Evaluation of Enogen Feed Corn on growth performance and carcass characteristics of finishing pigs

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ABSTRACT: Enogen Feed Corn (**EFC**; Syngenta Seeds, LLC, Downers Grove, IL) hybrids contain a trait for expression of heat-stable α-amylase in the grain. α-Amylase is an enzyme responsible for breakdown of starch in the small intestine; supplementation of exogenous α-amylase to pigs may result in greater starch digestibility and thus improved gain efficiency. A total of 288 pigs (Line 600 × 241, DNA, Columbus, NE; initially 41.6 kg) were utilized in an 82-d trial to determine if replacing conventional yellow dent corn (**CONV**) with EFC in diets with or without distillers dried grains with solubles (**DDGS**) influences growth performance and carcass characteristics. Pens of pigs were randomly assigned to one of four dietary treatments balancing for initial body weight. There were nine pens per treatment with eight pigs per pen (an equal number of barrows and gilts per pen). Treatments were arranged in a 2 × 2 factorial with main effects of corn source (CONV or EFC) and DDGS (0% or 25%). Experimental diets were fed in meal form in three phases: days 0 to 29, 29 to 47, and 47 to 82. Pigs were weighed approximately every 2 wk and at the beginning of each phase. On day 82, pigs were transported to a commercial abattoir for processing and carcass data collection. Data were analyzed using PROC GLIMMIX procedure of SAS with pen as the experimental unit. There were no corn source by DDGS interactions ($P > 0.05$) observed for overall performance or carcass characteristics. Overall, average daily gain (**ADG**) was marginally greater ($P < 0.089$) for pigs fed EFC than CONV with no evidence ($P > 0.196$) for difference in average daily feed intake (**ADFI**), gain:feed ratio (**G:F**), hot carcass weight (**HCW**), or other carcass traits. Addition of DDGS decreased ($P < 0.047$) overall ADG and G:F. Pigs fed DDGS had marginally lower ($P < 0.071$) HCW, less ($P < 0.050$) backfat depth, greater ($P < 0.026$) loin depth, and greater ($P < 0.020$) percentage lean and carcass fat iodine value (**IV**). In summary, addition of 25% DDGS to the diet decreased ADG and increased carcass fat IV. Pigs fed EFC tended to have improved overall ADG; however, G:F and carcass characteristics were not different between corn sources. These results suggest that EFC, although not beneficial, may be used as a substitute for CONV without any deleterious effects on growth performance. Further research should be conducted to understand whether addition of EFC to swine diets could be beneficial in younger pigs exhibiting decreased pancreatic α-amylase secretion following weaning or whether heat treatment of diets, such as pelleting, may influence the response to EFC.

Key words: DDGS, high amylase corn, finishing pig, yellow dent corn

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INTRODUCTION

Starch contained in cereal grains is the greatest source of energy in swine diets; therefore, novel technologies to increase starch digestibility may improve gain efficiency. Small intestinal digestibility of starch is greater than 95% for pigs and is attributed to greater pancreatic α-amylase activity compared with other monogastric species such as horses or rats (Kienzle et al., 1994; Bach Knudsen, 2001; Bauer et al., 2003).

Initially developed for ethanol production, Enogen Feed Corn (**EFC**; Syngenta Seeds, LLC, Downers Grove, IL), are corn hybrids with increased expression of heat-stable α-amylase. α-Amylase is an enzyme secreted into the small intestine that hydrolyzes starch to produce maltose, maltotriose, and α-limit dextrins. These products are further broken down into glucose, which is absorbed across the intestinal wall and utilized as an energy source for the pig. Therefore, supplementation of α-amylase may improve starch digestion, allowing for greater glucose absorption and utilization, translating to improved growth performance. Supplementation of α-amylase through EFC has been demonstrated to be beneficial in ruminant animals. Feeding EFC to both growing and finishing beef cattle has been shown to improve gain efficiency, attributed to greater starch breakdown and availability of glucose for growth (Horton et al., 2017; Johnson et al., 2019; Jolly-Breithaupt et al., 2019). These data indicate the potential for EFC to be used in livestock diets; however, research on the effect of feeding this hybrid to swine is limited.

