysis of Rations[1]

	RATION				
Item	Control	Dal	Froker	Hudson	"Mill" oats
Dry Matter	88.3	88.8	88.7	88.7	89.0
Crude Protein (N x 6.25)	17.5	12.2	11.9	10.0	11.2
Energy (Kcal/Kg.)	4872	4086	4475	4523	2185
ADF[2]	23.5	23.4	24.7	25.4	30.6
Ash[3]	6.6	7.0	6.9	6.8	7.8

[1]All values except Dry matter on 100% Dry matter basis.
[2]Acid Detergent Fiber.
[3]Total Ash.

Crude protein content had the greatest variation among treatments, ranging from 10 per cent for Hudson oats to 17.5 per cent for the control ration (table 2). The crude protein of the "mill" oat diet was comparable to that of the Dal or Froker oat rations. Energy content was greatest for the control, due to the inclusion of corn in the ration, and lowest for Dal, with Froker and Hudson rations intermediate and of similar energy density. However, the "mill" oats ration was drastically lower in energy than the control or oat rations containing approximately 45% less kilocalories per kilogram of feed.

Coefficients of digestion presented in table 3 reveal no significant differences ($P<.05$) for digestibility of ration components among oat varieties and(or) the control ration. Digestion coefficients for "mill" oat ration components were markedly lower than the control or oat varieties rations for dry matter and energy. Digestion of the "mill" oat crude protein component was strikingly comparable to that of the oat cultivars (table 3).

TABLE 3. Digestion Coefficients of Ration Components[1] (100% Dry Matter Basis)

	RATION[2]				
Item	Control	Dal	Froker	Hudson	"Mill"oats
Dry Matter (%)	67.7	51.8	62.4	69.4	47.1
Crude Protein (%) (N x 6.25)	79.4	68.4	73.1	75.2	67.1
Energy (%)	68.4	53.3	67.0	74.8	22.5

[1]Average of four animals.
[2]Values with different superscripts within rows except "Mill" oats significantly differ at $P<05$.

There appeared to be no difference in the digestibility of protein among oat varieties, contrary to results published by several authors (Brethour and Duitsman, 1971 and 1973; Varner and Woods, 1975; Riggs, 1971). Interesting to note, Dal oats were of the highest crude protein content, but lowest in digestible protein content. On the other hand, Hudson oats were lowest in crude protein and highest in digestible protein content (table 4). Digestible energy (DE) content followed a similar pattern to the digestible protein (DP) content in that Hudson was highest and Dal oats lowest in DE content. Froker oat ration was intermediate in both DE and DP values. "Mill" oat ration was surprisingly similar in DP content to the oat cultivars, although considerably lower in DE content (table 4).

TABLE 4. Digestible Nutrient Content of Rations[1] (100% Dry Matter Basis)

	RATION				
Item	Control	Dal	Froker	Hudson	"Mill" oats
Digestible Dry Matter (%)	59.7	47.4	56.5	62.6	41.9
Digestible Protein (%)	11.9	6.5	7.3	7.6	7.5
Digestible Energy (Kcal/Kg)	3334	2177	2999	3383	492

[1]Average of four animals.

Among the cultivated oat varieties, as the digestible energy content increased there was an increase in the digestible protein, which tends to support the work of Tagari *et al.* (1964) who reported that increasing levels of starch in sheep rations enhanced protein decomposition and digestion. Digestible protein and energy trends in "mill" oats appeared to be contrary to these findings since protein digestion was comparable to the other oat rations in spite of markedly lower DE content.

The addition of sunflower hulls to the four oats and control rations may have affected the digestibility of total acid detergent fiber. Erickson *et al.* (1970) stated that differences in the chemical composition of fiber from various sources can affect total fiber digestion and so digestible ADF data is not presented here.

In terms of the feeding value of Dal, Froker, Hudson and "mill" oats for lambs, all would provide adequate levels of digestible protein. This is interesting to note in that the crude protein content of Hudson oats is below the NRD-NAS (1975) recommended level for finishing lambs. When feeding ruminant animals, energy becomes the first limiting factor. Only Hudson oats contains an adequate level of DE. The DE content of Froker oats appears borderline. Dal and especially "mill" oats are below the NRC-NAS (1975) recommended allowances for finishing lambs. This is of particular concern since the higher fiber content of the "mill" oats ration might prevent optimum performance due to the animal's inability to increase consumption enough to compensate for the decreased energy density. A similar concern would be appropriate for the Dal oats ration, although compensation would be more likely due to higher DE content and lower fiber content than "mill" oats. Feedlot data for rations based on Dal, Froker or Hudson oats reflect these findings.

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this assumption would be small since the ground survey of the drainage basins above Enderlin and Portland are a large part of the Mapleton and Hillsboro basins, respectively. The current drainage upstream from Mapleton was estimated to be 64 per cent greater than the natural drainage, while the current drainage upstream from Hillsboro was estimated to be 180 per cent greater the natural drainage. This gave even higher correlations of predicted flow to acreage than the previous case (Table 5).

TABLE 4. Acreage in Maple River and Goose River basins and changes due to land drainage.

Total Catchment Basin	Natural Drainage Basin	Drained Land Estimate	Total Current Drainage Basin
Maple River			
636,000 acres	126,800 acres (19.9%)	80,700 acres (12.7%)	207,500 acres (32.6%)
Goose River			
609,800 acres	110,700 acres (18.2%)	199,000 acres (32.6%)	309,700 acres (50.8%)

TABLE 5. Comparison of predicted flow rates (ft^3/s) to natural drainage and current drainage area where r is the correlation coefficient.

Flow	Predicted flow rates for: Enderlin		Portland		r
	Natural Drainage	Current Drainage	Natural Drainage	Current Drainage	
	126,800 acres	207,500 acres	110,700 acres	309,700 acres	
	(ft^3/s)	(ft^3/s)	(ft^3/s)	(ft^3/s)	
Mean Annual	22.36	55.12	18.21	43.06	0.72
Maximum Daily	433.4	1891	896.0	1351	0.60
Mean Spring	59.76	157.6	68.84	147.2	0.84

	Predicted flow rates for: Mapleton		Hillsboro		
	Natural Drainage	Current Drainage	Natural Drainage	Current Drainage	
	1.00 Weighted acres	1.64 Weighted acres	1.00 Weighted acres	2.80 Weighted acres	
	(ft^3/s)	(ft^3/s)	(ft^3/s)	(ft^3/s)	
Mean Annual	21.56	125.4	15.04	115.8	0.79
Maximum Daily	669.6	3208	129.5	3528	0.86
Mean Spring	93.47	299.6	50.17	390.8	0.93

Conclusions

Significant increases in flow on the Maple, Wild Rice and Goose Rivers have occurred over the last 30 to 40 years. Flow rates were shown to be related to climate (precipitation); however, there appears to be no change in precipitation patterns to account for the increase in flow rates. Predicted flow rates were shown to be closely related to changes in basin size due to land drainage in the Maple River and Goose River basins. It appears that land drainage is a factor aggravating the flooding problem in eastern North Dakota; however, no attempt was made to quantify its overall significance.

Acknowledgement

The authors express their appreciation to Mr. Russell E. Harkness, US Geological Survey, Water Resources Division, Bismarck, ND for providing computer printouts of stream flow data used in this analysis.

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