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Effects of Dietary Corn Dried Distillers Grains with Solubles Withdrawal on Finishing Pig Performance and Carcass Characteristics[1]

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Summary

Two experiments were conducted to evaluate the effects of removing corn dried distillers grains with solubles (DDGS) at increasing intervals before harvest on finishing pig performance and carcass characteristics. For Exp. 1, 985 finishing pigs [initially 219 ± 5.5 lb body weight (BW)] were used in a 28-d growth study. There were 12 pens per treatment with 19 to 21 pigs per pen. There were four treatments decreasing in duration of withdrawal of DDGS from diets before final marketing: 28, 21, 14, or 0 d withdrawal. Regardless of treatment, pens of pigs were topped according to a typical summer marketing strategy with one top prior to final barn dump. All pens were topped by removing the 17% heaviest pigs on d -21 resulting in a final barn dump of approximately 83% of starting barn inventory. Overall, there was no evidence for effects of DDGS withdrawal time on final BW, average daily feed intake (ADFI), or feed efficiency (F/G; $P > 0.111$); however, as withdrawal time increased, average daily gain (ADG) linearly increased ($P = 0.022$) and iodine value decreased (linear, $P = 0.001$). There was no evidence for treatment differences for hot carcass weight (HCW) or loin depth ($P > 0.106$); however, dressing percentage was linearly increased ($P = 0.001$) with increased withdrawal time. Backfat depth was also decreased (quadratic; $P = 0.019$) and percentage lean increased (quadratic; $P = 0.033$) as DDGS withdrawal time increased. Feed cost and gain value were increased (linear, $P < 0.020$) resulting in a marginally significant ($P < 0.100$) increase in income over feed cost (IOFC) with increased withdrawal duration.

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In Exp. 2, 1,158 finishing pigs (initially 232 ± 4.3 lb BW) were used in a 35-d growth study. There were 15 pens per treatment with 17 to 21 pigs per pen. Similar to the first experiment, there were four treatments decreasing in duration of withdrawal of DDGS from diets before final marketing: 35, 28, 14, or 0 d withdrawal. All pens were topped according to a typical winter marketing strategy with two marketing events prior to the final barn dump. All pens were marketed by removing the 15% heaviest pigs on d -28, the 28% heaviest pigs on d -14, and a final barn dump of approximately 57% of starting barn inventory. There was no evidence that final BW, overall ADG, or overall F/G differed across treatments with increasing DDGS withdrawal times ($P > 0.116$). Overall average daily feed intake increased (linear, $P = 0.015$) as time withdrawn from DDGS before final marketing increased. Iodine value decreased ($P < 0.022$) and dressing percentage increased (linear; $P = 0.034$) with increasing withdrawal time. Lastly, feed cost and feed cost per lb of gain increased (linear, $P < 0.003$) with increasing DDGS withdrawal time.

In conclusion, these experiments demonstrate that longer feeding duration of DDGS before harvest decreases carcass yield and increases iodine value. Feed cost is reduced with longer feeding of DDGS, yet the gain value and IOFC responses varied depending on the marketing strategy.

Introduction

Dried distillers grains with solubles (DDGS) are a byproduct commonly incorporated into swine diets as a means of reducing diet cost. While DDGS can reduce input costs, they are higher in fiber and thus may negatively impact growth performance, hot carcass weights, and the level of saturation within pork fat due to the increased concentration of unsaturated fatty acids.[7] Asmus et al.[8] fed finishing pigs both DDGS and wheat middlings and manipulated the fiber levels in finishing diets either 43 or 67 d before slaughter, concluding that shorter withdrawal levels could recover yield losses, but longer withdrawal periods were needed to regain fat quality. Thus, it is important to understand the appropriate feeding duration of DDGS before harvest in order to maximize feed cost savings while minimizing reductions in performance, yield, and pork quality. Therefore, the objective of these experiments was to determine the appropriate withdrawal time of DDGS before marketing in finishing pig diets in two different marketing scenarios.

Procedures

The Kansas State University Institutional Animal Care and Use Committee approved the protocol used in these experiments. Both studies were conducted at a commercial research facility owned and operated by New Fashion Pork (Jackson, MN). The barns were tunnel-ventilated with completely slatted concrete flooring and deep pits for manure storage. Each pen (8 × 19 ft, Exp. 1; 8 × 18 ft, Exp. 2) was equipped with adjustable gates and contained a 3-hole, dry feeder (Thorp Equipment, Inc., Thorp, WI)

[7]Coble, K., J. M. DeRouchey, M. D. Tokach, S. S. Dritz, R. D. Goodband, and J. C. Woodworth. 2017. Effects of dried distillers grains with solubles and added fat fed immediately before slaughter on growth performance and carcass characteristics of finishing pigs. J. Anim. Sci 95(1):270-278.

