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Influence of Enogen Feed Corn and Conventional Yellow Dent Corn in Pelleted- or Meal-Based Diets on Finishing Pig Performance and Carcass Characteristics

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Abstract

A total of 288 pigs (DNA 241 × 600; initially 117 lb) were used in a 72-d trial to evaluate the influence of Enogen Feed corn (Enogen, Syngenta Seeds, LLC; Downers Grove, IL) and conventional yellow dent corn in pelleted or meal diets on finishing pig performance and carcass characteristics. Pigs were randomly assigned to pens (8 pigs per pen) and pens were allotted by weight to 1 of 4 dietary treatments in a randomized complete block design with 9 pens per treatment. Treatments were arranged in a 2 × 2 factorial with main effects of corn source (Enogen Feed corn or conventional yellow dent) and diet forms (meal or pellet). Overall, from d 0 to 72, there was a tendency ($P < 0.10$) for a difference between corn source for average daily gain (ADG) and feed efficiency (F/G) with slightly improved performance for pigs fed conventional yellow dent corn. When diets were fed as pellets, ADG was increased ($P = < 0.001$) and F/G was improved ($P = 0.001$) compared to pigs fed meal diets. In summary, feeding pellets to pigs increased ADG and improved feed efficiency with no major differences between corn sources on growth performance.

Keywords

corn, high amylase corn, meal, pellets, pig

Cover Page Footnote

Appreciation is expressed to Syngenta Seeds, LLC (Downers Grove, IL) for their partial financial support of this trial.

Authors

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Influence of Enogen Feed Corn and Conventional Yellow Dent Corn in Pelleted- or Meal-Based Diets on Finishing Pig Performance and Carcass Characteristics[1]

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Abstract

A total of 288 pigs (DNA 241 × 600; initially 117 lb) were used in a 72-d trial to evaluate the influence of Enogen Feed corn (Enogen, Syngenta Seeds, LLC; Downers Grove, IL) and conventional yellow dent corn in pelleted or meal diets on finishing pig performance and carcass characteristics. Pigs were randomly assigned to pens (8 pigs per pen) and pens were allotted by weight to 1 of 4 dietary treatments in a randomized complete block design with 9 pens per treatment. Treatments were arranged in a 2 × 2 factorial with main effects of corn source (Enogen Feed corn or conventional yellow dent) and diet forms (meal or pellet). Overall, from d 0 to 72, there was a tendency ($P < 0.10$) for a difference between corn source for average daily gain (ADG) and feed efficiency (F/G) with slightly improved performance for pigs fed conventional yellow dent corn. When diets were fed as pellets, ADG was increased (P = < 0.001) and F/G was improved ($P = 0.001$) compared to pigs fed meal diets. In summary, feeding pellets to pigs increased ADG and improved feed efficiency with no major differences between corn sources on growth performance.

Introduction

In a recent experiment conducted with finishing pigs fed mash diets, pigs fed Enogen Feed corn tended ($P < 0.08$) to have higher ADG than pigs fed conventional corn;[5] however, feed efficiency was not influenced. In another study conducted at Kansas State University with 3 different particle sizes (300, 600, and 900 microns) with either conventional or Enogen Feed corn, reducing particle size improved ADG (P = 0.014) and feed efficiency (P = 0.001) with no differences in performance observed between corn source. When comparing pellet quality with

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[5] P. Ochonski, F. Wu, E. Arkfeld, J. M. Lattimer, J. M. DeRouchey, S. S. Dritz, R. D. Goodband, J. C. Woodworth, and M. D. Tokach. 2019. Evaluation of High Amylase Corn on Growth Performance and Carcass Characteristics of Finishing Pigs. *Kansas Agricultural Experiment Station Research Reports:* Vol. 5: Iss. 8.

conventional corn and Enogen Feed corn, the percentage of gelatinized starch was greater for the Enogen Feed corn due to its high amylase content than for conventional yellow dent corn.[6] The greater starch gelatinization suggests that Enogen Feed corn may provide benefits over conventional corn in pelleted diets; however, this has not previously been tested. Therefore, the objective of this study was to evaluate the effects of feeding Enogen Feed corn vs. conventional yellow dent corn in pelleted and meal diets on finishing pig performance and carcass characteristics.

