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1133 State Avenue, Dickinson, ND 58601 Voice: (701) 483-2348 FAX: (701) 483-2005

EVALUATION OF BARLEY-NAKED OATS COMBINATIONS FOR GROWING-FINISHIG SWINE
(1998 Field Day Presentation)

Robert L. Harrold, Professor
Department of Animal and Range Sciences, North Dakota State University Fargo, ND 58105-5727
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RESEARCH SUMMARY

Previous research has shown that naked oats have excellent potential in diets for growing-finishing swine but that nutrient:energy relationships are critical to maintain carcass quality. In this experiment, pelleted diets based on various levels of barley (B) and(or) naked oats (NO)(as % of grain) were fed to growing-finishing pigs. A pelleted corn-based diet was used as the external control. Three dietary phases were used and nutrient concentrations in the 100% B and 100% NO diets were 94% and 106% of those in the corn-based diet. Diets were fed to three replicates of 4 barrows and 4 gilts. Pigs were assigned at random to pens on the basis of weight outcome groups, gender, and ancestry. Average initial weight was 24.9 kg and individual pens completed the study when average pen weight was 109 kg. Pigs receiving diets based on naked oats or corn had comparable ADG but those fed naked oats had superior F/G (P<.05). Pigs fed 100%B had lower ADG (P<.05) and higher F/G than pigs receiving the diets based on corn or NO. These data suggest that nutrient concentrations higher than those used in this experiment may be necessary to maximize desirable carcass characteristics of pigs fed diets in which naked oats represent the sole cereal grain.

OBJECTIVE

1. To determine the effects of selected combinations of feed barley and naked oats on performance and carcass characteristics of growing-finishing swine.

MATERIALS AND METHODS:

A total of 192 growing pigs having an average initial weight of approximately 54 pounds were assigned on the basis of litter, gender, and initial weight to pens in an environmentally-controlled building. Eight pigs (four barrows and four gilts) were assigned to each pen. Pens were equipped with nipple drinkers and stainless steel self-feeders.

There were four replications of the experimental dietary treatments and diets were randomly assigned to pens within replicates based on initial weight. A three-phase dietary sequence was utilized and changes to the next diet in the respective sequence were made when the average weight of the pen exceeded 120 or 190 pounds.

At the completion of the growth phase of the experiment, the two barrows and two gilts nearest the pen average weight were transported to the NDSU Meats Laboratory, fasted overnight, and slaughtered by approved practices and under USDA inspection. Carcasses were refrigerated for 24 hours and standard carcass measurements (including length, loin eye area, and backfat thickness) were collected. Backfat samples were taken at the 10th rib for fatty acid analysis by gas-liquid chromatography.

Performance and carcass data were analyzed using analysis of variance procedures (S.A.S., 1995) using the pen as the experimental unit for performance data and the individual as the experimental unit for carcass measurements.

EXPERIMENTAL DIETS (see Tables 1, 2, and 3):

The diets used in this experiment were:

- Diet 1: A corn-soy reference diet
- Diet 2: A barley-soy diet in which barley was the sole cereal grain in the diet
- Diet 3: A diet in which the cereal base was 75% barley and 25% naked oats
- Diet 4: A diet in which the cereal base was 50% barley and 50% naked oats

- Diet 5: A diet in which the cereal base was 25% barley and 75% naked oats
- Diet 6: A diet in which the cereal base was 100% naked oats

A grower diet was fed from the initiation of the experiment to an average pen weight of 120 pounds. An early finisher diet was fed from 120 lb to 190 lb and a late finishing diet was fed from 190 lb until the pigs were removed from the experiment at an average pen weight of approximately 240 lb. Diet formulations and minimum nutrient specifications for the corn-soy reference diet (Diet 1) are given in Tables 1, 2, and 3.

All diets were formulated with the "Professional Nutritionist for Swine" software as least-cost formulations. Nutrient concentrations for Diet 2 (grain = 100% barley) and for Diet 6 (grain = 100% naked oats) were formulated to 96% or 106%, respectively, of the nutrient concentration in the remaining diets because of differences in metabolizable energy content. Amino acid levels were formulated in the "Ideal Amino Acid" pattern as total amino acids.

RESULTS AND DISCUSSION:

Animal performance in this experiment was exceptional (Table 4), indicating that the experimental conditions were appropriate during this study. As expected, pigs receiving the corn-based reference diet sequence and those fed the diets for which naked oats was the sole grain gained more rapidly and efficiently than pigs given the diets in which barley was the only cereal grain ($P<.001$). Pigs fed the corn-based diets and those fed the barley-based dietary sequence consumed similar amounts of feed per day. Pigs receiving the dietary sequence based on naked oats as the sole grain consumed less feed per day ($P<.001$) than pigs receiving the corn- or barley-based diets, presumably because of the higher energy content of the naked oat-based diet.