[8]Asmus, M., J. DeRouchey, M. Tokach, S. Dritz, T. Houser, J. Nelssen, and R. Goodband. 2014. Effects of lowering dietary fiber before marketing on finishing pig growth performance, carcass characteristics, carcass fat quality, and intestinal weights. J. Anim. Sci 92(1):119-128.

and a pan waterer. Feed additions were delivered and recorded using a robotic feeding system (FeedPro; Feedlogic Corp., Willmar, MN).

For Exp. 1, a total of 985 finishing pigs (initially 219 ± 5.5 lb BW) were used in a 28-d experiment. Pen served as the experimental unit, and there were 12 pens per treatment with 19 to 21 pigs per pen. There were four treatments decreasing in duration of withdrawal of DDGS from diets before final marketing: 28, 21, 14, or 0 d withdrawal. Regardless of treatment, pens of pigs were topped according to a typical summer marketing strategy with one top prior to final barn dump. All pens were topped by removing the 17% heaviest pigs on d -21 resulting in a final barn dump of approximately 83% of starting barn inventory. Pigs were weighed every 7 d to determine ADG, ADFI, and F/G.

For Exp. 2, a total of 1,158 finishing pigs (initially 232 ± 4.3 lb BW) were used in a 35-d experiment. Pen served as the experimental unit, and there were 15 pens per treatment and 17 to 21 pigs per pen. Similar to Exp. 1, there were four treatments decreasing in duration of withdrawal of DDGS from diets before final marketing: 35, 28, 14, or 0 d withdrawal. All pens were topped according to a typical winter marketing strategy with two marketing events prior to the final barn dump. All pens were marketed by removing the 15% heaviest pigs on d -28, the 28% heaviest pigs on d -14, and a final barn dump of approximately 57% of starting barn inventory. Pigs were weighed every 7 d to determine ADG, ADFI, and F/G.

Pigs were given *ad libitum* access to feed and water at all times. Treatment diets were identical for both studies (Table 1). Prior to the experiments, all pigs were fed diets containing 30% DDGS starting at 75 lb BW. Both diets for the experimental period were corn and soybean meal-based and formulated to meet or exceed NRC (2012)[9] requirement estimates for finishing pigs. Diets contained either none or 30% DDGS. Experiment diets contained 0.77% standardized ileal digestible lysine and were balanced for net energy using choice white grease. Experimental feed was manufactured at a commercial mill (Worthington, MN). Composite diet samples were sent for proximate analysis (Ward Laboratories, Kearney, NE).

On all marketing days, pen weights were taken as well as individual weights on all pigs marketed. Pigs to be harvested were identified with tattoos indicating pen of origin and RFID ear tags for individual identification. Pigs were then transported to a USDA-inspected packing plant (Triumph Foods, St. Joseph, MO) for processing and carcass data collection. Carcass measurements collected included HCW, backfat, loin depth, and lean percentage. A proprietary equation specific to the packer was utilized to calculate percentage lean. Dressing percentage was calculated by dividing the individual pig's live weight at the farm by the individual pig's HCW. On the final barn marketing days (barn dump), belly fat samples anterior to the manubrium were collected from 4 (Exp. 1) or 5 (Exp. 2) barrows per pen and iodine value was calculated using near infrared spectroscopy (NIR; Triumph, St. Joseph, MO).

Economic analysis was evaluated on a pen basis. Feed cost per pig was calculated by multiplying the feed cost per lb of feed by the intake during each period, totaling these

[9]NRC. 2012. Nutrient Requirements of Swine, 11th ed. Natl. Acad. Press, Washington D.C.

values, and dividing by the number of marketed pigs. Feed cost per lb of gain was calculated by dividing the feed cost per pig by the average weight gain per pig. Gain value was calculated by multiplying carcass gain by an assumed value of $70 per cwt of carcass. Income over feed cost was calculated by subtracting the feed cost per pig from gain value per pig. Corn was valued at $3.58/bu ($128/ton), soybean meal at $340/ton, DDGS at $170/ton, L-lysine at $0.66/lb, DL-methionine at $1.21/lb, L-threonine at $1.78/lb, and L-tryptophan at $3.75/lb.

Data were analyzed as a completely randomized design with the fixed effects of treatment using the PROC GLIMMIX procedure of SAS (version 9.4, SAS Institute, Inc., Cary, NC). Pen was the experimental unit for growth and carcass data. To evaluate growth data, each intermediate period was analyzed with an individual ANOVA model to evaluate the fixed effect of treatment at that point in time. For example, during d -28 to -21 in Exp. 1, the only treatment to be applied was the -28 d withdrawal; therefore, these pigs are compared to the remaining pigs that have yet to be assigned to treatment and withdrawn from DDGS. Because final BW and carcass data were obtained for individual pigs, carcass data were analyzed with a mixed model using PROC GLIMMIX to account for the correlation among pigs sharing the same pen with a repeated measures design. To evaluate the effect of time, linear and quadratic contrasts were applied for the overall growth data, overall carcass data, and economics to evaluate the effect of duration of withdrawal across all treatments. The PROC IML procedure was utilized to generate linear and quadratic coefficients for unevenly spaced withdrawal times. In Exp. 1, one pen was removed from the data set for the final period, overall, and carcass data, due to incorrect feed provided to the pen during the final period. Residual outliers within the carcass data were removed if plant data provided evidence indicating a defect where the carcass was skinned. In addition, two carcasses in Exp. 2 were removed because their residual value was greater than 6 standard deviations while the remaining residuals were no greater than 4 SD. Results were considered significant at $P \leq 0.05$ and marginally significant between $P > 0.05$ and $P \leq 0.10$. Treatment means were separated at $P < 0.05$.

