Comparison of Grain Sources (Barley, White Corn, and Yellow Corn) for Swine Diets and Their Effects on Meat Quality and Production Traits

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Summary and Implications

Efficient pork production is a necessity for an economically viable swine industry. Number two yellow corn is considered the primary energy source for swine diets in the Midwest. Despite the low protein content, corn is considered one of the most economical feed stuffs available to the swine production system. Barley is a high fiber that has approximately 89% of the energy content of corn. While barley contains a higher protein and amino acid level than corn, animal performance is expected to be depressed due to the high fiber content. Because barley lacks the carotene content that yellow corn possesses, it has been hypothesized that barley-fed pigs will yield higher meat and fat quality that is desired by export markets. White corn was used in this trial to determine its contribution to meat quality and growth traits.

An experiment was conducted to evaluate the effect of energy source on performance and carcass traits of pigs. Diet treatments (primary energy source) were: 1) yellow corn, 2) white corn, 3) 1/3 yellow corn, 2/3 white corn, 4) 2/3 yellow corn, 1/3 white corn, 5) barley. Pigs completing the trial were from two sires lines, Duroc (n=500) and Hamp x Duroc (n=499), that were mated to PIC 1055 females. Pigs were randomly allocated to pens based on genetic type and gender using a 2 x 2 x 5 factorial arrangement with two genetic types, two sexes (barrows and gilts) and five treatments

Animals fed these diets differing in energy source did not express a difference in average daily gain, average daily feed intake, feed-to-gain ratio, backfat depth or percent fat free lean. However, barley-fed pigs did have a smaller ($p < .05$) loin muscle area than pigs fed corn-based diets. Diet did not have an effect on sensory panel traits for tenderness or chewiness and limited differences were observed for juiciness, flavor, and off-flavor. Percentage loin purge, and cooking loss did not differ among diets fed to the pigs with minimal difference noted for color values. Pigs fed barley diets did have lower iodine value content within the subcutaneous fat indicating that the fat is of firmer quality. Results of this trial suggest that barley does not have an advantage in meat quality traits when compared to traditional corn-based diets. Barley does however have a significant impact on the hardness of pork fat, but does not have a significant effect on subjective color values.

Introduction

The swine industry is rapidly evolving into two distinct segments: commodity pork production and value-added pork production. One of the most lucrative value-added markets is the export market to Asia. However, there is considerable international competition for this market. The primary requisite for entry into this market is high meat quality. This high meat quality is generally defined first as meat that has a bright reddish color. After color, the meat quality traits required include marbling and fat quality. There are some North American pork suppliers that compete with Iowa-based pork suppliers that are currently making claims that their barley-fed pigs are producing a higher quality product for the Asian market. This alleged superiority is primarily in terms of more desirable color, but also is implied for the other meat quality traits. Since these exporters are competitively located to ship fresh chilled pork to the Asian market, this claim of product superiority needs examination for unbiased, accurate information to use in competitive marketing. The availability of white corn for use as the energy source has been credited with creating a whiter, firmer fat quality in the carcass. This also has the potential to increase the value of pork for the value-added export market and needs examination.

The objective of this study are to evaluate the differences in meat quality and production traits in pigs fed traditional corn-based diets versus barley-based diets and white corn-based diets in the growing and finishing phases. The meat quality traits examined will be color, marbling, pH, fat quality, and consumer acceptance. The production traits examined would be growth rate, feed conversion and percent lean. The fat quality traits examined would be iodine value and subjective fat color score.

Materials and Methods

The experiment was designed completely randomized with five treatments. A total of 40 pens, each containing 26 pigs, was used in the trial. Two different genetic types as well as both barrows and gilts made up the population for this study (n=1,040). Pigs were individually weighed on test and randomly allocated to pens on the basis of gender and genetic type.

The pigs were housed in a mechanically ventilated, curtain-sided finisher building with totally slotted floors. Each pen was equipped with a five-space, single-sided, stainless steel self feeder, and nipple waterers allowing for ad libitum feed and water consumption. Pigs average on test weight was 61 lb. and fed one of five diets containing a primary energy source throughout the grow-finish period:

1. Yellow Corn (YC)
2. White Corn (WC)
3. 1/3 YC, 2/3 WC
4. 2/3 YC, 1/3 WC
5. Barley

Diet composition can be found in Table 1.

Feed consumption was measured on a pen basis with the use of Arkfeld feed hoppers and scales mounted on every feeder. Pens were weighed and feed inventories recorded at two-week intervals to monitor growth and performance. Upon completion of the trial a National Swine Improvement Federation certified technician collected measurements for backfat thickness and loin muscle area between the 10^{th} and 11^{th} rib on the live animal. Measurements were collected with the use of an ALOKA 500V ultrasound machine equipped with a 12.5-cm, 3.5-MHz linear array transducer.