There was an apparent linear response to increasing replacement of barley by naked oats for average daily gain, average daily feed intake, and feed per gain. These effects were also presumably due to the effect of dietary energy concentration.

Percent of the grain as naked oats did not influence parameters not expected to be influenced by diet (hot carcass weight, cold carcass weight, and carcass length) and did not influence average first rib or last lumbar backfat depth,

two factors that might have been altered by dietary energy. Backfat depth at the 10th rib was influenced by diet. Area of the loin eye muscle was influenced by diet.

The largest average loin eye area and least backfat at the 10th rib were noted for pigs receiving the diet sequence for which barley and naked oats represented equal proportions of the cereal grain in the diets. We do not have an explanation for these interactions.

There were no differences due to dietary treatment for pounds of fat-free lean, pounds of fat-free lean gain, or pounds of fat-free lean gain per day. These results indicate that all dietary sequences supported equal amounts of fat-free tissue gain and that any changes in carcass characteristics were due to the amount of fat deposited.

The fatty acid composition of a sample of backfat removed at the 10th rib (Table 5) was significantly influenced by diet for all but two minor fatty acids ($P<.05$ to $P<.0001$). There were linear changes in fatty acid composition as the proportion of naked oats was increased in the diet. These results were not unexpected because barley contains a low amount of total fat (about 1.8%) while naked oats will contain between 6% and 8% total fat. At higher levels of dietary fat, the fatty acid profile of the diet tends to be deposited in the carcass fat, while at low levels of dietary fat, pigs must synthesize more of the fatty acids stored in the carcass.

Fatty acids synthesized by the pig may contain higher levels of saturated fatty acids, an observation confirmed in these results. Increasing the proportion of naked oats in the diets resulted in a linear decrease in the percentage of saturated fatty acids and an increase in the percentage of unsaturated fatty acids. It is not known if these changes in fatty acid composition would influence consumer acceptance, product shelf-life, or curing characteristics.

When all characteristics are considered, it appears that using a grain mix of 50% barley and 50% naked oats can serve as a means of increasing animal performance during the growing-finishing phases while producing excellent carcass characteristics.

IMPLICATIONS:

The results of this study demonstrate that swine producers in North Dakota may successfully use various

combinations of barley and naked oats for growing-finishing swine of high genetic potential. Increasing proportions of naked oats in the diets were associated with weight gains that were more rapid and required less feed per pound of gain. Average daily feed intake was decreased when the diets contained higher proportions of naked oats.

Carcass characteristics (area of the loin eye muscle and depth of backfat at the 10^{th} rib) were optimized when pigs were fed diets containing equal amounts of barley and naked oats. Fatty acid composition of backfat samples removed at the 10^{th} rib were altered by feeding naked oats because of the greater proportion of unsaturated fatty acids in the lipid tissue.

The relative economics of feeding barley, naked oats, or barley-naked oat combinations as replacements for corn as the cereal grain(s) in diets for growing-finishing pigs can be expected to vary with the prices of barley, naked oats, corn, and soybean meal.

Before selecting a cereal grain or a combination of grains to feed to growing-finishing swine, individual swine producers should calculate the projected cost of production using the diet formulations presented in this summary, their production inputs (particularly their feed per gain values and cost of individual ingredients), and the anticipated effects of grain sources or combinations on carcass value.

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Animal care was supervised by Ron Zimprich. Drs. Paul Berg and Martin Marchello assisted with the collection of carcass data. Marsha Kapphahn supervised all laboratory analyses.

Table 1. Formulation of Grower Diets: Barley-Naked Oats Experiment[1] (Fed to an average pen weight of 120 lb.)