Procedures

The Kansas State University Institutional Animal Care and Use committee approved the protocol used in this experiment. The trial was conducted at the Kansas State University Swine Teaching and Research Center, Manhattan, KS. All diets were manufactured at the Hubbard Feed Mill, Columbus, NE. Both Enogen Feed corn (Enogen, Syngenta Seeds, LLC; Downers Grove, IL) and conventional yellow dent ground corn samples were collected for chemical analysis (Table 2). Corn was ground through the same roller mill using the same roller configurations to obtain consistent particle size. Ground corn samples were collected to verify particle size (Table 3). When running the particle size analysis, 2 samples of each corn source were used with and without the flow agent. All samples were determined according to ANSI/ASAE S319.2 standard particle size analysis method.[7] When pelleting the diets, the goal was to achieve a conditioning temperature of 185°F and hot pellet temperature of 190°F with a corn moisture target of 13% in order to achieve the necessary temperature rise during conditioning. All pellets were analyzed for PDI using the NHP100 with a 30-s run time and a 100-g sample with a filter. Pellets were sifted before and after analysis for separation of fines and pellets using a U.S. #6 standard sieve. Air temperature and pressure within the NHP100 were recorded throughout the experiment. During feed manufacturing, completed pellets were taken directly from the die to measure the hot pellet temperature and collect samples for chemical analysis (Table 4). Chemical analysis of pellets was conducted at Rock River Laboratory, Watertown, WI.

A total of 288 pigs (241 × 600; DNA, Columbus, NE; initially 117 lb) were used in a 72-d study. There were 9 pens per treatment and 8 pigs per pen with 4 barrows and 4 gilts per pen. Pens were randomly assigned to dietary treatments and balanced based on pen weight at the start of the study. Dietary treatments (Table 1) were arranged in a 2 × 2 factorial with two corn sources (conventional yellow dent or Enogen Feed corn) and two diet forms (pellet or meal). When formulating the diets, nutritional values were assumed to be the same between conventional yellow dent and Enogen Feed corn. The experimental diets were fed in two phases: grower (day 0 to 28) and finisher (day 28 to 73).

Pen and feeder weights were obtained approximately every 2 weeks in order to calculate ADG, ADFI, and F/G (Tables 5 and 6). On d 72, all pigs were individually weighed, ear tagged with a radio frequency identification (RFID) tag, and tattooed for individual carcass data measurements. Pigs were transported to a commercial packing plant (Triumph Foods, St. Joseph, MO) for processing and collection of hot carcass weight (HCW), loin depth, backfat depth, and percentage lean. Carcass yield was calculated as HCW divided by individual live animal weight determined at the farm.

Treatments were analyzed as randomized complete block design for one-way ANOVA using the lmer function from the lme4 package in R version 3.5.1 (2018-07-2) with pen considered the experimental unit, body weight as the blocking factor, and treatment as fixed effect. The

[6] C. Truelock, M. Tokach, C. Stark and C. Paulk. 2019. Pelleting and Starch Characteristics of Diets Containing High Amylase Corn. *Kansas Agricultural Experiment Station Research Reports*: Vol. 5: Iss. 8.
[7] ASABE Standards. (1995). S319.2: Method of determining and expressing fineness of feed materials by sieving. St. Joseph, Mich: ASABE.

main effects of corn source and diet form, as well as their interactions, were tested. Differences between treatments were considered significant at $P \leq 0.05$ and marginally significant at $0.05 < P \leq 0.10$.

Results and Discussion

There were no major differences in the chemical analysis of conventional and Enogen Feed corn (Table 2). Particle size was similar between corn sources (Table 3). Conditioning temperature for both corn sources was lower than targeted during the grower and finisher feed manufacturing process (Table 3). This result could be because the moisture of the corn was higher than expected upon arrival to the feed mill. Conditioner moisture was higher than intended, resulting in hot pellet temperatures being lower than planned. For pellet durability index, there were no major differences between the corn sources. Overall, the PDI was lower than expected and reasons for this are unknown. There were no major differences in complete pelleted diet chemical analysis between diets within the grower and finisher phases (Table 4). Samples of complete meal diets were sent to Ward Laboratories Inc., Kearney, NE, for chemical analysis. Diets for the grower and finisher phases containing the Enogen Feed corn tended to have increased neutral detergent fiber compared to the diets containing the conventional yellow dent corn. During the grower phase, the diets containing Enogen Feed corn tended to have increased crude fiber compared to the diets containing conventional yellow dent corn.