Results and Discussion

Analyzed diet composition (Table 2) values were similar to anticipated for all proximate analysis components. Also, DDGS diets contained increased neutral detergent fiber as expected.

Exp. 1

Initial BW on d -28 and all other BW showed no evidence of differences ($P > 0.640$) between treatments (Table 3). During d 28 to 21 before barn dump, there was no evidence that the 28 d dietary withdrawal of DDGS was different from the pens of pigs still fed DDGS for ADG, ADFI, F/G, or d -21 BW ($P > 0.198$). The following period, d -21 to -14, evaluated three treatments: 28, 21, vs. 0 d DDGS withdrawal. There was no evidence that ADFI or F/G differed between treatments ($P > 0.055$). Average daily gain was increased ($P < 0.05$) for pigs switched to corn and soybean meal-based diets compared to pens of pigs still fed diets containing DDGS, yet not different between the treatments that were withdrawn ($P > 0.05$). The third and final treatment was with pigs withdrawn from diets containing DDGS on d -14. Thus, for the subsequent period (d -14 to -7) and remainder of the trial, all treatments were

evaluated. During d -14 to -7, ADG did not result in evidence for differences across treatments ($P = 0.272$), yet ADFI and F/G showed differences ($P < 0.027$). Feed intake was increased ($P < 0.05$) for pigs withdrawn from DDGS on d -28 and d -21 compared to the pigs that remained on a DDGS-containing diet (0 d withdrawal), yet was not different from each other ($P > 0.05$). Pens of pigs withdrawn on d -14 remained intermediate for ADFI compared to the other treatments ($P > 0.05$). Feed efficiency was improved ($P < 0.05$) for the d -14 and no withdrawal treatments compared to the 21 d withdrawal treatment and not different from each other ($P > 0.05$). The 28-d withdrawal treatment remained intermediate to all others for F/G ($P > 0.05$). There was no evidence that ADG, ADFI, or F/G differed across treatments for the last 7 d of the trial ($P > 0.116$).

For the first marketing event on d -21 (Table 4), there was no evidence of treatment differences between pigs on the 28-d withdrawal treatment vs. all others for HCW dressing percentage, backfat, loin depth, or lean percentage ($P > 0.089$). The remaining pigs were marketed at the end of the trial, representing the barn dump in which all treatments were evaluated. There was a marginally significant linear response ($P = 0.061$) where increased HCW was a result of increased withdrawal time. Furthermore, dressing percentage was increased (linear, $P = 0.001$; quadratic, $P = 0.055$) as DDGS withdrawal time increased. There was a marginally significant response ($P = 0.073$) for backfat to quadratically increase, then decrease with increased withdrawal time. Loin depth and percentage lean resulted in marginally significant linear responses ($P < 0.084$) where increased withdrawal time increased loin depth and percent lean. Lastly, iodine value decreased (linear, $P = 0.001$; quadratic, $P = 0.069$) with increased withdrawal time.

Overall growth, carcass, and economic data for Exp. 1 are included in Table 5. There was no evidence for effects of DDGS withdrawal time on final BW, ADFI, or F/G ($P > 0.111$). However, as withdrawal time of DDGS increased before marketing, ADG was linearly increased ($P = 0.022$). Carcass data from both marketing events were combined to evaluate the effect of DDGS withdrawal before harvest on total pen performance. There was no evidence for treatment differences for HCW or loin depth ($P > 0.106$). Dressing percentage was linearly increased ($P < 0.001$) with increasing withdrawal time. Backfat was decreased (quadratic; $P = 0.019$) as withdrawal time increased. Lastly, percentage lean increased (quadratic; $P = 0.033$) as DDGS withdrawal time increased. For economic responses, feed cost and gain value were linearly increased ($P < 0.020$) with increased withdrawal duration before marketing. Income over feed cost displayed a marginally significant ($P = 0.100$) linear increase with increased DDGS withdrawal time.