% Corn	100	-	-	-	-	-
% Barley	-	100	75	50	25	0
% Naked Oats	-	-	25	50	75	100

Diet:	1	2	3	4	5	6
Ingredient:						
Corn	1405	-	-	-	-	-
Barley	-	1462.7	1154.7	813.3	430.6	-
Naked Oats	-	-	385.2	813.4	1293.7	1749.5
Soybean meal, 44%	522	462	383	294	194	163
Dical	35.3	31.7	31.1	30.4	29.6	32.5
Limestone	20.3	22.0	22.5	23.1	23.8	24.9
Salt	8.0	8.0	8.0	8.0	8.0	8.0
Premix	5.0	5.0	5.0	5.0	5.0	5.0
Zinc Oxide	0.3	0.3	0.3	0.3	0.3	0.3
Tylan 40 Medication	3.0	3.0	3.0	3.0	3.0	3.0
L-Lysine	0.5	2.1	3.4	5.0	6.7	7.7
DL-Methionine	0.6	2.9	3.1	3.3	3.6	4.0
L-Threonine	-	0.3	0.7	1.2	1.7	2.1

[1] Diets were formulated using the "Professional Nutritionist for Swine" software as least-cost formulations. Minimum nutrient specifications for the corn-soy basal diet were: Crude Protein, 17.5%; lysine, 0.95%; methionine + cystine, 0.62%; threonine, 0.67%; tryptophan, 0.20%; calcium, 0.88%, and total phosphorus, 0.70%.
Nutrient levels in diets 2 and 6 were 94% and 106%, respectively, of those in the corn-soy reference diet to reflect changes in the energy content of these diets.

Table 2. Formulation of Early-Finishing Diets: Barley-Naked Oats Experiment [1] (Fed from average pen weight of 120 lb. to 190 lb. average pen weight.)

% Corn	100	-	-	-	-	-
% Barley	-	100	75	50	25	0
% Naked Oats	-	-	25	50	75	100

Diet:	1	2	3	4	5	6
Ingredient:						
Corn	1507.7	-	-	-	-	-
Barley	-	1568.7	1239.2	872.3	462.5	-
Naked Oats	-	-	412.5	872.4	1387.2	1890.4
Soybean meal, 44%	434	371	285.8	190.4	83	39
Dical	25.8	21.9	21.7	22.4	23.1	24.1
Limestone	19.3	21.1	21.3	20.6	19.7	21.9
Salt	7.0	7.0	7.0	7.0	7.0	7.0
Premix	4.0	4.0	4.0	4.0	4.0	4.0
Zinc Oxide	0.3	0.3	0.3	0.3	0.3	0.3
Tylan 40 Medication	1.0	1.0	1.0	1.0	1.0	1.0
L-Lysine	0.9	2.5	4.0	5.6	7.1	8.6
DL-Methionine	-	2.5	2.7	3.0	3.2	3.7
L-Threonine	-	-	0.5	1.0	1.5	2.0

[1] Diets were formulated using the "Professional Nutritionist for Swine" software as least-cost formulations. Minimum nutrient specifications for the corn-soy basal diet were: Crude Protein, 16.0%; lysine, 0.85%; methionine + cystine, 0.56%; threonine, 0.60%; tryptophan, 0.17%; calcium, 0.75%, and total phosphorus, 0.60%.
Nutrient levels in diets 2 and 6 were 94% and 106%, respectively, of those in the corn-soy reference diet to reflect changes in the energy content of these diets.

Table 3. Formulation of Late-Finisher Diets: Barley-Naked Oats Experiment [1] (Fed from an average pen weight of 190 lb. to completion of the experiment.)

% Corn	100	-	-	-	-	-
% Barley	-	100	75	50	25	0

% Naked Oats	-	-	25	50	75	100
Diet:	1	2	3	4	5	6
Ingredient:						
Corn	1575.7	-	-	-	-	-
Barley	-	1637.7	1292.7	910.3	482	-
Naked Oats	-	-	432	910.4	1338.5	1943.2
Soybean meal, 44%	377.2	314.1	225.6	127.4	15.0	-
Dical	16.1	12.0	11.2	10.5	9.6	10.6
Limestone	18.5	20.4	21.0	21.7	22.5	23.7
Salt	7.0	7.0	7.0	7.0	7.0	7.0
Premix	4.0	4.0	4.0	4.0	4.0	4.0
Zinc Oxide	0.3	0.3	0.3	0.3	0.3	0.3
Tylan 40 Medication	1.0	1.0	1.0	1.0	1.0	1.0
L-Lysine	0.2	1.9	3.4	5.1	7.0	7.0
DL-Methionine	-	1.6	1.8	2.0	2.3	2.4
L-Threonine	-	-	-	0.3	0.8	0.8

[1] Diets were formulated using the "Professional Nutritionist for Swine" software as least-cost formulations. Minimum nutrient specifications for the corn-soy basal diet were: Crude Protein, 15.0%; lysine, 0.75%; methionine + cystine, 0.49%; threonine, 0.53%; tryptophan, 0.15%; calcium, 0.62%, and total phosphorus, 0.50%.

Nutrient levels in diets 2 and 6 were 94% and 106%, respectively, of those in the corn-soy reference diet to reflect changes in the energy content of these diets.

