Effect of Dried Distillers Grains with Solubles Withdrawal Regimens on Finishing Pig Performance and Carcass Characteristics[1]

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Summary

A total of 962 pigs (PIC L337 × 1050, initial BW = 86.1 lb) were used to determine the effect of dried distillers grains with solubles (DDGS) withdrawal regimens on growth performance and carcass traits. Pigs were randomly assigned to 1 of 6 treatments (6 pens per treatment) balanced by average BW within gender. Treatments were: (1) a corn-soybean meal-based diet without DDGS fed for 89 d (control), (2) 30% DDGS fed from d 0 to 48 and 0% DDGS fed from d 48 to 89, (3) 30% DDGS fed from d 0 to 69 and 0% DDGS fed from d 69 to 89, (4) 30% DDGS fed from d 0 to 48 and 15% DDGS fed from d 48 to 89, (5) 30% DDGS fed from d 0 to 69 and 15% DDGS fed from d 69 to 89, and (6) 30% DDGS diet fed from d 0 to 89. All diets contained 3% added fat. Pig BW, ADG, ADFI, and F/G were determined every 14 d. At the end of the trial, carcass fat quality was evaluated. There were no treatment × gender interactions ($P > 0.21$) for any criteria evaluated. Although there were some differences in F/G within phases, there were no overall differences ($P > 0.35$) in growth performance among treatments. Final weight numerically decreased as total DDGS level increased. Feeding continuously or withdrawing DDGS from the diet, regardless of the amount or duration, had no significant effect ($P > 0.39$) on any of the carcass criteria measured. Pigs fed DDGS had increased ($P < 0.01$) iodine value of fat depots compared with control pigs. When the DDGS withdrawal duration increased (Treatments 6, 3, 2, and 1), iodine values for all fat depots decreased (linear; $P < 0.01$). Feed cost per pig was highest ($P < 0.05$) when 0% DDGS was fed or withdrawn 6 wk before marketing (Treatments 1 and 2) and lowest when DDGS was added in the diets until at least 3 wk before marketing (Treatments 3, 4, 5, and 6). However, the reduction in feed cost did not significantly improve ($P > 0.57$) revenue or income over feed cost. In summary, DDGS reduction or withdrawal 3 or 6 wk before market did not affect growth performance or totally alleviate its negative effect on carcass fat iodine value.

Key words: carcass, dried distillers grains with solubles, growth

Introduction

Use of dried distillers grains with soluble (DDGS) in swine diets has become common in the swine industry over the past several years. Aside from being a relatively inexpensive ingredient, DDGS is a good source of energy and amino acids. Availability of phosphorus in DDGS is also high compared with corn, which reduces the need to

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add inorganic phosphorus in the diet. Thus, DDGS is a suitable alternative to other common energy and protein sources such as corn and soybean meal.

Unfortunately, the use of DDGS in pig diets has some disadvantages. In some studies, growth performance of pigs was negatively affected when DDGS was added to diets, especially at high levels (30% or greater). Another disadvantage is the negative effect of DDGS on carcass yield and fat quality. Soft carcass fat with a high iodine value (IV) has consistently been observed in pigs fed high levels of DDGS. Thus, it has been suggested that DDGS should be withdrawn from finishing diets several weeks prior to market to alleviate its negative effect on carcass quality. However, the optimum level and timing of DDGS reduction that will result in ameliorating its negative effects on fat quality (as measured by IV) warrants further investigation.

Therefore, we conducted this study to evaluate the effects of decreasing or withdrawing DDGS at different times before marketing on growth performance, carcass characteristics, and carcass fat quality of finishing pigs.

Procedures

This study was approved by and conducted in accordance with the guidelines of the Kansas State University Institutional Animal Care and Use Committee. The experiment was conducted in a commercial research finishing barn in southwestern Minnesota. The barns were naturally ventilated and double curtain sided. Pens had completely slatted flooring and deep pits for manure storage. Each pen was equipped with a 5-hole stainless steel dry self-feeder and a cup waterer for ad libitum access to feed and water. Daily feed additions to each pen were accomplished through a robotic feeding system (FeedPro; Feedlogic Corp., Willmar, MN) capable of providing and measuring feed amounts on an individual pen basis.