There was no corn source × diet form interaction other than during the finisher phase, where there was a tendency for a source × diet form interaction ($P = 0.092$; Tables 5 and 6) for F/G, where pelleting did not improve F/G in pigs fed conventional corn but did in pigs fed Enogen Feed corn. For carcass characteristics, there was a tendency for a source × diet form interaction ($P < 0.10$) for backfat depth and percentage lean with pigs fed Enogen Feed corn in meal diets having decreased backfat depth than pigs fed the other three diets, and pelleting conventional diets eliciting increased percent lean, but pelleting Enogen Feed corn diets eliciting reduced percent lean.

Overall, pigs fed the conventional corn tended to have increased ($P = 0.077$) ADG compared to pigs fed Enogen Feed corn, which resulted in a tendency ($P = 0.089$) for improvement in F/G. There were no other differences in performance detected between corn sources.

During the grower phase, pigs fed pelleted diets had increased ($P = < 0.001$) ADG compared to those fed meal diets. This resulted in an improvement ($P = 0.003$) in F/G for pigs fed pelleted diets. During the finisher phase, there was a significant main effect of diet form ($P = 0.049$) for ADG, with pigs fed pelleted diets having increased gain compared to pigs fed meal diets. Overall, pigs fed pelleted diets had improved ($P = < 0.001$) ADG and feed efficiency compared with pigs fed meal diets.

In conclusion, average daily gain and feed efficiency were improved when pelleted diets were fed compared to meal diets. Conventional yellow dent corn tended to improve average daily gain and feed efficiency when compared to Enogen Feed corn. The higher corn moisture at receiving made it impossible to reach the desired conditioning temperature of 185°F. Thus, starch gelatinization may have been limited, reducing the potential benefit of the Enogen Feed corn.

Table 1. Diet composition, as-fed basis

	Grower[1]		Finisher[2]	
Ingredient, %	Meal	Pellet	Meal	Pellet
Corn[3]	81.95	79.60	85.30	83.05
Soybean meal, 46.5% CP	15.65	16.50	12.35	13.10
Corn oil	---	1.50	---	1.50
Salt	0.50	0.50	0.50	0.50
Monocalcium phosphate, 21% P	0.40	0.40	0.35	0.35
Calcium carbonate	0.85	0.85	0.85	0.85
L-Lysine HCl	0.30	0.30	0.30	0.30
L-Threonine	0.10	0.10	0.11	0.11
L-Tryptophan	0.015	0.015	0.02	0.02
DL-Methionine	0.03	0.03	0.015	0.015
Phytase[4]	0.02	0.02	0.02	0.02
Selenium premix 0.06% 600 PPM	0.05	0.05	0.05	0.05
Trace mineral premix	0.08	0.08	0.08	0.08
Vitamin premix with biotin	0.05	0.05	0.05	0.05
Total	100	100	100	100
Calculated analysis				
Standardized ileal digestible (SID) amino acids %				
Lysine	0.83	0.84	0.75	0.76
Isoleucine:lysine	59	59	58	58
Leucine:lysine	144	142	150	148
Methionine:lysine	31	30	30	30
Threonine:lysine	65	64	67	67
Tryptophan:lysine	18	19	19	19
Valine:lysine	71	70	71	71
Total lysine, %	0.91	0.93	0.82	0.84
Net energy, kcal, lb	1,131	1,156	1,149	1,174
SID lysine:NE, g/Mcal	3.31	3.31	2.94	2.94
Crude protein, %	13.86	14.09	12.56	12.74
Calcium, %	0.48	0.49	0.47	0.47
Phosphorus, %	0.40	0.40	0.38	0.38
Analyzed Ca:analyzed P	1.21	1.21	1.24	1.25

[1]Grower diets were fed from d 0 to 28.
[2]Finisher diets were fed from d 28 to 72.
[3]Enogen Feed corn (Syngenta Seeds, LLC; Downers Grove, IL) replaced conventional corn on a lb:lb basis in the diets.
[4]Axtra PHY 2500 TPT provided an estimated release of 0.15 available P.

