Influence of Enogen Feed corn and conventional yellow dent corn in pelleted or meal-based diets on finishing pig performance and carcass characteristics

Hadley R. Williams^{†,1}, Mike D. Tokach[†], Jason C. Woodworth[†], Joel M. DeRouchey[†],
Robert D. Goodband[†], and Jordan T. Gebhardt^{†,2}

[†]Department of Animal Sciences and Industry, College of Agriculture, Kansas State University, Manhattan, KS 66506, USA and ²Department of Diagnostic Medicine/Pathobiology, College of Veterinary Medicine, Kansas State University, Manhattan, KS 66506, USA

ABSTRACT: Genetic modification of corn has enhanced the use of different corn hybrids in animal agriculture. Enogen Feed corn, developed by Syngenta Seeds (Downers Grove, IL), has potential for use in livestock diets due to increase α -amylase enzyme in the corn thus improving starch digestibility. In addition, the pelleting process also increases starch gelatinization which increases its digestibility by the pig, increasing growth rate and improving feed efficiency. Therefore, pelleting Enogen Feed corn might prove to provide a greater response in growth performance than conventional yellow dent corn. Thus, the objective of this experiment was to determine the effects of corn source and diet form on growth performance and carcass characteristics of finishing pigs. A total of 288 pigs (53.0 ± 0.5 kg) were used with eight pigs per pen and nine pens per treatment in a 72-d study. Treatments were arranged in a 2×2 factorial

with main effects of corn source (Enogen Feed corn or conventional yellow dent corn) and diet form (meal or pellet). For overall (d 0 to 72) performance, no interactions between corn source and diet form were observed. There was a tendency ($P < 0.10$) for slightly improved average daily gain (ADG) and gain:feed ratio (G:F) for pigs fed conventional yellow dent corn compared to those fed Enogen Feed corn. For feed form, pigs fed pelleted diets had increased ($P < 0.001$) ADG and G:F compared to pigs fed meal diets. For carcass characteristics, pigs fed pelleted diets had increased hot carcass weight compared to pigs fed meal diets ($P < 0.001$). In summary, feeding pelleted diets to finishing pigs increased ADG and improved feed efficiency compared to those fed meal-based diets. There were no major differences between observed corn sources or interactions between corn source and diet form on growth performance.

Key words: Carcass, Enogen Feed corn, finishing pigs, growth, meal, pellet

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INTRODUCTION

Cereal grains provide most of the dietary energy in swine diets. Corn is a widely available energy source in the United States and is commonly used in swine diets. Along with ample availability, corn has increased energy density compared to

other cereal grains. As genetic modification of corn improves, use of corn hybrids in the livestock industry has increased, and studies have observed increased in ADG and improved G:F when corn hybrids with specialized nutritional traits, like high lysine and high oil corn, are fed compared to conventional yellow dent corn (O'Quinn et al., 2000; Hastad et al., 2005). Enogen Feed corn contains an α -amylase enzyme trait, which is used in the ethanol industry to reduce the viscosity of the corn mash and improve the efficiency of ethanol

¹Corresponding author: hadley1@ksu.edu

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production. Increase of the α -amylase enzyme in the corn helps increase the conversion of corn starch to sugar to provide more energy for beef cattle (Brinton, 2019). Ochonski et al. (2021) fed Enogen Feed corn to finishing pigs and observed a tendency for increased daily gain compared to pigs fed conventional yellow dent corn but did not find differences in feed efficiency. Conversely, Williams et al. (2020) observed no difference in growth performance when feeding Enogen Feed corn in the diets compared to conventional yellow dent corn. Diets were fed in meal form in both of these studies.