Exp. 2

Weekly growth performance data for Exp. 2 is included in Table 6. There was no evidence that initial BW or final BW were different ($P > 0.481$). During d -35 to -28, there was no evidence for treatment differences in ADG or F/G ($P > 0.066$). Pigs withdrawn from DDGS-containing diets on d -35 had increased feed intake ($P = 0.007$) compared to those pigs still consuming DDGS. The effects between three treatments were evaluated from day -28 to -21. There was no evidence for differences across treatments for ADG or ADFI ($P > 0.135$), but there was a significant response

for F/G ($P = 0.003$). Pigs withdrawn from DDGS on d -35 had poorer F/G compared to pigs either withdrawn on d -28 or not yet withdrawn ($P < 0.05$), which were not different from each other ($P > 0.05$). The subsequent period (d -21 to -14) evaluated the same three treatments and resulted in no evidence for treatment differences for F/G ($P = 0.317$), although both ADG and ADFI displayed significant responses ($P < 0.034$). Average daily gain was similar ($P > 0.05$) between the treatments that were withdrawn (d -35 and d -28), with both increased compared to pens remaining on the 30% DDGS diet ($P < 0.05$). Feed intake during d -21 to -14 increased ($P < 0.05$) for pens of pigs withdrawn from DDGS on d -28 compared to those still fed DDGS, with the 35 d withdrawal pigs intermediate ($P > 0.05$). All four treatments were evaluated starting with the d -14 to -7 period. Average daily feed intake was different across treatments ($P = 0.001$), with no evidence for differences in ADG or F/G. Average daily feed intake was decreased for the treatment that was still fed DDGS compared to all other treatments ($P < 0.05$), which were not different from each other ($P > 0.05$). During d -7 to 0, ADG and ADFI did not differ across treatments ($P > 0.066$); however, F/G was poorer for pigs withdrawn from DDGS 28 d before market compared to all other treatments ($P < 0.05$), which were similar to each other ($P > 0.05$).

Carcass data from individual marketing events for Exp. 2 is displayed in Table 7. The first marketing event occurred at d 28 prior to barn dump and removed the 15% heaviest pigs from all pens. The next cut from pens occurred at d -14 and removed the next 28% heaviest pigs. Both of these marketing events resulted in no evidence for treatment differences in any carcass response criteria ($P > 0.067$). For the barn dump on d 0, no evidence of treatment differences ($P > 0.05$) was observed for HCW, backfat, loin depth, and percentage lean. Dressing percentage increased and iodine value decreased (linear, $P < 0.022$) as withdrawal time from DDGS diets increased before marketing.

There was no evidence that final BW or overall ADG and F/G differed across treatments with increasing DDGS withdrawal times ($P > 0.116$; Table 8). However, ADFI increased (linear, $P = 0.015$) as time withdrawn from DDGS before final marketing increased. For the overall carcass data, HCW, backfat, loin depth, and percentage lean were not different based on treatment ($P > 0.05$). Dressing percentage increased (linear; $P = 0.034$) with increasing withdrawal time before marketing. Evaluation of economic responses resulted in no evidence for differences in gain value or IOFC ($P > 0.149$); however, feed cost and feed cost per lb of gain increased (linear, $P < 0.003$) with increasing DDGS withdrawal time.

Soto et al.[10] developed a regression model to predict dressing percentage (also referred to as carcass yield) based on NDF level in the diets immediately before harvest. This equation predicted a 1.0, 1.0, and 0.9% increase in carcass yield for Exp. 1 for withdrawal durations of 28, 21, and 14 d, respectively. The actual carcass yield increased by 1.1, 0.8, and 0.9%. Experiment 2 is a bit more variable with predicted increases in carcass yield of 1.2, 1.1, and 1.0 with a 35, 28, and 14 d withdrawal, respectively. The actual increase was 0.5, 0.4, and 0.2% in carcass yield. This equation appears to be a

[10]Soto, J.; Tokach, M. D.; Dritz, S. S.; Gonçalves, M. A.; Woodworth, J. C.; DeRouchey, J. M.; and Goodband, R. D. (2017) "Regression Analysis to Predict the Impact of High Neutral Detergent Fiber Ingredients on Carcass Yield," Kansas Agricultural Experiment Station Research Reports: Vol. 3: Iss. 7. https://doi.org/10.4148/2378-5977.7495

useful tool to determine expected dressing percentage with varying dietary NDF levels and withdrawal times; however, the reason that yield was not as greatly affected in the second experiment as in the first experiment remains unknown.

The data in the present experiments are similar to results by Jacela et al.[11] where a 3 or a 6-week withdrawal from DDGS before slaughter did not affect growth performance but iodine value of fat depots was decreased. Also, Coble et al.[7] found changes in carcass yield, but did not observe final BW differences when pigs were withdrawn from DDGS 20 d before slaughter. These results are similar to our studies where carcass yield linearly increased with increasing DDGS withdrawal time; however, the yield improvement did not always result in a statistically significant change in HCW. The greater variability in HCW as compared to yield may have contributed to this lack of consistent response in HCW. Nevertheless, the effects of feeding DDGS up to marketing decreased carcass yield, increased iodine value, and decreased feed cost, consistent with other data. In Exp. 1, it was most economically advantageous to remove DDGS early as indicated by increased IOFC. Growth performance varied during the intermediate periods but often resulted in increased ADFI for pigs fed corn and soybean meal-based diets compared to those fed diets containing DDGS. The typical reduction in gain, intake, and feed efficiency often observed when pigs are fed DDGS diets compared with diets that do not contain DDGS was not as evident within these experiments. In the current experiments, diets were balanced for net energy, whereas they were not balanced for energy in many of the previous experiments, which may help explain the differences observed. In conclusion, feeding finishing pig diets containing DDGS up to harvest results in decreased dressing percentage and increased iodine value compared to pigs switched from DDGS to corn-soybean meal diets before market.

