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PIGEON GRASS AND BEET PULP AS SUBSTITUTES FOR BARLEY IN STEER RATIONS

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Pigeon grass seed (PGS), also called foxtail (green foxtail; Setaria viridis, yellow foxtail; Setaria lutescens), has been one of the most abundant of "screenings" produced in North Dakota. These screenings have been used as ruminant feeds for decades. During the dry "thirties", much of the harvested feed grains contained from 30 to 70 per cent pigeon grass seed.

The summer of '74 was a year for an abundance of pigeon grass and shortage of feed grains. The interest in the feeding value of these screenings, sometimes almost pure pigeon grass seed, was widespread and pigeon grass screenings were sold to livestock producers for from 1.5 to 4 cents a pound.

Research data on the nutritive value of pigeon grass seed was lacking. In 1933, D.J. Griswold reported results of a trial with fattening lambs which was conducted in 1923-24 at the North Dakota Agricultural Experiment Station. The control ration was one-third alfalfa hay and two-thirds concentrates. The control concentrate was 80 per cent barley and 20 per cent wheat bran. Pigeon grass seed replaced either half or all of the barley in the test rations. The screenings contained 89.5 per cent pigeon grass, 4.4 per cent cracked wheat and 6.1 per cent of other weed seeds. Because of the wheat, 4.4 per cent wheat was also substituted for the amount of the "good grade feed barley" to eliminate this as a possible variable. No mention was made whether the pigeon grass and barley were fed in meal or whole form.

Griswold's conclusions stated, "used as 40 per cent of the concentrates, it (pigeon grass) was of practically equal value compared to barley." ". . . when substituted for all the barley in these rations, the results were not nearly so good. The daily gains were about 78 per cent as great and a unit of gain required 42 per cent more concentrates and 22 per cent more hay." From this trial it might be calculated that if the barley contained 75 per cent TDN (total digestible nutrients), the pigeon grass would have been about 59 per cent TDN. This value is substantiated by Morrisons Feed and Feeding Tables (1956, 22nd Ed.), where the TDN for pigeon grass seed is given as 58.2 per cent. The protein was listed as 14.4 per cent with a digestible protein of 9.4 per cent. The values from Morrison's were calculated using average analysis and average digestion coefficients for a similar feed and not determined by a digestion trial with pigeon grass seed.

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Because of the shortage of feed grains, possible substitutes were considered. With the increasing production of sugar beets in the area and the resulting by-product, molasses beet pulp was also evaluated as a substitute for barley in rations where roughage was used as approximately half of the rations.

In previous research with molasses-beet pulp (MBP) at this station, Dinusson et al. (1963, 1964, 1969, 1972) showed that MBP as 70 per cent of the ration was too high a level, resulting in extreme looseness of feces. In high energy finishing rations (over 85 per cent concentrates), substitution of 20 per cent MBP for barley showed MBP to be equal pound-for-pound to the grain. Feeding 50:50 alfalfa wafers and MBP in growing rations for steer calves increased gains by 42 per cent over the alfalfa wafers alone. Molasses beet pulp as 30 per cent of the grain gave greater benefits in wheat rations than in barley or oat rations when grain formed over 85 per cent of the total ration for finishing steers. The MBP was not quite equal pound-for-pound for barley or oats when substituted as 30 per cent of the grain.

Experimental Procedure

Thirty-five Hereford yearling steers were allotted to seven lots. Feed intake and weight gains were recorded every 21 days, with weights taken after about 15 hours with no feed. Water was available at all times and a trace-mineral salt-mineral mixture was offered free-choice. The feeds were analyzed for the customary nutrients. In addition, tannic acid equivalents were determined. Rumen samples were obtained by the suction strainer technique to permit determination of rumen pH. *In vitro* dry matter digestibility (IVDMD) studies were carried out to get relative digestibilities of the rations. The steers were slaughtered and carcass data obtained.