Research has proven that feeding pelleted diets increased ADG and G:F (Wondra et al., 1995; De Jong et al., 2013a, 2013b; Nemecek et al., 2015). Pelleting pig diets improves performance by increasing nutrient digestibility and reducing feed wastage (Ball et al., 2015). During pelleting, starch gelatinization occurs which allows the pig to better utilize the starch. Truelock et al. (2020) evaluated pelleting Enogen Feed corn and conventional yellow dent corn with different pellet die length to diameter (L/D) ratios and conditioning temperatures on starch gelatinization. As conditioning temperature increased, starch gelatinization increased. Due to Enogen Feed corn having increased starch gelatinization when pelleted, we hypothesize that feeding Enogen Feed corn will improve growth performance when fed in a pellet form more than in a meal form when compared to diets with conventional yellow dent corn. Therefore, the objective of this study was to determine the effects of feeding Enogen Feed corn in meal or pellet form on finishing pig growth performance and carcass characteristics.

MATERIALS AND METHODS

The Kansas State University and Institutional Animal Care and Use committee approved the protocol used in these experiments.

Ingredients and Chemical Analysis

Conventional U.S. No. 2 dent corn and Enogen Feed corn (Syngenta Seeds; Downers Grove, IL) from a single source was used in this study. Both corn sources were ground to approximately 600 microns using a roller mill (Model DP 900-36, Roskamp, Waterloo, IA) equipped with three roll pairs. Roller mill settings were kept the same throughout the study for conventional yellow dent corn and Enogen Feed corn. Samples of ground corn were taken directly from the roller mill during each feed manufacturing event for each experiment

and analyzed (Table 1, Ward Laboratories, Inc., Kearney, NE) for dry matter (method 935.29; AOAC Inc., 2019), starch (Application #322. 2000), crude protein (method 990.03; AOAC Inc., 2019), ether extract (ANKOM Technology, 2004), acid detergent fiber and neutral detergent fiber (ANKOM Technology, 2005), calcium (method 6.3; Kovar, 2003), and phosphorus (method 6.3; Kovar, 2003).

Particle size analysis was conducted on ground corn samples (100 g) in duplicate according to the ASADE S319.2 (1995) standard method. Samples were analyzed with (0.5 g) a dispersing agent (Gilson Company, Inc., Lewis Center, OH). Sieve stacks contained agitators and were placed in the Ro-Tap (Model RX-29, W. S. Tyler Industrial Group, Mentor, OH) machine for 15 min.

Representative diet samples from each manufacturing event were obtained from each treatment within experiment and stored at -20°C until analysis. All manufacturing events occurred on the same days to use the same lots of corn for both the meal and pelleted diets. Samples were analyzed (Table 2, Ward Laboratories, Inc., Kearney, NE) for dry matter, crude protein, acid detergent fiber, neutral detergent fiber, Ca, and P using the same procedures as used for ground grain samples.

All experimental diets were manufactured at Hubbard Feeds (Columbus, NE) from January until March. The pellet mill production rate was held constant at 6.5 ton/h. Target conditioner temperature was set at 82.2°C . Truelock et al. (2020) evaluated pelleting Enogen Feed corn compared to conventional yellow dent corn. The authors observed that when pelleting Enogen Feed corn to increased conditioner temperatures, there was increased starch gelatinization compared to

Table 1. Chemical analysis of ground corn^{a,b}

Item	Conventional ^c	Enogen Feed corn ^d
Dry matter	88.20	87.50
Crude protein	9.00	8.50
Ether extract	4.15	4.03
Ash	1.43	1.54
Acid detergent fiber	2.58	3.30
Neutral detergent fiber	8.25	8.38
Starch	71.85	71.93
Ca	0.05	0.05
P	0.24	0.25

^aGround corn samples were taken from the roller mill at time of feed manufacturing. Values represent the mean of two samples.

^bAll samples were sent to Ward Laboratories, (Kearney, NE), for chemical analysis.

^cYellow dent corn.

^dEnogen[®] Feed corn, Syngenta Seeds, LLC, Downers Grove, IL.