Eight pigs from each pen were randomly selected for meat quality analysis for a total of 319 samples. Pigs were rested overnight at a commercial abattoir prior to slaughter. One whole skin-on boneless loin was collected from each pig. Loins were cryovac sealed and transported to the Iowa State University Meat Lab and stored for 25-27 days at 30 degrees Fahrenheit. Upon reaching 25-27 days loins were processed for further meat quality, and trained sensory panel analysis. Samples of subcutaneous fat were collected for fatty acid profiles.

Data were analyzed using the GLM procedure of SAS; treatment means (least-squares means) were considered significant at P values < .05.

Results & Discussion

Least squares means for performance and carcass traits by diet, gender, and sire line are presented in Table 2. There were no significant differences among the five diets for average daily gain, average daily feed intake, and feed-to-gain during the grow–finish period. Likewise, no effects (P>.05) on backfat thickness or percent fat-free lean were observed. Barley-fed animals had a smaller loin muscle area than pigs on either the yellow corn or white corn treatments (P<.05). Pigs on the barley diet also exhibited a poorer lean gain on test (P<.05) compared with pigs fed diets containing all yellow corn, all white corn, and two-thirds yellow corn, one-third white corn diets. The results of the trial indicated that yellow corn could be replaced in a diet with barley or white corn as an energy source with no significant effect on performance. Decisions whether to include barley or white corn as an energy source should be based on their relative cost and availability.

Least squares means for meat quality traits by diet, gender, and sire line are presented in table 3. There were no significant differences among the five diet treatments for 24 hour pH, chewiness, sensory tenderness, instron tenderness, loin purge, and cook loss. Yellow corn-fed animals had a higher sensory juiciness value than did pigs fed 1/3 yellow corn, 2/3 white corn diet. Pigs fed 2/3 yellow corn, 1/3 white corn had a higher Japanese color score than did pigs fed barley, white corn, and 1/3 yellow corn, 2/3 white corn diets. Likewise pigs fed 2/3 yellow corn, 1/3 white corn had a more desirable hunter L* value than did barley fed pigs. The results of this trial suggest that pigs fed barley do not have an advantage in meat and eating quality traits over pigs fed traditional corn-based diets, dietary energy source has no effect on sensory traits.

Least squares means for fat quality traits by diet, gender, and sire line are presented in Table 4. Barley-fed pigs had a significantly lower iodine value relating to a higher saturated fatty acid content than pigs fed corn-based diets. While no differences were observed in subjective fat color score among diets. Barley-fed pigs also showed a significant difference compared to pigs fed corn-based diets for palmitic, palmitoleic, linoleic, linolenic, arachidic, eicosenoic, and arachidonic values. Results from this data suggest that fatty acid profile can be manipulated with the use of different energy sources. However subjective fat color score is not affected by diet treatment.

Table 1. Composition phase four diets (as-fed basis).

	Diet				
Ingredient, %	1	2	3	4	5
Yellow corn	82.1		27.1	54.9	
White corn		82.1	54.9	27.1	
Barley					89.1
Soybean meal	13.8	13.8	13.8	13.8	6.9
Dicalcium phosphate	0.85	0.85	0.85	0.85	0.39
Calcium carbonate	0.85	0.85	0.85	0.85	1.0
Choice white fat	1.0	1.0	1.0	1.0	1.0
Salt	0.35	0.35	0.35	0.35	0.35
Vitamin premix	0.50	0.50	0.50	0.50	0.50
Trace mineral premix	0.25	0.25	0.25	0.25	0.25
Tylan 40	0.25	0.25	0.25	0.25	0.25

Table 2. Effect of yellow corn, white corn, 1/3 yellow corn and 2/3 white corn, 2/3 yellow corn and 1/3 white corn, and barley on finishing pig performance and carcass traits.

	Diet					Gender		Sire Line	
Trait	1	2	3	4	5	B	G	HxD	D
Average daily gain, lb.	1.74	1.75	1.72	1.76	1.72	1.8^{d}	1.67e	1.73	1.74
Average daily feed intake, lb.	5.35	5.39	5.33	5.40	5.47	5.72	5.06	5.24^{f}	5.54^{g}
Feed-to-gain, lb.	3.08	3.09	3.10	3.07	3.17	3.18e	3.03^{d}	3.03^{f}	3.18^{g}
Backfat, in.	.90	.88	.88	.89	.87	.95^{e}	.82^{d}	.92^{g}	.85^{f}
Loin muscle area, in.	7.74^{a}	7.68^{a}	7.66^{a}	7.77^{a}	7.48^{b}	7.48e	7.85^{d}	7.55^{g}	7.84^{f}
Percent fat-free lean, %	52.59	52.49	52.52	52.63	52.25	50.98e	54.02^{d}	52.11^{g}	52.88^{f}
Lean gain on test,lb.	.71^{a}	.71^{a}	.70^{ab}	.72^{a}	.69^{b}	.71	.71	.70^{g}	.72^{f}

^{abcdefg} Means with different superscripts within a row and treatment differ (P<0.05)

Table 3. Effect of yellow corn, white corn, 1/3 yellow corn and 2/3 white corn, 2/3 yellow corn and 1/3 white corn, and barley on meat and eating quality traits.