A total of 962 pigs (PIC L337 × 1050, initial BW = 86.1 lb) were randomly assigned to 1 of 6 treatments balanced by average BW within gender. There were 6 single-gender pens (3 pens of barrows and 3 pens of gilts) per treatment. Pigs were fed a common nursery diet based on corn and soybean meal with 15% DDGS for approximately 27 d before the start of the experiment. Treatments were: (1) a corn-soybean meal-based diet without DDGS fed for 89 d (control), (2) 30% DDGS fed from d 0 to 48 and 0% DDGS fed from d 48 to 89, (3) 30% DDGS fed from d 0 to 69 and 0% DDGS fed from d 69 to 89, (4) 30% DDGS fed from d 0 to 48 and 15% DDGS fed from d 48 to 89, (5) 30% DDGS fed from d 0 to 69 and 15% DDGS fed from d 69 to 89, and (6) 30% DDGS diet fed from d 0 to 89 (Table 1). Diets contained 3% added fat and were fed in 4 phases formulated to contain a minimum of 2.70, 2.43, 2.05, and 2.72 standardized ileal digestible lysine/Mcal ME during Phases 1 to 4, respectively. In diet formulation, the DDGS used in this experiment was assumed to have the same ME content as corn. Dietary Phases 1 to 4 were fed from approximately 80 to 130, 130 to 185, 185 to 230, and 230 to 270 lb, respectively. Pigs from each pen were weighed as a group and feed disappearance was determined every 2 wk to determine ADG, ADFI, and F/G.

On d 76 of the experiment, the 3 heaviest pigs from each pen (determined visually) were sold in accordance with the normal marketing procedure of the farm. At the end of the experiment, pigs were individually tattooed according to pen number to allow for carcass data collection at the packing plant and data retrieval by pen. Pigs were transported to JBS Swift and Company (Worthington, MN) for processing and carcass data collection. Standard carcass criteria of loin and backfat depth, HCW, percentage lean, and yield were collected. Fat-free lean index was calculated using the equation: 50.767 + (0.035 × HCW) - (8.979 × backfat).

Two average-weight pigs from every pen were tattooed with unique identification numbers to distinguish them from the rest of the pigs when the whole finishing group was marketed. From these pigs, fat samples from jowl fat, backfat, and belly fat were collected and processed for fatty acid analysis using gas chromatography. Fatty acids from each of the fat samples were expressed as a percentage of the total fatty acids. Iodine value, expressed as g/100 g of fat, was then calculated based on the fatty acid profile of each sample according to the following equation[4]:

$$IV = [C16{:}1] \times 0.95 + [C18{:}1] \times 0.86 + [C18{:}2] \times 1.732 + [C18{:}3] \times 2.616 + [C20{:}1] \times 0.785 + [C22{:}1] \times 0.723$$

where the brackets imply concentration (percentage) of the fatty acid.

Statistical analysis was performed by analysis of variance using the MIXED procedure of SAS (SAS Institute, Inc., Cary, NC). Data were analyzed as a completely randomized design with pen as the experimental unit. The main effects of the different treatment regimens, gender, and their interaction were tested. Backfat, loin depth, percentage lean, and fat-free lean index were adjusted to a common carcass weight. Linear and polynomial contrasts were used to determine the effects of withdrawal duration and level of DDGS reduction (100%, 50%, and 0%). Contrast coefficients for withdrawal duration (0, 20, 41, and 89 d) were determined for unequally spaced treatments by using the IML procedure of SAS. The main effects of duration of DDGS reduction (3 vs. 6 wk) and level of DDGS reduction (100% vs. 50%) were determined using single degree of freedom contrast statements.

Results and Discussion

There were no treatment × gender interactions ($P > 0.21$) for any of the criteria evaluated. Overall gender differences in growth performance were as expected, with barrows having greater ($P < 0.05$) ADG and ADFI but poorer ($P < 0.05$) F/G than gilts (Table 2). From d 0 to 42, when all pigs were fed 30% DDGS diets with the exception of the control pigs, there were no differences ($P > 0.31$) among treatments. However, ADG, ADFI, and F/G of pigs fed 0% DDGS were numerically improved by 6.3%, 3.6% and 2.9%, respectively, compared with pigs fed 30% DDGS.