[11]Jacela, J. Y., J. M. Benz, S. S. Dritz, M. D. Tokach, J. M. DeRouchey, R. D. Goodband, J. L. Nelssen, and K. J. Prusa. 2009. Effect of dried distillers grains with solubles withdrawal regimens on finishing pig performance and carcass characteristics. In: Proc. Swine Day, Stn. Rep. Prog. 1020, Manhattan, KS. p. 181–191.

Table 1. Diet composition (as-fed), Exp. 1 and 2[1]

Ingredient, %	Corn-soybean meal	DDGS[2]
Corn	80.86	61.15
Soybean meal, 46.5% crude protein	15.17	4.61
Corn DDGS	---	30.00
Choice white grease	1.65	2.00
Calcium carbonate	0.83	1.10
Monocalcium phosphate, 21% phosphorus	0.43	---
Sodium chloride	0.45	0.35
L-Lysine-HCl	0.28	0.50
DL-Methionine	0.07	---
L-Threonine	0.11	0.11
L-Tryptophan	0.03	0.06
Phytase[3]	0.03	0.03
Vitamin and mineral premix[4]	0.10	0.10
Total	100.00	100.00
Calculated analysis		
Standardized ileal digestible (SID) amino acids, %		
Lysine	0.77	0.77
Isoleucine:lysine	62	61
Leucine:lysine	150	191
Methionine:lysine	36	34
Methionine and cysteine:lysine	64	64
Threonine:lysine	68	68
Tryptophan:lysine	21	21
Valine:lysine	71	77
Total lysine, %	0.87	0.92
Metabolizable energy, kcal/lb	1,543	1,527
Net energy, kcal/lb	1,185	1,185
SID lysine:metabolizable energy, g/Mcal	2.26	2.29
Crude protein, %	14.3	16.3
Calcium, %	0.46	0.49
Phosphorus, %	0.41	0.41
Available phosphorus, %	0.26	0.31

[1]Diets were fed from approximately 220 to 280 lb in Exp. 1 and 232 to 291 lb in Exp. 2.
[2]DDGS = dried distillers grains with solubles.
[3]Ronozyme HiPhos 2500 (DSM Nutritional Products, Inc., Parsippany, NJ) provided 1,135,000 FTU/lb with an assumed release of 0.12% P.
[4]Provided 1,187,000 IU vitamin A from vitamin A acetate, 120,959 vitamin D_3 from cholecalciferol, 237,382 IU vitamin D from 25-hydroxycholecalciferol, 7,334 mcg vitamin B_{12} from vitamin B_{12}, 2,667 mg riboflavin, 8,000 mg niacin from nicotinic acid, 5,334 mg d-pantothenic acid from dl-pantothenic acid, 800 mg menadione from menadione sodium bisulfate complex, 300 ppm Se from sodium selenite, 15,000 ppm Cu from Intellibond C, 50,666.7 ppm Fe from ferrous sulfate, 90,000 ppm Zn from Intellibond Z, 25,000 ppm Mn from Intellibond M, and 253.3 ppm I from ethylenediamine dihydriodide per lb of premix.

Table 2. Diet analysis, Exp. 1 and 2[1]

Item, %	Corn-soybean meal	DDGS[2]
Dry matter, %	88.31	89.08
Crude protein, %	14.3	16.6
Acid detergent fiber, %	4.6	5.8
Neutral detergent fiber, %	8.6	12.8
Calcium, %	0.55	0.63
Phosphorus, %	0.40	0.48
Ether extract, %	4.4	5.7

[1]Diets were fed from approximately 220 to 280 lb in Exp. 1 and 232 to 291 lb in Exp. 2.
[2]DDGS = dried distillers grains with solubles.

Table 3. Effects of DDGS withdrawal on weekly finishing pig performance, Exp. 1[1,2,3]

	DDGS diet withdrawal before market, d					
Item[4]	28	21	14	0	SEM	Probability, *P* =
BW, lb						
d -28	219.5	---	---	219.4	0.93-1.62	0.961
d -21	237.4	236.7	---	236.7	1.31-1.85	0.947
d -14	250.1	249.9	247.3	247.3	2.05	0.640
d -7	264.4	263.1	261.7	261.6	2.02	0.731
d 0	280.2	278.8	276.8	277.4	2.07-2.17	---[5]
d -28 to -21						
n (pens):	12	--	---	36	---	---
ADG, lb	2.56	---	---	2.47	0.037-0.064	0.198
ADFI, lb	6.65	---	---	6.65	0.064-0.11	0.452
F/G	2.62	---	---	2.71	0.038-0.066	0.483
d -21 to -14						
n (pens):	12	12	---	24	---	---
ADG, lb	2.53[a]	2.53[a]	---	2.30[b]	0.061-0.086	0.033
ADFI, lb	6.38	6.18	---	6.13	0.102-0.144	0.213
F/G	2.53	2.46	---	2.71	0.049-0.070	0.055
d -14 to -7						
n (pens):	12	12	12	12	---	---
ADG, lb	2.03	1.88	2.06	2.04	0.069	0.272
ADFI, lb	6.37[a]	6.31[a]	6.08[a,b]	5.87[b]	0.126	0.027
F/G	3.18[a,b]	3.40[a]	2.97[b]	2.93[b]	0.110	0.015
d -7 to 0						
ADG, lb	2.26	2.25	2.12	2.27	0.057-0.060	0.259
ADFI, lb	6.67	6.67	6.58	6.47	0.084-0.087	0.303
F/G	2.97	2.98	3.16	2.87	0.081-0.085	0.116