Production of ethanol has resulted in availability of by-products, such as distillers dried grains with solubles (**DDGS**), which have become a relatively common ingredient in swine diets due to their low cost, and moderate lysine and digestible phosphorus content. A review by Stein and Shurson (2009) determined that growth performance of pigs fed diets with up to 30% DDGS was unaffected compared with those fed a corn-based diet. However, some studies have observed adding DDGS to swine diets may negatively affect growth performance and carcass quality because of its high-fiber and unsaturated fatty acid content (Whitney et al., 2006; Linneen et al., 2008; Graham et al., 2014). Due to DDGS being included in swine diets primarily at the expense of corn, it is important to assess whether any interaction exists between corn variety and DDGS inclusion rate. We hypothesize that addition of exogenous amylase from EFC may increase starch digestibility and mitigate deleterious effects of DDGS on growth performance. Therefore, the objective of this trial was to determine whether replacing conventional yellow dent corn (**CONV**) with EFC in diets with or without DDGS influences growth performance and carcass characteristics of finishing pigs.

MATERIALS AND METHODS

All procedures used in this study were approved by the Kansas State University Institutional Animal Care and Use Committee. This study was conducted at the Kansas State University Swine Teaching and Research Center, Manhattan, KS. Pigs were housed in a fully enclosed, environmentally regulated barn containing 36 pens with slatted concrete floors. Pens were equipped with a two-space single sided feeder (Farmweld, Teutopolis, IL) and a cup waterer, and pigs were allowed access to feed and water ad libitum. The floor space allowance per pig was maintained at 0.73 m^2. An automated feeding system (FeedPro; Feedlogic Corp., Wilmar, MN) was used to deliver and record feed to each pen.

Study Design

A total of 288 pigs (Line 600 × 241; DNA, Columbus, NE) initially weighing 41.6 kg were utilized in an 82-d trial. There were nine pens per treatment and eight pigs per pen with an equal number of barrows and gilts. 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 main effects of corn source (CONV or EFC) and DDGS (0% or 25% of the diet). Diets were formulated to meet or exceed nutrient requirements (NRC, 2012). The diets with and without DDGS in each phase were formulated to the same standard ileal digestible (**SID**) lysine, threonine, and tryptophan concentration with all other amino acids above minimum ratios relative to lysine. The DDGS was assumed to contain 2,387 kcal/kg of net energy and 0.484% SID lysine in diet formulation (Graham et al., 2014). The experimental diets were fed in three phases: days 0 to 29, days 29 to 47, and days 47 to 82. Diets were fed in meal form, and both corn sources were ground to a similar particle size, approximately 700 microns for the experiment. Both corn varieties and DDGS were sourced from one location and lot for the duration of the experiment. Pens of pigs and feed refusals were weighed approximately every 2 wk and at the

Table 1. Diet composition (as fed basis)[1]