It was intended to use rations with an average roughage-to-concentrate ratio of 40:60. However, upon conclusion of the 178-day feeding period the ratio was closer to 50:50. Alfalfa hay was chopped and fed as about 20 per cent of the ration, chopped prairie hay as about 22 per cent of the ration and chopped barley straw was added as 7 to 8 per cent for the last 30 days of the experiment to stretch the roughage available.

Molasses beet pulp was to be substituted for barley at 20, 30 and 40 per cent levels to measure effect of substitution when grain was limited. The actual levels reached were 22, 28 and 36 per cent. MBP was used as 20 per cent of the grain portion of the ration where pigeon grass seed was used as a substitute for 20, 40 or 60 per cent of the barley. Thus, ration 1 is the control ration for lots 2, 3 and 4, and ration 2 is the control for comparisons for lots 5, 6 and 7. The barley was dry rolled, the PGS was ground fine enough to crush 90 per cent of the seeds and the pelleted molasses beet pulp was ground. Where combinations of concentrates were used, they were mixed together and fed as one feed to avoid sorting.

Results and Discussion

Chemical composition of the feedstuffs used is given in Table 1. The values are given on a 100 per

Table 1. Chemical compositions of the feedstuffs (100% DM)

	Feedstuff					
Item	Pigeon grass seed	Molasses beet pulp (pelleted)	Rolled barley	Chopped alfalfa hay	Prairie hay	Barley straw
Dry matter	92.23	93.44	91.26	89.62	95.68	91.50
Ash	7.37	7.87	2.85	13.43	12.34	11.04
Crude protein	17.24	11.13	15.21	22.09	6.27	7.10
Ether extract	3.79	.47	1.86	1.67	2.50	.86
ADF[a]	20.74	23.87	8.10	36.74	48.74	50.26
ADL[b]	4.01	3.10	1.31	7.03	4.80	6.23
Cell wall	36.35	42.74	37.21	53.45	71.85	67.72
Hemicellulose[c]	15.61	18.87	29.11	16.71	23.11	17.46
Cellulose[d]	16.73	20.77	6.79	29.71	43.94	44.03
Calcium	.17	.83	.09	1.70	.09	.27
Phosphorus	.41	.09	.39	.32	.04	.16
Magnesium	.26	.24	.18	.55	.16	.13
Potassium	.46	1.13	.48	3.25	.56	2.73
Tannic acid equivalents	.49	.75	.35	2.12	2.80	1.31

[a]*Acid detergent fiber*
[b]*Acid detergent lignin*
[c]*Cell wall — ADF = hemicellulose*
[d]*ADF — ADL = cellulose*

Table 2. Composition of the rations (%)

Feedstuff	Ration (lot) 1	2	3	4	5	6	7
Pigeon grass[a]	—	—	—	—	20	40	60
Rolled barley[b]	100	78	72	64	60	40	20
Pelleted molasses beet pulp[c]	—	22	28	36	20	20	20
Chopped alfalfa hay	21	19	18	20	21	21	21
Prairie hay	23	22	22	22	23	23	23
Barley straw*	8	7	7	7	8	8	8
Roughage: concentrate	53:47	48:52	47:53	49:51	51:49	51:49	51:49

[a,b,c]As % of the concentrate mixture
**Started feeding at 147 days of the experiment*

cent dry matter basis. To convert these values to roughly "air-dry" or "as fed" basis, for comparisons to chemical composition of other feedstuffs, multiply the values by 90 per cent. The ration formulations are given in Table 2. Note that the MBP and PGS substitutions are reported on the basis of the concentrate portion of the ration and not the total ration. The chemical analysis of the rations are given in Table 3. Note again these values are on a 100 per cent dry matter basis.

Summary of feedlot results is given in Table 4. One steer in lot 1 (Bly) died after 165 days on experiment with an undiagnosed nervous disease, apparently not the result of treatment.

As can be noted from the poor gains, the barley available for use was poor quality, probably weighing only 39 to 40 pounds per bushel. On the basis of feed intake and if the barley had been of good quality, the estimated gains would have been over 2.25 pounds per day. During part of the experimental feeding period, inclement weather reduced gains, which also contributed to the poor overall gains. However, all lots were fed under the same conditions and comparisons among treatments are valid.