[ab]Means within a row with different superscripts differ, $P < 0.05$.

[1]A total of 985 finishing pigs (initially 219 ± 5.5 lb BW) were used in a 28-d experiment to evaluate the effects of removing corn dried distillers grains with solubles (DDGS) from diets at increasing intervals before harvest.

[2]Pigs were fed diets containing 30% DDGS until the start of the trial. Diets with DDGS during the trial also contained 30%.

[3]Pens of pigs were topped according to a typical summer marketing strategy with one top prior to final barn dump. All pens were topped by removing the 17% heaviest pigs on d -21 resulting in a final barn dump of approximately 83% of starting barn inventory.

[4]ADG = average daily gain. ADFI = average daily feed intake. F/G = feed/gain ratio. BW = body weight.

[5]Linear, $P = 0.378$; quadratic, $P = 0.476$.

Table 4. Effects of DDGS withdrawal on carcass characteristics for individual marketing events, Exp. 1[1,2,3]

	DDGS diet withdrawal before market, d					Probability, *P* =		
Item[4]	28	21	14	0	SEM	Trt	Linear	Quadratic
d -21 top								
HCW, lb	196.6	---	---	194.3	1.38-2.42	0.401	---	---
Dressing percentage, %	73.9	---	---	73.3	0.17-0.30	0.089	---	---
Backfat,[5] in.	0.60	---	---	0.62	0.010-0.018	0.314	---	---
Loin depth,[5] in.	2.41	---	---	2.38	0.011-0.022	0.265	---	---
Lean,[5] %	54.9	---	---	54.5	0.14-0.25	0.252	---	---
Dump								
HCW, lb	212.9	212.4	211.0	208.5	1.76-1.84	---	0.061	0.812
Dressing percentage, %	76.2	76.0	76.2	75.0	0.20-0.21	---	0.001	0.055
Backfat,[5] in.	0.58	0.59	0.61	0.59	0.008	---	0.225	0.073
Loin depth,[5] in.	2.51	2.48	2.49	2.47	0.013	---	0.072	0.631
Lean,[5] %	54.9	54.7	54.6	54.6	0.11-0.12	---	0.084	0.111
Iodine value	71.0	71.3	71.3	73.0	0.25-0.26	---	<.0001	0.069

[1]A total of 985 finishing pigs (initially 219 ± 5.5 lb BW) were used in a 28-d experiment to evaluate the effects of removing corn dried distillers grains with solubles (DDGS) from diets at increasing intervals before harvest.
[2]Pigs were fed diets containing 30% DDGS until the start of the trial. Diets with DDGS during the trial also contained 30%.
[3]Pens of pigs were topped according to a typical summer marketing strategy with one top prior to final barn dump. All pens were topped by removing the 17% heaviest pigs on d -21 resulting in a final barn dump of approximately 83% of starting barn inventory.
[4]HCW = hot carcass weight. Dressing percentage, % = individual pig HCW / individual pig live weight.
[5]Adjusted for hot carcass weight.

Table 5. Effects of DDGS withdrawal on overall growth performance, carcass characteristics, and economics, Exp. 1[1,2,3]

	DDGS diet withdrawal before market, d					Probability, *P* =	
Item[4]	28	21	14	0	SEM	Linear	Quadratic
Growth performance							
ADG, lb	2.36	2.30	2.26	2.25	0.30-0.31	0.022	0.202
ADFI, lb	6.52	6.44	6.39	6.32	0.091-0.095	0.111	0.729
F/G	2.77	2.80	2.83	2.81	0.029-0.031	0.440	0.282
d 0 BW, lb	280.2	278.8	276.8	277.4	2.07-2.17	0.378	0.476
Carcass characteristics							
HCW, lb	210.0	208.6	207.5	206.5	1.77-1.83	0.166	0.702
Dressing percentage, %	75.8	75.5	75.6	74.7	0.18	<0.001	0.256
Backfat,[5] in.	0.58	0.60	0.61	0.59	0.008	0.492	0.019
Loin depth,[5] in.	2.49	2.46	2.48	2.46	0.011	0.106	0.388
Lean,[5] %	54.9	54.6	54.5	54.7	0.11	0.214	0.033
Economics, $/pig							
Feed cost	14.40	13.94	13.66	13.57	0.212-0.222	0.009	0.178
Feed cost per lb of gain[6]	0.237	0.234	0.238	0.237	0.0032-0.0034	0.818	0.839
Gain value[7]	29.99	28.99	28.56	28.08	0.550-0.574	0.020	0.403
IOFC[8]	15.59	15.06	14.90	14.50	0.442-0.462	0.100	0.697