Table 2. Chemical analysis of ground corn[1,2]

Item	Conventional[3]	Enogen Feed corn[4]
Crude protein	8.98	8.39
Ether extract	3.14	3.31
Ash	1.60	1.52
ADF	3.23	3.20
Starch	70.22	71.56
Calcium	0.05	0.05
Phosphorus	0.24	0.25

[1]Ground corn samples were taken from the roller mill at time of feed manufacturing.
[2]All samples were sent to Rock River Laboratory (Watertown, WI), for chemical analysis.
[3]Yellow dent corn.
[4]Enogen, Syngenta Seeds, LLC; Downers Grove, IL.

Table 3. Pelleting parameters for conventional and Enogen Feed corn[1]

	Grower		Finisher	
Item	Conventional[2]	Enogen Feed corn	Conventional	Enogen Feed corn
Particle size, µm	690	771	605	632
Conditioner mash moisture, %	19.82	20.16	18.89	20.03
Conditioning temperature, °F	155.5	151.5	154.8	156.0
Hot pellet temperature, °F	167.7	170.0	166.6	166.7
Pellet durability index,[2] %	53.1	63.5	56.2	53.1

[1]A double pass conditioner was used, with a 3/16-in die on the pellet mill. Production rates were held constant for all 3 dietary phases at 6.5 ton/h.
[2]Yellow dent corn.
[3]Enogen, Syngenta Seeds, LLC; Downers Grove, IL.
[4]All pellets were analyzed for PDI using the NHP100 with a 30-s run time and a 100-g sample with a filter. Pellets were sifted before and after analysis for separation of fines and pellets using a U.S. #6 standard sieve. Air temperature and pressure within the NHP100 were recorded throughout the experiment.

Table 4. Chemical analysis of complete diets[1,2]

	Meal diets[3]		Pelleted diets[4]	
Item, %	Conventional[5]	Enogen Feed corn	Conventional	Enogen Feed corn
Grower				
Dry matter	86.3	86.1	---	---
Crude protein	14.0	14.1	15.77	14.5
Ether extract	4.1	5.1	4.45	3.96
Ash	3.6	3.4	2.54	2.4
Acid detergent fiber	---	---	4.69	5.42
Neutral detergent fiber	6.8	7.9	---	---
Starch	---	---	52.54	55.54
Crude fiber	2.3	2.8	---	---
Finisher				
Dry matter	87.1	85.9	---	---
Crude protein	12.7	12.9	14.82	12.73
Ether extract	4.0	4.8	4.37	4.46
Ash	3.3	3.1	5.67	5.44
Acid detergent fiber	---	---	5.88	6.12
Neutral detergent fiber	6.4	9.1	---	---
Starch	---	---	54.68	55.47
Crude fiber	2.7	2.9	---	---

[1]Pellets were collected directly from the die at time of feed manufacturing.
[2]Meal diets were taken directly from the feeder 3 days after each phase began. A composite diet was riffle-divided and one sample of each treatment per phase was sent for analysis.
[3]Samples were sent to Ward Laboratories, Kearney, NE.
[4]All samples were sent to Rock River Laboratory, Watertown, WI.
[5]Yellow dent corn.
[6]Enogen, Syngenta Seeds, LLC; Downers Grove, IL.
[7]Grower diets were fed from d 0 to 28.
[8]Finisher diets were fed from d 28 to 72.

Table 5. Interactive effects of diet form and corn sources on finishing pig performance[1]