	0% DDGS[2]			25% DDGS		
Item	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3
Ingredient, %						
Corn[3]	75.45	81.90	85.25	59.95	65.65	68.20
Soybean meal, 46% crude protein	21.80	15.65	12.35	12.30	6.95	4.50
Corn DDGS, 7.5% oil	—	—	—	25	25	25
Calcium carbonate	0.93	0.85	0.85	1.08	1.03	1.03
Monocalcium P (21% P)	0.55	0.40	0.35	0.20	—	—
Salt	0.50	0.50	0.50	0.50	0.50	0.50
L-Lysine-HCl	0.30	0.30	0.30	0.50	0.48	0.45
DL-Methionine	0.07	0.03	0.02	0.02	—	—
L-Threonine	0.09	0.10	0.11	0.09	0.09	0.09
L-Tryptophan	0.01	0.02	0.02	0.04	0.04	0.04
Trace mineral premix	0.15	0.13	0.10	0.15	0.13	0.10
Vitamin premix	0.15	0.13	0.10	0.15	0.13	0.10
Phytase[4]	0.02	0.02	0.02	0.02	0.02	0.02
Total	100	1100	100	100	100	100
Calculated analysis						
SID[5] amino acids, %						
Lysine	0.95	0.80	0.72	0.95	0.80	0.72
Isoleucine:lysine	62	61	60	60	60	61
Leucine:lysine	139	148	154	165	181	193
Methionine:lysine	32	31	30	31	32	34
Methionine and cysteine:lysine	58	58	58	58	62	65
Threonine:lysine	63	65	68	63	65	68
Tryptophan:lysine	18.6	18.5	18.8	18.5	18.3	18.4
Valine:lysine	69	70	70	72	75	78
Histidine:lysine	42	43	43	43	44	46
Total lysine, %	1.07	0.90	0.82	1.11	0.94	0.86
Net energy, Mcal/kg	2.48	2.52	2.55	2.47	2.51	2.53
SID lysine:NE, g/Mcal	3.82	3.16	2.82	3.83	3.18	2.84
Crude protein, %	17.0	14.6	13.3	18.4	16.3	15.3
Calcium, %	0.59	0.51	0.48	0.59	0.51	0.49
Phosphorus, %	0.47	0.41	0.38	0.47	0.40	0.39
STTD[6] P, %	0.33	0.28	0.26	0.33	0.28	0.27

[1]The experimental diets were fed in three phases: days 0 to 29, days 29 to 47, and days 47 to 82.

[2]DDGS = distillers dried grains with solubles; one lot used for entire experiment.

[3]Enogen Feed Corn (Syngenta Seeds, LLC, Downers Grove, IL) or conventional (yellow dent corn); one lot of each variety used for entire experiment.

[4]HiPhos 2700 (DSM Nutritional Products, Inc., Parsippany, NJ) providing 891 phytase units (FTU)/kg and an estimated release of 0.08% available P.

[5]SID = standardized ileal digestible.

[6]STTD P = standardized total tract digestible phosphorus.

end of each phase change to calculate average daily gain (**ADG**), average daily feed intake (**ADFI**), and gain:feed ratio (**G:F**; Table 4). During the study, six pigs died or were removed due to illness or injury unrelated to the dietary treatments. On day 82, 282 pigs were individually weighed, ear tagged with a radiofrequency identification tag and tattooed for individual carcass identification and data measurements at the packing plant. All pigs were transported to a commercial packing plant (Triumph Foods, St. Joseph, MO) on the same day for processing and collection of hot carcass weight (**HCW**), loin depth, backfat depth, and percentage lean in the carcass. Carcass yield was calculated as HCW divided by the individual final live weight measured at the farm. Loin depth and backfat depth were determined using an optical probe (Fat-O-Meter, SFK, Herlev, Denmark) placed between the third and fourth (counting from the ham end of the carcass) rib at a distance approximately 7 cm from the dorsal midline. Percentage lean was estimated using propriety equations from the packing plant. Belly fat samples anterior to the manubrium were obtained prior to carcass chilling and analyzed for fat iodine value (**IV**) using near-infrared spectroscopy.

Chemical Analysis

Corn samples were collected at time of feed manufacturing, and feed samples were collected approximately 2 d after each feed delivery. Samples were stored at −20 °C until analysis. Pooled samples for each phase were sent to a commercial laboratory (Ward Laboratories, Inc., Kearney, NE) and analyzed in duplicate for dry matter (method 935.29; AOAC International, 1990), starch (method 920.40; AOAC International, 1990), crude protein (method 990.03; AOAC International, 1990), crude fiber (method 978.10; AOAC International, 1990), fat (method 920.39; AOAC International, 1990), calcium (method 985.01; AOAC International, 1990), and phosphorus (method 985.01; AOAC International, 1990; Tables 2 and 3).