[1]A total of 985 finishing pigs (initially 219 ± 5.5 lb BW) were used in a 28-d experiment to evaluate the effects of removing corn dried distillers grains with solubles (DDGS) from diets at increasing intervals before harvest.
[2]Pigs were fed diets containing 30% DDGS until the start of the trial. Diets with DDGS during the trial also contained 30%.
[3]Pens of pigs were topped according to a typical summer marketing strategy with one top prior to final barn dump. All pens were topped by removing the 17% heaviest pigs on d -21 resulting in a final barn dump of approximately 83% of starting barn inventory.
[4]ADG = average daily gain. ADFI = average daily feed intake. F/G = feed/gain ratio. BW = body weight. HCW = hot carcass weight. Dressing percentage, % = individual pig HCW / individual pig live weight.
[5]Adjusted for hot carcass weight.
[6]Feed cost per lb of gain = feed cost per pig ÷ overall gain per pig.
[7]Gain value = (HCW × $0.70) – (d 0 BW × 0.75 × $0.70).
[8]Income over feed cost = gain value – feed cost.

Table 6. Effects of DDGS withdrawal on weekly finishing pig performance, Exp. 2[1,2,3]

	DDGS diet withdrawal before market, d					
Item[4]	35	28	14	0	SEM	Probability, *P* =
BW, lb						
d -35	231.9	---	---	231.8	0.65-1.13	0.978
d -28	248.2	247.5	---	247.6	0.88-1.24	0.912
d -21	259.3	260.5	---	260.9	1.01-1.42	0.646
d -14	275.6	276.2	275.6	275.9	1.44	0.989
d -7	282.5	282.1	284.2	282.8	1.65	0.817
d 0	299.5	297.4	301.1	299.9	1.79	---[5]
d -35 to -28						
n (pens):	15	--	---	45	---	---
ADG, lb	2.35	---	---	2.23	0.031-0.054	0.066
ADFI, lb	6.81[a]	---	---	6.52[b]	0.053-0.091	0.007
F/G	2.92	---	---	2.93	0.030-0.052	0.876
d -28 to -21						
n (pens):	15	15	---	30	---	---
ADG, lb	2.31	2.42	---	2.45	0.042-0.059	0.135
ADFI, lb	7.04	6.98	---	6.84	0.064-0.089	0.164
F/G	3.09[a]	2.89[b]	---	2.80[b]	0.047-0.066	0.003
d -21 to -14						
ADG, lb	2.28[a]	2.25[a]	---	2.11[b]	0.032-0.046	0.004
ADFI, lb	7.09[a,b]	7.13[a]	---	6.85[b]	0.069-0.097	0.034
F/G	3.12	3.20	---	3.26	0.055-0.077	0.317
d -14 to -7						
n (pens):	15	15	15	15	---	---
ADG, lb	2.27	2.29	2.42	2.20	0.061	0.094
ADFI, lb	7.06[a]	7.05[a]	7.28[a]	6.72[b]	0.096	0.001
F/G	3.19	3.09	3.01	3.09	0.108	0.705
d -7 to 0						
ADG, lb	2.42	2.19	2.42	2.44	0.075	0.066
ADFI, lb	7.76	753	7.71	7.39	0.110	0.086
F/G	3.21[b]	3.49[a]	3.20[b]	3.07[b]	0.076	0.002

[ab]Means within a row with different superscripts differ, $P < 0.05$.

[1]A total of 1,158 finishing pigs (initially 232 ± 4.3 lb BW) were used in a 35-d experiment to evaluate the effects of removing corn dried distillers grains with solubles (DDGS) from diets at increasing intervals before harvest.

[2]Pigs were fed diets containing 30% DDGS until the start of the trial. Diets with DDGS during the trial also contained 30%.

[3]Pens of pigs were topped according to a typical winter marketing strategy with two tops prior to final barn dump. All pens were topped by removing the 15% heaviest pigs on d -28 and the 28% heaviest pigs on d -14 resulting in a final barn dump of approximately 57% of starting barn inventory.

[4]ADG = average daily gain. ADFI = average daily feed intake. F/G = feed/gain ratio. BW = body weight.

[5]Linear, $P = 0.481$; quadratic, $P = 0.829$.