Table 2. Chemical analysis of complete diets^{a,b}

Item, %	Meal diets ^c		Pelleted diets	
	Conven- tional ^d	Enogen Feed corn ^e	Conven- tional	Enogen Feed corn
Grower^f				
Dry matter	88.2	90.1	88.1	87.9
Crude protein	14.9	14.8	15.0	15.2
Ether extract	4.1	4.1	5.9	4.8
Ash	3.8	3.4	3.4	3.4
Acid detergent fiber	2.5	3.4	3.0	3.6
Neutral deter- gent fiber	6.0	7.6	6.0	7.9
Starch	51.5	50.3	47.1	48.1
Finisher^g				
Dry matter	88.5	90.2	90.2	91.3
Crude protein	14.8	15.3	13.7	14.5
Ether extract	4.2	4.1	4.3	4.5
Ash	3.3	3.3	3.4	3.6
Acid detergent fiber	2.4	2.6	2.9	2.9
Neutral deter- gent fiber	6.8	7.7	7.2	6.7
Starch	51.5	49.7	52.6	50.4

^aPellets were collected directly from the die at time of feed manufacturing. Values represent the mean of two samples.

^bMeal diets were taken directly from the feeder 3 days after each phase began. A composite diet was riffle divided and on sample of each treatment per phase was sent for analysis.

^cSamples were sent to Ward Laboratories, Kearney, NE.

^dYellow dent corn.

^eEnogen®, Syngenta Seeds, LLC, Downers Grove, IL.

^fGrower diets were fed from d 0 to 28.

^gFinisher diets were fed from d 28 to 72.

conventional yellow dent corn. To optimize the feed manufacturing, corn needed to be 13% to 14% moisture upon arrival to the feed mill to allow moisture rise required to achieve this temperature. Corn moisture was analyzed upon arrival to the feed mill, conventional yellow dent corn averaged 16% moisture and Enogen Feed corn averaged 17.5%. Getting the conditioner temperature to 82.2 °C is ideal to achieve maximum starch gelatinization of Enogen Feed corn. When pelleting the diets, the conditioning temperature averaged 68.4 °C for conventional yellow dent corn and 67.7 °C for Enogen Feed corn. The hot pellet temperature averaged 75.1 °C for conventional yellow dent corn averaged and 75.8 °C for Enogen feed corn. Conditioned mash corn was taken directly from the conditioner (Model 18 × 120, Andritz Sprout Bauer, Muncy, PA) to determine the moisture of the conditioned mash. Conditioned mash moisture for the diet containing conventional yellow dent corn averaged

19.3% and conditioned mash for Enogen Feed corn diets averaged 20.1%. The conditioned mash moisture shows the amount of moisture added to the mash when passing through the conditioner. For optimal pelleting, conditioned mash moisture should be between 18% and 20% for the pellets to move through die with less friction. A 4.8 mm × 3.2 cm die was used during pelleting, and pellets were taken directly from the die (Model 26W – 300 HL, Sprout Waldron, Tyler, TX), allowed to cool and analyzed for pellet durability index (PDI) using a NHP100 with a 30-sec 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 analysis. During feed manufacturing, completed pellets were taken directly from the die to measure hot pellet temperature and chemical analysis (Table 4). Pellets were taken directly from feeders using a grain probe to measure percentage fines.

Animals and Diets

Treatments were arranged in a 2 × 2 factorial with main effects of corn source (conventional yellow dent corn or Enogen Feed corn) and diet form (pellet or meal). Enogen Feed corn replaced conventional yellow dent corn on an equal weight basis (Table 3).