Table 2. Chemical analysis of corn varieties (as fed basis)[1]

Item, %	CONV[2]	EFC[3]
Dry matter	87.1	87.4
Starch	60.6	60.8
Crude protein	7.2	7.9
Ether extract	3.1	3.1
Crude fiber	1.7	1.4
Ca	0.05	0.06
P	0.20	0.22

[1]Corn samples were collected at time of feed manufacturing and pooled for analysis (Ward Laboratories, Inc., Kearney, NE).

[2]CONV = Conventional yellow dent corn, one lot used for entire experiment.

[3]EFC = Enogen Feed Corn (Syngenta Seeds, LLC, Downers Grove, IL), one lot used for entire experiment.

Statistical Analysis

Data were analyzed using the PROC GLIMMIX procedure of SAS (v. 9.4, SAS Institute, Inc., Cary, NC), with pen serving as the experimental unit. The main effects of corn source, DDGS, and their interactions were tested using orthogonal contrasts. For analyses of loin depth, backfat depth, and percentage lean, HCW was used as a covariate. Results were considered significant at $P \leq 0.05$ and marginally significant at $P \leq 0.10$.

RESULTS

Nutrient composition of analyzed diets (Tables 3) was reasonably consistent with formulated values considering expected analytical variation. As expected, treatments containing 25% DDGS possessed greater crude fat and crude fiber compared with diet without DDGS. Corn varieties used in this trial (Table 2) were consistently similar to each other and standard values documented in the literature (NRC, 2012).

There was no main effect ($P \geq 0.204$) of corn type observed during phase 1 or 2. Pigs fed EFC tended to have greater ADG during phase 3 ($P = 0.077$) and overall ($P = 0.089$) than pigs fed CONV. No differences were observed ($P \geq 0.196$) in ADFI, G:F, HCW, yield, backfat depth, loin depth, percentage lean, or carcass fat IV between corn sources.

Table 3. Chemical analysis of experimental diets (as fed basis)[1]

	Phase 1[2]				Phase 2				Phase 3			
	CONV[3]		EFC[4]		CONV		EFC		CONV		EFC	
Item, % DDGS,[5] %	0	25	0	25	0	25	0	25	0	25	0	25
Dry matter	88.6	88.9	88.1	88.1	87.8	88.3	87.6	88.4	89.2	89.5	86.9	88.2
Starch	48.4	37.5	44.1	36.3	48.3	38.4	46.5	39.0	46.5	41.5	53.1	39.9
Crude protein	16.2	18.9	16.3	18.6	13.4	16.6	14.2	16.5	13.6	15.7	11.3	15.8
Ether extract	2.3	4.3	2.6	4.1	3.0	4.6	3.4	4.4	3.3	4.4	1.8	4.3
Crude fiber	1.4	3.7	2.2	3.4	2.2	3.4	2.2	3.6	2.9	3.6	1.7	3.5
Ca	0.59	0.68	0.78	0.63	0.64	0.60	0.54	0.53	0.55	0.47	0.61	0.64
P	0.38	0.46	0.43	0.44	0.36	0.44	0.39	0.39	0.36	0.39	0.33	0.40

[1]Feed samples were collected approximately 2 d after each feed delivery, pooled within treatment for each phase, and analyzed (Ward Laboratories, Inc., Kearney, NE).

[2]The experimental diets were fed in three phases: days 0 to 29, days 29 to 47, and days 47 to 82.

[3]CONV = conventional yellow dent corn; one lot used for entirety of experiment.

[4]EFC = Enogen Feed Corn (Syngenta Seeds, LLC, Downers Grove, IL); one lot used for entirety of experiment.

[5]DDGS = distillers dried grains with solubles; one lot used for entirety of experiment.