From d 42 to 69, pigs in all treatment groups had similar ($P > 0.47$) growth performance. However, when the amount of DDGS was lowered to 0% or 15% of the diet (6 wk vs. 3 wk withdrawal; Treatments 2 and 4 vs. 3 and 5), reducing DDGS earlier tended ($P < 0.10$) to lead to a greater ADG but poorer F/G.

From d 69 to 89, ADFI decreased (linear; $P < 0.01$) but F/G tended to improve (linear; $P < 0.10$) as the duration of complete DDGS withdrawal from the diet (Treatments

[4] AOCS. 1998. Official Methods and Recommended Practices of the AOCS. 5th ed. Am. Oil. Chem. Soc., Champaign, IL.

1, 2, 3, and 6) increased. When DDGS level during the last 3 wk (0%, 15%, and 30%; Treatments 3, 5, and 6) was compared, F/G tended ($P < 0.10$) to improve as less DDGS was withdrawn from the diet. Complete withdrawal or reduction to 15% DDGS in the diet 6 wk before pigs were marketed improved ($P < 0.05$) F/G compared with a 3-wk complete DDGS withdrawal or reduction to 15% (Treatments 2 and 4 vs. 3 and 5). From d 42 to 89, there were no differences ($P > 0.42$) in ADFI or F/G among the 6 treatments. However, increasing the duration of DDGS withdrawal increased ADG (quadratic; $P < 0.05$; Treatments 1, 2, 3, and 6).

Overall, there were no differences in growth performance among treatments ($P > 0.35$). However, when comparing the effect of amount of DDGS withdrawn from the diet during the last 6 wk before market (100%, 50%, and 0% DDGS withdrawn; Treatments 2, 4, and 6), F/G became worse (quadratic; $P = 0.05$). The effect of DDGS withdrawal observed in this experiment agrees with the findings from a previous study that evaluated the effects of feeding diets with 30% DDGS and a withdrawal (0% DDGS) duration of 0, 3, or 6 wk before marketing on growth performance (Gaines et al., 2007[5]). Gaines et al. (2007) reported that pigs continuously fed 30% DDGS had poorer F/G than pigs that were fed diets with 0% DDGS. Possible explanations for the differences in results between our study and that of Gaines et al. (2007) include the quality of DDGS used and method of diet formulation. We used higher levels of synthetic amino acids to minimize excess CP. Because of the similar growth performance exhibited by all the treatment groups in our study, no significant differences in final weights were observed. However, feeding DDGS for longer durations numerically reduced market weight.

Feeding DDGS continuously or withdrawing it from the diet, regardless of the amount, had no significant effect ($P > 0.39$) on any of the carcass characteristics measured (Table 3). This is in contrast to results of Gaines et al. (2007), who observed an improvement in carcass yield and weight when DDGS was withdrawn from the diet several weeks before market.

As expected, fat quality was negatively affected in pigs fed diets containing DDGS. Fat firmness is less desirable when it contains high amounts of polyunsaturated fatty acids (PUFA), which are correlated to a high IV. All DDGS-fed pigs had increased ($P < 0.01$) PUFA in all fat depots compared with the non-DDGS-fed pigs (Table 4). When the duration of DDGS withdrawal decreased (Treatments 1, 2, 3, and 6), PUFA increased in backfat (quadratic; $P < 0.01$), belly fat (linear; $P < 0.01$), and jowl fat (linear; $P < 0.01$). Thus, feeding DDGS increased ($P < 0.01$) the IV of all 3 fat depots compared with the controls. Complete withdrawal of DDGS from the diet did not reduce IV to levels similar or close to the controls, which is not consistent with other studies that showed a reduction in IV when DDGS was withdrawn from the diet for as little as 3 wk (Xu et al., 2008[6]). Results of our study indicate that a 6-wk withdrawal or reduction of DDGS in the diets is not enough to totally alleviate the negative effect of feeding

[5] Gaines, A. M., J. D. Spencer, G. I. Petersen, N. R. Augspurger, and S. J. Kitt. 2007. Effect of corn distillers dried grains with solubles (DDGS) withdrawal program on growth performance and carcass yield in grow-finish pigs. J. Anim. Sci. 85(Suppl. 1):438. (Abstr.)