The experiment was conducted at the Kansas State University Swine Teaching and Research Center (Manhattan, KS). Pens of pigs were allotted to one of four dietary treatments in a randomized complete block design with BW as the blocking factor with eight pigs per pen, four barrows and four gilts, and nine pens per treatment. Diets were fed in either mash or pellet form for 72 d, split into two separate phases, grower and finisher phase. A total of 288 pigs (line 241 × 600; DNA, Columbus, NE; initially 53.43 ± 0.5 kg) were used in a 72-d trial. The facility was totally enclosed and environmentally regulated, containing 36 pens. Each pen (3.00 × 2.44 m) was equipped with a dry, single-sided feeder (Farmweld, Teutopolis, IL) with two feeder spaces and a 1-cup waterer. Pens were located over a completely slatted concrete floor with a 1.22-m deep pit underneath for manure storage. A robotic feeding system (FeedPro; Feedlogic Corp., Wilmar, MN) was used to deliver and record daily feed additions to each individual pen. Pens were equipped with adjustable gates to allow space allowance per pig to be maintained if a

Table 3. Diet composition, (as-fed basis)

Ingredient, %	Grower ^a	Finisher ^b
Corn ^c	79.60	83.05
Soybean meal, 46.5% CP	16.50	13.10
Corn oil	1.50	1.50
Salt	0.50	0.50
Monocalcium phosphate, 21% P	0.40	0.35
Calcium carbonate	0.85	0.85
L-Lysine HCl	0.30	0.30
L-Threonine	0.10	0.11
L-Tryptophan	0.015	0.02
DL-Methionine	0.03	0.015
Phytase ^d	0.02	0.02
Selenium premix	0.05	0.05
Trace mineral premix ^e	0.08	0.08
Vitamin premix ^f	0.05	0.05
Total	100	100
Calculated analysis		
Standardized ileal digestible (SID) amino acids %		
Lysine	0.84	0.76
Isoleucine:lysine	59	58
Leucine:lysine	142	148
Methionine:lysine	30	30
Threonine:lysine	64	67
Tryptophan:lysine	19	19
Valine:lysine	70	71
Total lysine, %	0.93	0.84
Net energy, kcal/kg	2,548	2,588
SID lysine:NE, g/Mcal	3.31	2.94
Crude protein, %	14.09	12.74
Ca, %	0.49	0.47
P, %	0.40	0.38
Analyzed Ca:analyzed P	1.21	1.25

^aGrower diets were fed from d 0 to 28.

^bFinisher diets were fed from d 28 to 72.

^cEnogen Feed corn replaced conventional corn on an equal weight basis

^dAxtra PHY 2500 TPT (DuPont, Wilmington, DE) provided an estimated release of 0.15% available P.

^eProvided per kg of premix: 160,090 mg Zn from zinc oxide, 134,000 mg Fe of FeS Monohydrate, 40,000 mg Mn from Manganese sulfate, 13,340 mg Cu from copper sulfate, 666 mg I from EDDI 80% iodine.

^fProvided per kg of premix: 24,255 IU vitamin A, 4,410 IU vitamin D, 132,268 IU vitamin E, 13,228 vitamin K, 110.2 mg vitamin B₁₂, 99,212 mg niacin, 90,390 mg pantothenic acid, 17,640 mg riboflavin.

pig died or was removed during the experiment. All experimental pens of pigs were weighed, and feed disappearance was measured every two weeks to calculate average daily gain (ADG), average daily feed intake (ADFI), and gain to feed ratio (G:F).

On d 72, pigs were individually tattooed with a unique ID number, and a radio frequency identification transponder was inserted into the right ear to allow carcass measurements to be recorded

on a pig basis. Final pen weights and individual pig weights were taken, and pigs were transported approximately 2.5 h to a commercial packing plant (Triumph Foods, St. Joseph, MO) and held in lairage for approximately 7 h before slaughter. At the plant, hot carcass weight (HCW) was determined immediately after evisceration. Backfat and loin depth were measured with an optical probe (Fat-O-Meter, SFK, Herley, Denmark) inserted between the third and fourth rib (counting from the ham end of the carcass) at a distance approximately 7 cm from the dorsal midline. Percentage lean was calculated using proprietary equations from the packing plant. Carcass yield was calculated by dividing the individual HCW obtained from the packing plant by the individual final live weight measured at the farm.