Table 7. Effects of DDGS withdrawal on individual marketing event carcass characteristics, Exp. 2[1,2,3]

	DDGS diet withdrawal before market, d					Probability, *P* =		
Item[4]	35	28	14	0	SEM	Trt	Linear	Quadratic
d -28 top								
HCW, lb	206.6	---	---	203.2	1.20-1.89	0.132	---	---
Dressing percentage, %	73.7	---	---	73.4	0.20-0.33	0.484	---	---
Backfat,[5] in.	0.62	---	---	0.61	0.010-0.016	0.605	---	---
Loin depth,[5] in.	2.42	---	---	2.41	0.016-0.024	0.662	---	---
Lean,[5] %	54.4	---	---	54.4	0.15-0.23	0.980	---	---
d -14 top							---	---
HCW, lb	226.0	224.3	---	221.8	1.09-1.45	0.067	---	---
Dressing percentage, %	74.9	74.8	---	74.4	0.22-0.30	0.302	---	---
Backfat,[5] in.	0.63	0.61	---	0.61	0.010-0.013	0.329	---	---
Loin depth,[5] in.	2.53	2.55	---	2.54	0.017-0.024	0.895	---	---
Lean,[5] %	54.2	54.3	---	54.4	0.14-0.19	0.653	---	---
Dump								
HCW, lb	225.1	224.7	226.2	224.8	1.33-1.34	---	0.935	0.574
Dressing percentage, %	75.3	75.3	75.0	74.8	0.19	---	0.022	0.854
Backfat,[5] in.	0.61	0.63	0.61	0.61	0.009	---	0.224	0.608
Loin depth,[5] in.	2.58	2.55	2.56	2.56	0.015	---	0.629	0.603
Lean,[5] %	54.4	54.2	54.4	54.4	0.012	---	0.703	0.577
Iodine value	68.1	69.3	70.1	71.7	0.37	---	<.0001	0.971

[1]A total of 1,158 finishing pigs (initially 232 ± 4.3 lb BW) were used in a 35-d experiment to evaluate the effects of removing corn dried distillers grains with solubles (DDGS) from diets at increasing intervals before harvest.
[2]Pigs were fed diets containing 30% DDGS until the start of the trial. Diets with DDGS during the trial also contained 30%.
[3]Pens of pigs were topped according to a typical winter marketing strategy with two tops prior to final barn dump. All pens were topped by removing the 15% heaviest pigs on d -28 and the 28% heaviest pigs on d -14 resulting in a final barn dump of approximately 57% of starting barn inventory.
[4]HCW = hot carcass weight. Dressing percentage, % = individual pig HCW / individual pig live weight.
[5]Adjusted for hot carcass weight.

Table 8. Effects of DDGS withdrawal on overall growth performance, carcass characteristics, and economics, Exp. 2[1,2,3]

	DDGS diet withdrawal before market, d					Probability, *P* =	
Item[4]	35	28	14	0	SEM	Linear	Quadratic
Growth performance (d -35 to 0)							
ADG, lb	2.32	2.30	2.32	2.26	0.026	0.116	0.480
ADFI, lb	7.11	7.00	6.94	6.83	0.076-0.079	0.015	0.854
F/G	3.06	3.05	3.00	3.03	0.024-0.025	0.205	0.225
Final BW, lb	299.5	297.4	301.1	299.9	1.79	0.481	0.829
Carcass characteristics							
HCW, lb	222.7	221.8	222.2	221.7	1.02-1.05	0.610	0.913
Dressing percentage, %	75.0	74.9	74.7	74.5	0.18	0.034	0.898
Backfat,[5] in.	0.62	0.62	0.60	0.61	0.007	0.128	0.423
Loin depth,[5] in.	2.55	2.54	2.55	2.53	0.011	0.370	0.587
Lean,[5] %	54.3	54.3	54.5	54.3	0.09-0.10	0.759	0.388
Economics, $/pig							
Feed cost	17.77	17.38	17.18	16.78	0.217-0.225	0.003	0.816
Feed cost per lb of gain[6]	0.263	0.264	0.249	0.249	0.0035-0.0036	0.001	0.350
Gain value[7]	35.80	35.64	36.54	34.92	0.724-0.749	0.562	0.244
IOFC[8]	18.03	18.26	19.36	18.15	0.616-0.638	0.669	0.149

[1]A total of 1,158 finishing pigs (initially 232 ± 4.3 lb BW) were used in a 35-d experiment to evaluate the effects of removing corn dried distillers grains with solubles (DDGS) from diets at increasing intervals before harvest.
[2]Pigs were fed diets containing 30% DDGS until the start of the trial. Diets with DDGS during the trial also contained 30%.
[3]Pens of pigs were topped according to a typical winter marketing strategy with two tops prior to final barn dump. All pens were topped by removing the 15% heaviest pigs on d -28 and the 28% heaviest pigs on d -14 resulting in a final barn dump of approximately 57% of starting barn inventory.
[4]ADG = average daily gain, ADFI = average daily feed intake, F/G = feed/gain ratio, BW = body weight, HCW = hot carcass weight. Dressing percentage, % = individual pig HCW / individual pig live weight.
[5]Adjusted for hot carcass weight.
[6]Feed cost per lb of gain = feed cost per pig ÷ overall gain per pig.
[7]Gain value = (HCW × $0.70) – (d 0 BW × 0.75 × $0.70).
[8]Income over feed cost = gain value – feed cost.