[6] Xu, G., S. K. Baidoo, L. J. Johnston, J. E. Cannon, D. Bibus, and G. C. Shurson. 2008. Effects of dietary corn dried distillers grains with solubles (DDGS) and DDGS withdrawal intervals, on pig growth performance, carcass traits, and fat quality. J. Anim. Sci. 86(Suppl. 2):52. (Abstr.)

DDGS on carcass fat. However, this may depend on the quality or crude fat content of the DDGS. As the duration of complete DDGS withdrawal increased (Treatments 6, 3, 2, and 1), IV for all fat depots decreased (linear; $P < 0.01$). The rate of IV decrease in backfat, belly fat, and jowl fat was 0.02, 0.02, and 0.08 g/100g, respectively, for every week that DDGS was reduced to 15% (Figures 1, 2, and 3). When DDGS was completely withdrawn from the diet, IV of backfat, belly fat, and jowl fat decreased by 0.18, 0.31, and 0.34 g/100g per wk, respectively. The change in IV for the 3 fat depots appears to be more variable between the 3 and 6 wk data when DDGS was reduced to only 15% compared with complete withdrawal.

Feed cost per pig was highest ($P < 0.05$) when 0% DDGS was fed in the diets or withdrawn 6 wk before marketing (Treatments 1 and 2; Table 5) and lower when DDGS was added in the diets until at least 3 wk before marketing (Treatments 3, 4, 5, and 6). As the number of days that DDGS was withdrawn from the diet decreased (Treatments 1, 2, 3, and 6), feed cost per pig also decreased (linear; $P < 0.01$). Feed cost per pig was also reduced (linear; $P < 0.05$) as the level of DDGS withdrawn from the diet was reduced from 100% to 0% during the last 6 wk prior to market (Treatments 2, 4, and 6). However, the reduction in feed cost did not result ($P > 0.57$) in any significant improvement in revenue or income over feed cost (IOFC), although IOFC was numerically highest in pigs that were fed 30% DDGS continuously.

In summary, feeding 30% DDGS in finishing pigs did not affect growth performance but resulted in softer fat as indicated by increased carcass fat IV. Diet cost was reduced when DDGS was fed continuously in finishing pigs, which resulted in a numeric increase in IOFC. Reducing or completely withdrawing DDGS from diets 3 or 6 wk before pigs were marketed did not totally alleviate the negative effect of DDGS on carcass fat IV but numerically reduced the IV compared with continuously feeding DDGS until marketing.

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

	Phase 1		Phase 2		Phase 3			Phase 4		
DDGS, %[2]:	0	30	0	30	0	15	30	0	15	30
Ingredient, %										
Corn	72.2	49.1	73.7	53.0	78.9	69.4	57.0	69.6	59.0	47.8
Soybean meal (46.5% CP)	22.6	15.6	21.4	12.0	16.2	10.9	8.1	25.4	21.3	17.2
DDGS	---	30.0	---	30.0	---	15.0	30.0	---	15.0	30.0
Choice white grease	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Monocalcium P (21% P)	0.5	0.3	0.4	---	0.3	---	---	0.3	---	---
Limestone	0.9	1.1	0.9	1.1	1.0	0.9	1.1	1.0	1.0	1.2
Salt	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
L-lysine HCl	0.3	0.5	0.2	0.5	0.2	0.4	0.4	0.2	0.3	0.4
L-threonine	0.03	---	---	---	---	---	---	0.04	---	---
DL-methionine	0.02	---	---	---	---	---	---	0.035	---	---
Ractopamine HCl, 9 g/lb[3]	---	---	---	---	---	---	---	0.025	0.025	0.025
Vitamin-trace mineral premix	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Phytase[4]	0.013	---	0.013	0.005	0.013	0.013	0.005	0.010	0.010	0.005
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Calculated analysis:										
SID[5] amino acids, %										
Lysine	0.94	0.94	0.85	0.85	0.72	0.72	0.72	0.95	0.95	0.95
Isoleucine:lysine	65	69	69	69	70	68	72	69	70	71
Leucine:lysine	148	186	161	196	173	192	219	154	171	188
Methionine:lysine	28	33	29	34	30	33	38	31	30	33
Met & Cys:lysine	56	66	59	69	63	68	77	60	62	67
Threonine:lysine	60	63	61	64	62	63	68	65	63	65
Tryptophan:lysine	18	17	19	17	19	17	17	19	19	18
Valine:lysine	74	83	80	85	82	84	91	78	82	85
Total lysine, %	1.05	1.10	0.96	1.00	0.81	0.84	0.87	1.07	1.09	1.12
ME, kcal/lb	1,580	1,582	1,582	1,587	1,583	1,589	1,587	1,581	1,587	1,585
SID Lysine:ME, g/Mcal	2.70	2.70	2.44	2.43	2.06	2.05	2.06	2.73	2.72	2.72
CP, %	16.7	19.6	16.2	18.3	14.2	15.0	16.7	17.7	19.0	20.2
Ca, %	0.54	0.54	0.52	0.48	0.50	0.41	0.48	0.54	0.46	0.52
P, %	0.46	0.52	0.43	0.44	0.40	0.38	0.43	0.44	0.42	0.47
Available P, %	0.27	0.27	0.24	0.26	0.23	0.23	0.25	0.23	0.23	0.26
Cost, $/ton[6]	189.3	175.9	183.4	165.6	169.7	159.1	154.7	212.0	202.0	195.0