Statistical Analysis

Treatments were analyzed as randomized complete block design for two-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 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

Chemical Analysis

This experiment was conducted in January through March, with relatively new crop corn. Whole corn at the mill averaged 17% moisture. Samples were collected throughout the study and stored before sending for proximate analysis. The chemical analysis for ground corn was similar for both corn sources (Table 1). Ground corn was collected at each manufacturing event, approximately five events, and particle size was analyzed. Corn particle size was analyzed with the inclusion of dispersing agent. In both the grower and finisher phases, Enogen Feed corn tended to have slightly greater ground corn particle size compared to the conventional yellow dent (Table 4).

Conditioning temperature for both corn sources was lower than targeted during the grower and finisher feed manufacturing process. This result could be because the moisture of the corn was higher than expected upon arrival to the feed mill as previously

Table 4. Feed manufacturing parameters for conventional and Enogen Feed corn^a

Item	Grower		Finisher	
	Conventional ^b	Enogen Feed corn ^c	Conventional	Enogen Feed corn
Particle size, μm^d	690	771	605	632
Sgw	2.85	2.75	3.21	3.23
Conditioner mash moisture, %	19.82	20.16	18.89	20.03
Conditioning temperature, °C	68.6	66.4	68.2	68.9
Hot pellet temperature, °C	75.4	76.7	74.8	74.8
Pellet durability index ^e , %	53.1	63.5	56.2	53.1
Fines ^f , %	46.55	54.42	36.03	22.04

^aA double pass conditioner (Model 18 × 120, Andritz Sprout Bauer, Muncy, PA) was used, with a 4.8 mm die on the pellet mill (Model 26W – 300 HL, Sprout Waldron, Tyler, TX). Production rates were held constant for all three dietary phases at 6.5 ton/h. Values represent the mean of two samples per phase.

^bYellow dent corn.

^cEnogen®, Syngenta Seeds, LLC, Downers Grove, IL.

^dParticle size analysis was measured on ground corn samples taken directly from the roller mill at each manufacturing event.

^eAll pellets were cooled then analyzed for PDI using the NHP100 with a 30-sec 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.

^fPellets were taken directly from the feeder using a grain probe for analysis of percent fines.

stated. The higher corn moisture content resulted in a conditioning temperature of 66–68 °C and a hot pellet temperature of 74–76 °C. For PDI samples collected at the mill, Enogen Feed corn has a 10-percentage unit greater PDI than conventional yellow dent corn in the grower phase, with no major differences between the corn sources in the finisher phase. During the grower phase, there was no difference in percent fines in the pelleted feed, but during the finisher phase, pellets with Enogen Feed corn had increased percent fines compared to conventional yellow dent corn. Grower diets had increased percent fines compared to pellets in the finisher phase. Also, complete pelleted diets were generally similar in chemical analysis within the grower and finisher phases; however, diets for the grower and finisher phases containing the Enogen Feed corn tended to have increased neutral detergent fiber and slightly higher crude fiber compared to the diets containing the conventional yellow dent corn (Table 4).

Growth Performance

There was no evidence for interactions other than during the finisher phase, where there was a tendency for a corn source × diet form interaction ($P = 0.091$; Tables 5 and 6) for G:F. Pelleting did not improve G:F in pigs fed conventional corn but did in pigs fed Enogen Feed corn. Pigs fed conventional yellow dent meal diets had similar G:F to pigs fed conventional yellow dent corn that was pelleted. For carcass characteristics interactions, there

was a tendency for a corn 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 compared with pigs fed the other three diets and pelleting increasing percentage lean in pigs fed conventional corn diets, with pigs fed Enogen Feed corn diets having reduced percentage lean when pelleted.