Substituting molasses beet pulp for a like amount of barley increased gains and increased feed efficiency slightly. Most of the increase in gain of the steers fed the MBP can be accounted for by increased feed intake. The results with the pigeon grass seed substitutions tell a different story. The control lot for these comparisons is lot 2, containing the same amount of beet pulp as those lots fed the PGS. Steer gains were 9, 22 and 28 per cent less than the control when 20, 40 and 60 per cent PGS was substituted for barley. These same treatments required 4, 22 and 33 per cent more feed per pound of gain than the controls. The steers were not offered the concentrate mix at appetite, but fed at predetermined levels to assist in estimating the energy value of the pigeon grass seed.

Table 3. Chemical compositions of the rations (100% D.M.)

Item	Ration Composition* (%) Bly	22 MBP	28 MBP	36 MBP	20 MBP 20 PGS	20 MBP 40 PGS	20 MBP 60 PGS
Lot	1	2	3	4	5	6	7
D.M.	92.10	92.32	92.24	92.37	92.22	92.42	92.50
Ash	8.06	8.14	8.22	8.56	8.82	9.29	9.67
Crude protein	13.68	13.24	13.02	13.05	13.49	13.67	13.88
ADF (fiber)	27.65	27.64	28.00	28.84	29.75	31.12	32.06
ADL (ligmin)	3.76	3.72	3.72	3.86	4.09	4.38	4.61
Cellulose	23.89	23.92	24.28	24.98	25.66	26.74	27.45
Calcium	.43	.48	.47	.54	.50	.50	.51
Phosphorus	.26	.24	.22	.23	.24	.24	.25
Tannic acid equivalents	1.39	1.36	1.36	1.38	1.42	1.44	1.44

**All substitutions were made for the barley*
Bly = rolled barley, MBP = molasses beet pulp, PGS = pigeon grass seed

Table 4. Animal performance as affected by rations

	Ration Composition* (%)						
	Bly	22 MBP	28 MBP	36 MBP	20 MBP 20 PGS	20 MBP 40 PGS	20 MBP 60 PGS
Lot number	1	2	3	4	5	6	7
Number of steers	4[1]	5	5	5	5	5	5
Avg. initial wt. (lbs)	749.0	734.0	754.0	750.0	740.0	730.0	746.0
Avg. final wt. (lbs)	1033.0	1042.0	1062.0	1081.0	1022.0	971.0	966.0
Avg. daily gain (ADG), lbs.	1.60_{abc}	1.73_{ab}	1.73_{ab}	1.86_{a}	1.58_{abc}	1.35_{bc}	1.24_{c}
Adjusted ADG, lbs. [2]	1.59_{abc}	1.75_{ab}	1.71_{ab}	1.85_{a}	1.59_{abc}	1.38_{bc}	1.23_{c}
Avg. daily feed intake, lbs.	24.19	25.36	25.12	25.72	24.17	24.20	24.17
Avg. daily dry matter intake, lbs.	20.47	21.54	21.40	21.93	20.59	20.47	20.66
Feed/lb. of gain	15.12	14.66	14.52	13.83	15.30	17.93	19.49

**All substitutions were made for the barley — Bly = rolled barley, MBP = molasses beet pulp, PGS = pigeon grass seed*
[1]One animal died at 165 days of the experiment
[2]Steers adjusted to the same initial weight
a,b,cAny two means of the same item without superscript differ significantly P<.01

It was noted early in the feeding period that much of the pigeon grass was visible in the feces. This was not as expected because the PGS was ground fine enough so over 90 per cent of the seeds were crushed. The presence of the PGS hulls continued to be visible in the feces until the end of the trial.