	Conventional[2]		Enogen Feed corn[3]			Probability, P =		
Item	Meal	Pellet	Meal	Pellet	SEM	Source × diet form	Source	Diet form
Body weight, lb								
d 0	117.8	117.8	116.8	118.0	1.388	0.534	0.726	0.535
d 28	188.4	198.0	188.9	196.1	1.912	0.536	0.715	<0.001
d 72	297.0	306.6	292.8	304.4	2.059	0.588	0.106	<0.001
Grower[4]								
ADG, lb	2.53	2.85	2.55	2.80	0.060	0.576	0.809	<0.001
ADFI, lb	6.05	6.19	6.03	6.31	0.133	0.585	0.705	0.123
F/G	2.40	2.18	2.35	2.27	0.052	0.158	0.678	0.003
Finisher[5]								
ADG, lb	2.44	2.46	2.33	2.46	0.037	0.133	0.152	0.049
ADFI, lb	6.96	7.07	6.98	7.08	0.098	0.958	0.883	0.297
F/G	2.85	2.88	2.99	2.87	0.044	0.092	0.153	0.305
Overall								
ADG, lb	2.48	2.62	2.42	2.58	0.028	0.769	0.077	<0.001
ADFI, lb	6.60	6.73	6.60	6.78	0.091	0.766	0.786	0.103
F/G	2.67	2.57	2.72	2.62	0.030	0.913	0.089	0.001
Carcass characteristics								
HCW, lb	224.1	233.1	220.7	230.6	2.312	0.837	0.221	0.001
Carcass yield, %	75.2	75.5	75.3	75.2	0.200	0.266	0.418	0.638
Backfat depth, in	0.70	0.69	0.66	0.71	0.016	0.068	0.333	0.271
Loin depth, in	2.57	2.66	2.61	2.62	0.026	0.120	0.963	0.109
Lean, %	53.60	54.01	54.13	53.76	0.202	0.061	0.492	0.927

[1]A total of 288 pigs (DNA 241 × 600, initially 117 lb) were used in a 72-d trial. There were 9 pens per treatment with 8 pigs per pen.
[2]Yellow dent corn.
[3]Enogen Feed corn, Syngenta Seeds, LLC; Downers Grove, IL.
[4]Grower diets were fed from d 0 to 28.
[5]Finisher diets were fed from d 28 to 72.

Table 6. Main effects of diet form and corn source on finishing pig growth performance[1]

Item	Corn source				Diet form			
	Conventional[2]	Enogen Feed corn[3]	SEM	Probability, $P =$	Meal	Pellet	SEM	Probability, $P =$
Body weight, lb								
d 0	117.8	117.4	1.220	0.726	117.3	117.9	1.210	0.535
d 28	193.2	192.5	1.380	0.715	188.6	197.0	1.375	<0.001
d 72	301.8	298.6	1.593	0.106	294.9	305.5	1.576	<0.001
Grower[4]								
ADG, lb	2.69	2.68	0.042	0.809	2.54	2.83	0.042	<0.001
ADFI, lb	6.12	6.17	0.094	0.705	6.04	6.25	0.094	0.123
F/G	2.29	2.31	0.039	0.678	2.38	2.22	0.039	0.003
Finisher[5]								
ADG, lb	2.45	2.40	0.027	0.152	2.39	2.46	0.027	0.049
ADFI, lb	7.01	7.03	0.069	0.883	6.97	7.07	0.069	0.297
F/G	2.87	2.93	0.031	0.153	2.92	2.88	0.031	0.305
Overall								
ADG, lb	2.55	2.50	0.023	0.077	2.45	2.60	0.023	<0.001
ADFI, lb	6.67	6.69	0.065	0.786	6.60	6.75	0.065	0.103
F/G	2.62	2.67	0.023	0.089	2.70	2.60	0.023	0.001
Carcass characteristics								
HCW, lb	228.5	225.6	1.654	0.221	222.3	231.8	1.611	<0.001
Carcass yield, %	75.4	75.2	0.100	0.418	75.3	75.3	0.100	0.638
Backfat depth, in	0.70	0.68	0.011	0.333	0.68	0.70	0.011	0.271
Loin depth, in	2.62	2.61	0.018	0.963	2.59	2.64	0.018	0.109
Lean, %	53.80	53.95	0.141	0.492	53.87	53.88	0.142	0.927

[1]A total of 288 pigs (DNA 241 × 600, initially 117 lb) were used in a 72-d trial. There were 9 pens per treatment with 8 pigs per pen.
[2]Yellow dent corn.
[3]Enogen Feed corn, Syngenta Seeds, LLC; Downers Grove, IL.
[4]Grower diets were fed from d 0 to 28.
[5]Finisher diets were fed from d 28 to 72.
BW = body weight. ADG = average daily gain. ADFI= average daily feed intake. F/G = feed efficiency.