For the overall experimental period, pigs fed the conventional yellow dent corn tended to have increased ($P = 0.077$) ADG compared to pigs fed Enogen Feed corn, which resulted in a tendency ($P = 0.100$) for an improvement in G:F. There was no other evidence for difference in performance or carcass characteristics detected between corn sources.

For overall feed form effects, during the grower phase, pigs fed pelleted diets had increased ($P < 0.003$) ADG and G:F compared to those fed meal diets. During the finisher phase, pigs fed pelleted diets had increased ADG ($P = 0.049$) compared to pigs fed meal diets. Overall, pigs fed pelleted diets had improved ($P < 0.001$) ADG and G:F compared with pigs fed meal diets. For carcass characteristics, pigs fed pelleted diets had increased HCW ($P < 0.001$) compared to pigs fed meal diets with no differences found for other carcass parameters.

DISCUSSION

Starch is the major storage carbohydrate of cereal grains with corn having a starch content of

Table 5. Interactive effects of diet form and corn source on finishing pig performance^a

Item ^d	Conventional ^b		Enogen Feed corn ^c		SEM	Probability, <i>P</i>		
	Meal	Pellet	Meal	Pellet		Source × Diet form	Source	Diet form
BW, kg								
d 0	53.4	53.4	53.0	53.5	0.63	0.534	0.726	0.535
d 28	85.5	89.8	85.7	89.0	0.87	0.536	0.715	<0.001
d 72	134.7	139.1	132.8	138.1	0.93	0.588	0.106	<0.001
Grower ^e								
ADG, g	1,148	1,294	1,157	1,272	27.2	0.576	0.809	<0.001
ADFI, g	2,744	2,807	2,734	2,863	60.2	0.585	0.705	0.123
G:F, g/kg	418	462	427	443	9.6	0.129	0.602	0.003
Finisher ^f								
ADG, g	1,108	1,116	1,059	1,117	16.7	0.133	0.152	0.049
ADFI, g	3,156	3,205	3,165	3,210	44.4	0.958	0.883	0.297
G:F, g/kg	351	348	334	350	5.2	0.091	0.170	0.276
Overall								
ADG, g	1,123	1,189	1,099	1,172	12.9	0.769	0.077	<0.001
ADFI, g	2,996	3,052	2,994	3,075	41.1	0.766	0.786	0.103
G:F, g/kg	375	389	368	382	4.4	0.973	0.100	0.001
Carcass characteristics								
HCW, kg	101.6	105.7	100.1	104.6	1.05	0.837	0.221	<0.001
Carcass yield, %	75.2	75.5	75.3	75.2	0.20	0.266	0.418	0.638
Backfat depth, mm	17.8	17.5	16.6	17.9	0.41	0.068	0.333	0.271
Loin depth, mm	65.3	67.5	66.3	66.4	0.66	0.120	0.963	0.109
Lean, %	53.60	54.01	54.13	53.76	0.20	0.061	0.492	0.927

^aA total of 288 pigs (Line 241 × 600, DNA, Columbus, NE initially 53.0 ± .5 kg) were used in a 72-d trial. There were nine pens per treatment with eight pigs per pen.^bYellow dent corn.^cEnogen Feed corn, a product of Syngenta, Downers Grove, IL.^dBW = body weight; ADG = average daily gain; ADFI = average daily feed intake; G:F = gain to feed ratio; HCW = hot carcass weight^eGrower diets were fed from d 0 to 28.^fFinisher diets were fed from d 28 to 72.