To see if the digestibility of the ration was actually affected, an *in vitro* dry matter digestibility (IVDMD) was performed on the rations. As can be seen from Table 5, the rations containing the PGS had lower dry matter digestibilities. To further investigate a possible cause, the tannic acid equivalents of the feeds and rations were determined (Tables 1 and 3). Tannic acid is known to have an effect on digestibility. The pigeon grass seed had less tannic equivalent than expected, only a little more than barley, The alfalfa and prairie hays contributed much more. However, the rations containing the PGS were much higher than the other rations and the tannic acid levels had a significant negative correlation with gains and a positive correlation with feed per pound of gain. The tannic acid equivalent was not great enough to fully explain all the reduction in gain even though its effect is primarily on the rumen microorganisms.

Harrold et al. (1975) found PGS could be used up to 40 per cent of the ration for growing-finishing swine and have about 90 per cent the value of barley. From the data reported here, the value of PGS, even at the 20 per cent level of substitution, had a much lower value. This is a different response than reported by Griswold (1933) with finishing lambs.

Carcass evaluations (Table 6) bear out the results seen in Table 4. Carcass grades on all treatments were lower than expected. These cattle should probably have been fed longer as indicated by grade and yield. The backfat of lots 1, 2 and 4 was adequate to make the choice grade, but none of the lots had enough marbling to make the choice grade, and the steers receiving the substitution rate of 60 per cent PGS for barley had neither finish nor marbling to grade more than standard. The condemned (abscessed) livers did not reflect any ration effect.

Summary

This preliminary report suggests that molasses beet pulp can be substituted for barley up to 36 per cent of the concentrate portion of a ration with a roughage:concentrate ratio of about 50:50 and have an energy value of average barley. The molasses beet pulp had slightly higher than average crude protein content, the barley and alfalfa was also

Table 5. In vitro dry matter digestibility of the rations (%)

Ration composition (%)*	IVDMD
Bly	75.78 ± 1.57
22 MBP	76.70 ± 5.22
28 MBP	75.59 ± 1.09
36 MBP	75.44 ± 1.85
20 MBP 20 PGS	72.11 ± 5.08
20 MBP 40 PGS	67.20 ± 3.21
20 MBP 60 PGS	69.83 ± 12.43

**All substitutions were made for the barley — Bly = rolled barley, MBP = molasses beet pulp, PGS = pigeon grass seed*

Table 6. Average carcass characteristics as affected by rations

	Ration Composition* (%)						
	Bly	22 MBP	28 MBP	36 MBP	20 PGS	40 PGS	60 PGS
Lots	1	2	3	4	5	6	7
Carcass weight (lbs)	593.25	613.40	620.20	624.20	582.60	564.00	553.20
Dressing %	57.40	58.83	58.36	57.69	56.98	58.02	57.25
% Kidney fat	1.92	1.86	1.69	2.14	1.60	1.59	1.47
Conformation[1]	11.50	11.60	11.80	11.00	11.40	11.80	10.60
Marbling score[2]	3.65	3.80	2.92	3.66	3.94	3.26	2.28
USDA grade[3]	8.25_{a}	7.60_{abc}	6.60_{c}	8.20_{a}	8.20_{a}	6.80_{bc}	5.20_{d}
Loin eye area, (sq. in.)	11.72	12.38	12.76	12.48	11.30	11.30	11.64
Back fat, in.	$.44_{a}$	$.37_{ab}$	$.32_{abc}$	$.45_{a}$	$.29_{abc}$	$.26_{bc}$	$.16_{c}$
Condemned livers	0	1	0	1	0	1	1

**All the substitutions were made on the barley — Bly = rolled barley, MBP = molasses beet pulp, PGS = pigeon grass seed*
[1]12 = choice plus, 11 = choice avg., 10 = choice minus
[2]4 = small, 3 = slight, 2 = traces
[3]9 = good plus, 8 = good avg., 7 = good minus, 6 = standard plus, 5 = standard avg.
a,b,cAny two means in the same row without common superscript letter differ significantly $P < .05$

above average in protein content so protein supplements were not needed.

Pigeon grass seed, although high in protein, had an energy value for finishing cattle even lower than the Morrison's estimate of 58 per cent, making it only slightly higher than hay.

More research is needed to ascertain how best to use this type of screenings and why swine digest the pigeon grass seed better than cattle.

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