A main effect of DDGS was observed when pigs fed 25% DDGS had decreased ADG during phase 1 ($P = 0.045$), phase 2 ($P = 0.005$), and overall ($P = 0.026$). There was no detectable difference ($P \geq 0.151$) during any phase or overall for ADFI between pigs fed 0 and 25% DDGS. Overall, pigs fed diets containing 25% DDGS had poorer ($P = 0.047$) G:F. Pigs fed 25% DDGS had a marginally lower ($P = 0.071$) HCW, less ($P = 0.050$) backfat, greater ($P = 0.026$) loin depth, and greater ($P = 0.020$) percentage lean and carcass fat IV ($P < 0.0001$) than pigs fed diets without DDGS.

During phase 1 (days 0 to 29), there was a corn source by DDGS interaction ($P < 0.05$) observed for ADG and ADFI (Table 4). Pigs fed the diet containing EFC without DDGS had greater ($P = 0.019$) ADG than pigs fed the EFC with 25% DDGS diet, whereas there were no differences between the CONV treatments with or without DDGS. ADFI was greater ($P = 0.035$) for pigs

Table 4. Effects of corn variety and dried distillers grains with solubles (DDGS) on growth performance and carcass characteristics of finishing pigs[1]

	CONV[2]		EFC[3]			Probability, *P*-value		
Item DDGS, %	0	25	0	25	SEM	Corn	DDGS	Corn × DDGS
Body weight, kg								
Day 0	41.6	41.5	41.6	41.5	0.682	1.000	0.887	0.924
Day 29	71.2[ab]	71.3[ab]	71.8[a]	70.4[b]	0.891	0.632	0.071	0.036
Day 47	90.2	89.4	90.6	88.9	0.918	0.956	0.020	0.403
Day 82	130.4	128.6	130.3	129.9	0.873	0.353	0.097	0.305
Phase 1 (days 0 to 29)[4]								
ADG,[5] kg/d	1.02[ab]	1.03[ab]	1.04[a]	0.99[b]	0.011	0.580	0.045	0.019
ADFI,[5] kg/d	2.30[a]	2.38[b]	2.40[b]	2.34[ab]	0.043	0.434	0.879	0.035
G/F[5]	0.44	0.43	0.43	0.42	0.015	0.224	0.092	0.664
Phase 2 (days 29 to 47)								
ADG, kg/d	1.06	1.00	1.07	1.03	0.014	0.204	0.005	0.571
ADFI, kg/d	3.00	2.96	3.04	2.96	0.049	0.606	0.151	0.652
G/F	0.35	0.34	0.35	0.35	0.025	0.527	0.206	0.385
Phase 3 (days 47 to 82)								
ADG, kg/d	1.15[ab]	1.10[a]	1.14[ab]	1.17[b]	0.018	0.077	0.541	0.041
ADFI, kg/d	3.61[x]	3.52[y]	3.54[y]	3.71[z]	0.073	0.430	0.566	0.081
G/F	0.32	0.31	0.32	0.32	0.031	0.547	0.277	0.971
Overall (days 0 to 82)								
ADG, kg/d	1.08	1.05	1.09	1.08	0.009	0.089	0.026	0.304
ADFI, kg/d	3.01	3.00	3.02	3.06	0.440	0.328	0.760	0.444
G/F	0.359	0.350	0.361	0.353	0.018	0.814	0.047	0.999
Carcass characteristics								
HCW,[6] kg	97.9	95.9	97.4	96.6	0.080	0.883	0.071	0.448
Carcass yield, %	75.1	74.6	74.8	74.4	0.230	0.651	0.139	0.863
Backfat,[7] mm	16.26	15.49	16.26	16.00	0.279	0.196	0.050	0.448
Loin depth,[7] mm	64.26	65.02	63.75	65.28	0.584	0.767	0.026	0.420
Lean,[7] %	54.37	54.80	54.24	54.65	0.160	0.400	0.020	0.951
Iodine value,[8] mg/g	64.41[x]	72.48[y]	66.12[z]	71.78[y]	0.600	0.400	<0.0001	0.053

[1]A total of 288 pigs (DNA Line 600 × 241; initially 41.6 ± 1.9 kg) were enrolled in an 82-d trial. There were nine pens per treatment with four barrows and four gilts per pen.