Table 6. Main effects of diet form and corn source on finishing pig growth performance^a

Item ^d	Corn source		SEM	Probability, <i>P</i>	Diet form		SEM	Probability, <i>P</i>
	Conventional ^b	Enogen Feed corn ^c			Meal	Pellet		
BW, kg								
d 0	53.4	53.3	0.55	0.726	53.2	53.5	0.55	0.535
d 28	87.6	87.3	0.63	0.715	85.6	89.4	0.62	<0.001
d 72	136.9	135.4	0.72	0.106	133.8	138.6	0.71	<0.001
Grower ^e								
ADG, g	1,221	1,214	19.2	0.809	1,153	1,283	19.2	<0.001
ADFI, g	2,775	2,798	42.8	0.705	2,739	2,835	42.7	0.123
G:F, g/kg	440	435	7.2	0.602	423	452	7.2	0.003
Finisher ^f								
ADG, g	1,112	1,088	12.2	0.152	1,083	1,116	12.1	0.049
ADFI, g	3,181	3,187	31.4	0.883	3,160	3,208	31.4	0.297
G:F, g/kg	349	342	3.7	0.170	343	349	3.7	0.276
Overall								
ADG, g	1,156	1,136	10.5	0.077	1,111	1,181	10.4	<0.001
ADFI, g	3,024	3,035	29.7	0.786	2,995	3,063	29.5	0.103
G:F, g/kg	382	375	3.5	0.101	371	386	3.4	0.001
Carcass characteristics								
HCW, kg	103.7	102.3	0.75	0.221	100.8	105.2	0.73	<0.001
Carcass yield, %	75.4	75.2	0.10	0.418	75.3	75.3	0.100	0.638
Backfat depth, mm	17.7	17.3	0.01	0.333	17.7	17.2	0.011	0.271
Loin depth, mm	66.4	66.4	0.02	0.963	67.0	65.9	0.018	0.109
Lean, %	53.80	53.95	0.14	0.492	53.87	53.88	0.142	0.927

^aA total of 288 pigs (Line 241 × 600, DNA, Columbus, NE initially 53.0 ± 0.5 kg) were used in a 72-d trial. There were nine pens per treatment with eight pigs per pen.^bYellow dent corn.^cEnogen Feed corn. A product of Syngenta, Downers Grove, IL.^dBW = body weight; ADG = average daily gain; ADFI = average daily feed intake; G:F = gain to feed ratio; HCW = hot carcass weight.^eGrower diets were fed from d 0 to 28.^fFinisher diets were fed from d 28 to 72.

65% (NRC, 2012). Enogen Feed corn contains an α -amylase enzyme trait (SYT-EFC). The SYT-EFC α -amylase enzyme is thought to improve starch digestibility by improving conversion of starch into fermentable sugars. Although research on starch digestion of Enogen Feed corn is limited in pigs, a recent study by Jolly-Breithaupt et al. (2016) observed when finishing cattle were fed corn with SYT-EFC α -amylase enzyme, there was numerically increased post ruminal starch digestibility compared to cattle fed conventional yellow dent corn. From a different point of view, this increase in sugars could potentially lead to an increased potential for occurrence of the Maillard reaction during the pelleting process. However, a recent study conducted by Dunmire et al. (2020) evaluated pelleting diets with high concentrations of free amino acids and reducing sugars educing sugars. When the diets were pelleted at 85 °C, the authors observed no evidence reduction in amino acid digestibility that would have resulted from Millard reaction. Therefore, it is hypothesized that pelleting conditions and diets used in the experiment conducted herein should not have reduced amino acid digestibility due to the pelleting process.

Research dedicated to evaluating grain processing methods that increase starch digestibility, includes grinding and thermal processing. Starch availability during pelleting is increased through a process known as starch gelatinization. Gelatinization occurs during a four-step process that irreversibly solubilizes raw starch granules through the application of heat and moisture. As mash feed passes through the conditioner, the feed is mixed with heat and moisture in the form of steam, allowing starch granules to swell. As the mash feed exits the conditioner, it passes through the pellet mill die, which generates frictional heat and drives starch gelatinization. Gelatinization of starch during the pelleting process increases the starch availability in the pig as shown by Rojas et al. (2016) which observed an increase in apparent ileal digestibility (AID) of starch from 93.4 in mash diets to 97.7% in pelleted diets. Lundblad et al. (2011) increased the steam temperature in the conditioner to 90 °C which resulted in increased starch gelatinization and nursery pig G:F compared with mash diets or steam conditioning at 47 °C (Lundblad et al., 2011). Truelock et al. (2020) observed that increasing the conditioner temperature from 74 °C to 85 °C, when pelleting Enogen Feed corn, increases starch gelatinization in the pellet compared to conventional yellow dent corn. In our study, we originally planned to pellet the diets for