	Diet					Gender		Sire Line	
Item	1	2	3	4	5	B	G	HxD	D
24 hour pH	5.99	5.97	6.01	5.99	5.99	5.98	5.99	5.97^{f}	6.0^{g}
Intramuscular fat, %	1.89^{ab}	1.81^{c}	2.13^{a}	2.05^{ab}	1.93^{abc}	2.11^{d}	1.81^{e}	1.92	2.01
Juiciness	4.19^{a}	4.49^{ab}	4.77^{b}	4.5^{ab}	4.29^{ab}	4.52	4.39	4.34	4.56
Tenderness	6.21	6.47	6.54	6.55	6.27	6.59^{d}	6.23^{e}	6.37	6.44
Chewiness	3.06	2.99	2.84	2.94	3.06	2.84^{d}	3.11^{e}	2.96	2.99
Flavor	1.95^{ab}	1.79^{a}	1.93^{ab}	2.13^{b}	1.84^{a}	2.03^{d}	1.82e	1.8^{f}	2.05^{g}
Off-flavor	3.46^{ab}	4.07^{a}	3.59^{ab}	3.36^{b}	3.76^{ab}	3.46	3.84	3.96^{f}	3.34^{g}
Instron tenderness, kg	5.9	5.85	5.74	5.7	5.79	5.63^{d}	5.97^{e}	5.85	5.75
Loin purge, %	1.13	1.0	1.07	.94	.95	.96	1.1	1.04	1.01
Cook loss, %	21.37	20.1	20.07	20.27	21.4	20.43	20.85	20.84	20.44
Japanese color score	2.88^{ab}	2.76^{b}	2.72^{b}	3.0^{a}	2.73^{b}	2.92^{d}	2.72^{e}	2.68^{f}	2.97^{g}
Hunter L*	50.38^{ab}	50.38^{ab}	50.44^{ab}	49.35^{a}	50.65^{b}	49.93	50.56	51.27^{f}	49.21^{g}

^{abcdefg} Means with different superscripts within a row and treatment differ (P<0.05)

Table 4. Effect of yellow corn, white corn, 1/3 yellow corn and 2/3 white corn, 2/3 yellow corn and 1/3 white corn, and barley on fat quality traits.

	Diet					Gender		Sire Line	
Item	1	2	3	4	5	B	G	HxD	D
Iodine Value	61.84[b]	62.17[b]	62.10[b]	61.83[b]	58.74[a]	60.40[d]	62.31[e]	61.52	61.15
Myrisitic 14:0	1.36[a]	1.33[ab]	1.30[c]	1.32[bc]	1.35[ab]	1.37[d]	1.30[e]	1.31[f]	1.35[g]
Stearic 18:0	12.74[b]	12.61[b]	12.76[b]	12.92[ab]	13.16[a]	12.97[d]	12.71[e]	12.52[f]	13.15[g]
Palmitic 16:0	24.35[ab]	24.10[b]	24.16[b]	24.24[b]	24.66[a]	24.71[d]	23.89[e]	24.20[f]	24.40[g]
Palmitoleic 16:1	2.22[b]	2.28[b]	2.13[b]	2.14[b]	2.37[a]	2.26[d]	2.17[e]	2.25[f]	2.18[g]
Oleic 18:1	42.91[b]	43.02[b]	43.10[b]	42.88[b]	44.39[a]	43.22	43.30	43.82[g]	42.69[f]
Linoleic 18:2	11.96[b]	12.06[b]	12.05[b]	11.99[b]	9.17[a]	10.90[d]	11.99[e]	11.28[f]	11.62[g]
Linolenic 18:3	.58[b]	.60[b]	.59[b]	.59[b]	.68[a]	.59[d]	.63[e]	.60	.61
Arachidic 20	.22[b]	.21[a]	.21[a]	.22[b]	.20[a]	.22[d]	.20[e]	.20[f]	.22[g]
Eicosenoic 20:1	.76[b]	.76[b]	.76[b]	.78[b]	.84[a]	.79[d]	.76[e]	.76[g]	.80[f]
Arachidonic 20:4	.21[b]	.21[b]	.20[b]	.20[b]	.18[a]	.19[d]	.21[e]	.20	.20
Subjective fat color score	1.71	1.72	1.67	1.67	1.67	1.6[d]	1.77[e]	1.64	1.73

[abcdefg] Means with different superscripts within a row and treatment differ ($P<0.05$)

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