[2]CONV = conventional yellow dent corn.

[3]EFC = Enogen Feed Corn (Syngenta Seeds, LLC, Downers Grove, IL).

[4]The experimental diets were fed in three phases: days 0 to 29, days 29 to 47, and days 47 to 82.

[5]ADG = average daily gain; ADFI = average daily feed intake; G/F = gain efficiency.

[6]HCW = hot carcass weight.

[7]HCW used as a covariate in statistical analysis.

[8]Belly fat samples anterior to the manubrium were obtained prior to carcass chilling and analyzed for fat iodine value (IV) using near-infrared spectroscopy.

[ab]Means within the same row without a common superscript are different ($P \leq 0.05$).

[xy]Means within the same row without a common superscript are different ($0.05 < P \leq 0.10$).

fed CONV with DDGS compared with pigs fed CONV without DDGS, with no differences between EFC treatments. Furthermore, there was no evidence of a corn source by DDGS interaction ($P = 0.664$) for G:F. There was no evidence for interactions observed between corn source and DDGS inclusion for phase 2 (days 29 to 47). During phase 3 (days 47 to 82), there was a corn source by DDGS interaction ($P < 0.05$) observed for ADG. ADG was greater ($P = 0.041$) for pigs fed EFC diets containing 25% DDGS compared with the 25% DDGS diet with CONV; there were no detectable differences between corn sources when fed without DDGS. Additionally, during phase 3, ADFI was marginally ($P = 0.081$) A marginal increase ($P = 0.053$) in carcass fat IV was observed in pigs fed EFC without DDGS compared with pigs fed CONV without DDGS, with no differences observed for pigs fed DDGS. There were no interactions observed between corn source and DDGS for overall performance or any of the remaining carcass measurements ($P \geq 0.10$).

DISCUSSION

Starch is primarily digested by pancreatic α-amylase in the small intestine. This enzyme cleaves α-1,4 linkages in the starch molecule to produce maltose, maltotriose, and α-limit dextrins (Gray, 1992). These products are further broken down by brush border enzymes to yield glucose, which is transported across the intestinal wall primarily by Na^+/glucose co-transporter 1 (SGLT1) and utilized by the host (Moran et al., 2010). The rate and extent of starch digestion is highly dependent on starch chemistry, particularly crystallinity and relative ratios of amylose and amylopectin (Svihus et al., 2005). Evaluation of glucose absorption kinetics identified an inverse relationship, as pigs exhibited decreased rates of glucose uptake as starches of increased amylose concentration were fed (Regmi et al., 2010). Although total starch digestibility has been observed as greater than 95% in pigs (Bach Knudsen, 2001), there is still potential for improvements through feed processing (Rojas et al., 2016) or addition of exogenous enzymes (Kim et al., 2003; Kerr and Shurson, 2013).