both conventional yellow dent corn and Enogen feed corn with a conditioner temperature of 85 °C but were unable to reach the temperature because of the moisture content of both Enogen Feed corn and conventional yellow dent corn. Increased corn moisture content decreases steam uptake and consequently the conditioner cannot reach the desired temperatures.

In this study, pelleting diets resulted in increased ADG and G:F. This agrees with Wondra et al. (1995) who observed a 7% improvement in G:F when feeding pelleted diets compared with meal. De Jong et al. (2013a, 2013b) and Nemecek et al. (2015) observed a 6% improvement in G:F when pelleted diets were fed during the finishing period. However, the benefits in G:F when feeding pellets are not always consistent. Meyers et al. (2013) observed no difference in G:F when feeding pelleted diets compared to meal. The authors suggest the PDI of the pellets could be the reason for the lack of differences. In the current study, overall G:F was improved by 3.9% for pigs fed pellets compared to pigs fed meal diets. During the grower stage, a 6.4% improvement in G:F was observed when pellets were fed compared to meal diets. During the finisher phase, no difference in G:F was observed when comparing pigs fed pelleted diets or meal diets. Reasons for lack of difference in G:F during the finishing period between pigs fed pelleted and meal diets is not fully understood. There did not appear to be any difference in PDI between the grower and finisher phases. Interestingly, the percentage fines for both the conventional yellow dent corn and Enogen Feed corn were higher during the grower phase compared to the finisher phase. The influence of pellet fines on G:F has also been inconsistent in previous research. Langdon (2015) found no impact on G:F when pellet fines ranged from 0 to 60%. However, these findings were different from Stark et al. (1993) who reported improved G:F as pellet fines were decreased from 60% to 0%.

In the current study, we observed a 6% improvement in ADG when pigs were fed pelleted diets compared to meal diets. These finding are similar to Ball et al. (2015) and Wondra et al. (1995) who observed a 5% improvement in daily gain when feeding pelleted diets compared to meal diets. Research has shown feeding pelleted swine diets compared to meal diets improves nutrient utilization with higher energy digestibility (Wondra et al., 1995; Lundblad et al., 2011; Ball et al., 2015).

Pigs fed pelleted diets had a 4.2% improvement in HCW compared to pigs fed meal diets. The increase in ADG and final body weight by pigs fed

pelleted diets led to the increase in HCW. These results are consistent with Nemechek et al. (2015) who observed an increase in ADG and a numerical improvement in final BW and HCW when pigs were fed pelleted diets compared to meal diets. Similarly, Overholt et al. (2016) observed an increase in final BW and HCW when pigs were fed pelleted diets compared to meal diets. A study conducted by Potter et al. (2010) observed pigs fed pelleted diets had improved carcass yield and a tendency for decreased percentage lean and loin depth. The authors suggested the increase in carcass yield could be attributed to the increased weight gain of pigs fed the pelleted diets. However, in our study, we did not observe any difference on carcass yield, loin depth or lean percentage between pigs fed pelleted or meal diets.

In summary, this study did not find any advantages in finishing pig growth performance when feeding Enogen Feed corn compared to conventional yellow dent corn. The study confirmed previous research that observed feeding pelleted diets to finishing pigs improved ADG and G:F compared to feeding meal diets. However, feeding Enogen Feed corn did not improve growth performance when compared to conventional yellow dent corn whether fed in meal or pelleted diets.

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