Table 4. Performance Summary of Growing-Finishing Pigs Fed Various Combinations of Barley and Naked Oats

% Corn	100	-	-	-	-	-	

% Barley	-	100	75	50	25	0	
% Naked Oats	-	-	25	50	75	100	
Diet:	1	2	3	4	5	6	
Item:							Stat.
Growth:							Sign. (P<)[1]
No. of Pigs	32	32	32	32	32	32	
Initial Wt., lb.	54.55	54.14	54.74	54.34	54.21	54.32	
Final Wt., lb.	240.2	241.1	241.7	240.6	242.1	237.3	n.s.
ADG, lb.	1.94	1.78	1.86	1.86	1.91	1.93	.001
ADFI, lb.	5.12	5.20	5.32	4.97	4.85	4.75	.001
F/G	2.64	2.92	2.86	2.67	2.54	2.46	.001
Carcass:							
Hot Carcass Wt., lb.	182.8	178.5	180.7	182.2	184.6	182.2	n.s.
Dressing %	76.14	74.08	74.76	75.74	76.25	76.77	.001
Cold Carcass Wt., lb.	178.6	174.0	175.9	177.4	180.2	177.8	n.s.
Cooler Shrink, %	2.34	2.52	2.68	2.61	2.38	2.38	.001
Length, in.	31.4	31.7	31.6	31.5	31.7	31.3	n.s.
Backfat Depth, in.							
First Rib	1.59	1.53	1.57	1.65	1.66	1.67	n.s.
10^{th} Rib	0.98	0.86	0.87	0.84	1.00	0.96	0.02
Last Lumbar	1.00	0.85	0.90	0.92	1.00	1.00	n.s.
LEA, sq. in.	6.24	6.56	6.34	7.02	6.73	6.25	0.03

Lean Gain:							
Lb. Lean	87.4	91.0	89.7	93.3	89.3	88.0	n.s.
Lean Gain, lb.	68.2	72.2	70.4	74.3	70.2	69.2	n.s.
Lean Gain/day, lb.	0.72	0.70	0.69	0.71	0.72	0.73	n.s.
[1] Effect due to treatment.							

Table 5. Average Fatty Acid composition of 10th Rib Backfat Samples of Growing-Finishing Pigs Fed Various Combinations of Barley and Naked Oats

% Corn	100	-	-	-	-	-	
% Barley	-	100	75	50	25	0	
% Naked Oats	-	-	25	50	75	100	
Diet:	1	2	3	4	5	6	
Item:							Stat.
							Sign. (P<)[1]
No. of Pigs	16	16	16	16	16	16	
Fatty Acid:							
C14:0 (Myristic)	0.73	0.75	0.74	0.69	0.65	0.63	0.0001
C16:0 (Palmitic)	19.96	20.58	20.44	19.34	18.34	17.93	0.0001
C16:1 (Palmitoleic)	1.41	1.92	1.66	1.36	1.30	1.11	0.0001
C17:0 (Margaric)	0.37	0.68	0.66	0.39	0.27	0.22	0.0001
C18:0 (Stearic)	15.21	15.00	15.07	14.04	12.50	12.90	0.0001
C18:1E (Elaidic)	0.21	0.27	0.41	0.22	0.18	0.17	0.05
C18:1Z (Oleic)	41.13	43.15	42.41	42.63	43.77	43.08	0.001
C18:2 (Linoleic)	17.91	14.44	15.32	18.08	19.76	20.63	0.0001

C18:3 (Linolenic)	0.66	0.91	0.88	0.78	0.64	0.71	0.05
C20:0 (Arachidonic)	0.35	0.31	0.31	0.32	0.31	0.31	n.s.
C20:1 (Eicosenoic)	0.92	1.01	1.07	0.97	1.08	1.08	0.01
C20:3 (Eicosatrienoic)	0.84	0.68	0.71	0.81	0.85	0.88	0.0001
C22:0 (Behenic)	0.31	0.32	0.32	0.36	0.35	0.35	n.s.
Total Saturated:	36.93	37.64	37.51	35.14	32.43	32.34	
Total Unsaturated:[2]	63.08	62.38	62.46	64.85	67.58	67.66	
Polyunsaturated:	19.41	16.03	16.91	19.67	21.25	22.22	

[1] Effect due to treatment.

[2]The total of saturated and unsaturated fatty acids may not total 100.0% because of rounding of individual values.

LITERATURE CITED

SAS. 1995. SAS User's Guide: Statistics. SAS Inst. Inc. Cary, NC.

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