Pancreatic α-amylase secretion is decreased following weaning and increases as pigs age and are transitioned to high-starch diets (Jensen et al., 1997). Nevertheless, a main effect of corn type was not observed during phase 1. An interaction of corn type and DDGS was observed during phase 1, with pigs consuming EFC without DDGS having a greater ADG than pigs consuming EFC with DDGS; this can be attributed to pigs consuming EFC without DDGS having a greater ADFI. This response was not observed for phase 2 or 3. There was an interaction of corn type and DDGS observed during phase 3, with pigs consuming EFC with DDGS having greater ADG than pig consuming CONV with DDGS. Addition of EFC to late finishing swine diets may mitigate deleterious effects of DDGS on growth performance through increased starch digestibility attributed to additional amylase. Additionally, there was tendency for greater ADG during phase 3 and overall for pigs consuming EFC. Data have demonstrated substitutional effects of exogenous α-amylase supplementation in poultry. Jiang et al. (2008) observed improved ADG, decreased mRNA expression of pancreatic α-amylase, and unchanged gain efficiency in broiler chickens, suggesting that supplementation with exogenous α-amylase results in less energy expended to secrete endogenous amylase. This theory of conservation of digestive enzymes has been described by Rothman et al. (2002). Briefly, this mechanism suggests that a portion of pancreatic enzymes are absorbed into the bloodstream and recycled in an enteropancreatic circulation to conserve energy that would otherwise be expended through the synthesis of new enzymes with each meal. Addition of exogenous amylase would increase the amount of this enzyme in enteropancreatic circulation and thus further decrease the need for production of endogenous amylase. The tendency for improved phase 3 and overall ADG may be attributed to decreased endogenous secretion of pancreatic α-amylase; however, further research is needed to determine the effect of EFC on endogenous enzyme secretion at both the protein and mRNA level in swine.

All previously published data on EFC have been in beef cattle, and a majority of results demonstrate its ability to improve gain efficiency when fed to ruminants (Horton et al., 2017; Johnson et al., 2019; Baker et al., 2019; Jolly-Breithaupt et al., 2019). Ruminants secrete less pancreatic α-amylase compared with pigs, making EFC a potential method to increase postruminal starch digestion (Harmon et al., 2004). In this experiment, data indicate that inclusion of EFC did not enhance digestibility of starch enough to observe consistent improvements in gain efficiency. However, it is important to note that ileal starch digestibility was not measured for this experiment.

Corn DDGS are often included in swine diets due to their favorable economics, high availability, and moderate amino acid profile, but in some cases, this has been reported to decrease growth performance (Whitney et al., 2006; Lerner et al., 2020). Inclusion level of DDGS required to observe these effects vary and may be attributed to source and quality of the ingredient (Stein and Shurson, 2009; Urriola et al., 2010). In this experiment, pigs consuming 25% dietary DDGS exhibited decreased ADG and G:F, and thus tended to have lower HCW. Diets with DDGS contained greater crude fiber content, which has been demonstrated to decrease nutrient digestibility and subsequently growth performance (Fu et al., 2004; Weimer et al., 2008). The marginally lower back fat and percentage lean may be attributed to the increased fiber and lower energy intake of pigs consuming DDGS, although the observed greater loin depth remains unclear.

Carcass fat IV is used in commercial pork processing plants to characterize the proportion of unsaturated fat, and thus carcass firmness. Corn DDGS contain a high proportion of unsaturated fatty acids, leading to increased deposition of unsaturated fatty acids in adipose tissue (Madsen et al., 1992). Consistent with some previous research, pigs consuming 25% DDGS exhibited greater carcass fat IV, indicating a higher concentration of unsaturated fatty acids and presumably less fat firmness (Hill et al., 2008; Linneen et al., 2008; Graham et al., 2014; Lerner et al., 2020). Unexpectedly, a marginally greater carcass IV was observed for pigs consuming EFC with no DDGS compared with pigs consuming CONV with no DDGS; the reasons for this observation remain unclear.

In summary, the results of this trial suggest that EFC can be fed to pigs without observing deleterious effects on growth performance, as no evidence of differences in gain efficiency and carcass characteristics were observed between corn sources. Consistent with previous research, the addition of DDGS decreased growth performance and most carcass measurements. Further research should be conducted to understand whether addition of EFC to swine diets could be beneficial in younger pigs exhibiting decreased pancreatic α-amylase secretion following weaning or whether heat treatment of diets, such as pelleting, may influence the response to EFC. Furthermore, data regarding endogenous α-amylase secretion and starch digestibility in pigs fed EFC are needed to further evaluate the efficacy of this product.

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