[1] Phases 1, 2, 3, and 4 were fed from approximately 80 to 130, 130 to 185, 185 to 230, and 230 to 270 lb BW, respectively.
[2] Dried distillers grains with solubles.
[3] Paylean; Elanco Animal Health, Greenfield, IN.
[4] OptiPhos 2000 (Enzyvia LLC, Sheridan, IN) provided per pound of diet: 227 and 0 FTU in the 0% and 30% DDGS diets, respectively, in Phase 1; 227 and 91 FTU in the 0% and 30% DDGS diets, respectively, in Phase 2; 227 FTU in the 0% and 15% DDGS diets and 91 FTU in the 30% DDGS diet in Phase 3; and 181 FTU in the 0% and 15% DDGS diets and 91 FTU in the 30% DDGS diet in Phase 4.
[5] Standardized ileal digestible.
[6] Diet cost was based on corn at $3.05/bu and 46.5% soybean meal at $370/ton.

Table 2. Effect of dried distillers grains with solubles (DDGS) step-down or withdrawal regimen on growth performance of growing-finishing pigs[1]

	DDGS, %									
Treatment:	1	2	3	4	5	6				
d 0 to 48:	0	30	30	30	30	30				
d 48 to 69:	0	0	30	15	30	30		Gender		
d 69 to 89:	0	0	0	15	15	30	SEM	Barrow	Gilt	SEM
Weight, lb										
d 0	85.9	85.7	85.9	87.1	86.6	85.1	2.11	86.6	85.6	1.22
d 42	171.6	166.9	167.3	166.6	166.6	167.4	3.61	169.5	166.0	2.08
d 69	225.4	221.1	221.3	218.5	218.5	219.1	3.99	223.3	218.0	2.30
d 76	241.5	237.4	236.7	235.4	233.2	235.0	3.98	239.8	233.3	2.30
d 89[a]	267.8	266.4	267.0	263.2	261.7	261.4	4.06	268.1	261.1	2.34
d 0 to 42										
ADG, lb	2.02	1.91	1.91	1.88	1.88	1.92	0.051	1.95	1.89	0.030
ADFI, lb[a]	4.84	4.66	4.71	4.80	4.69	4.57	0.135	4.86	4.56	0.078
F/G[e]	2.40	2.44	2.47	2.57	2.49	2.38	0.063	2.50	2.42	0.036
d 42 to 69										
ADG, lb[a,h]	5.74	5.82	5.73	5.85	5.54	5.71	0.111	5.95	5.51	0.064
ADFI, lb	1.92	1.96	1.97	1.89	1.90	1.91	0.050	1.96	1.89	0.029
F/G[a,h]	3.00	2.97	2.91	3.09	2.93	2.99	0.063	3.04	2.92	0.037
d 69 to 89										
ADG, lb	2.29	2.50	2.25	2.38	2.39	2.41	0.072	2.39	2.34	0.042
ADFI, lb[a,b]	5.84	6.30	6.32	6.15	6.34	6.38	0.126	6.48	5.97	0.073
F/G[a,c,f,g]	2.55	2.54	2.82	2.59	2.67	2.65	0.068	2.72	2.56	0.040
d 42 to 89										
ADG, lb[d]	2.06	2.17	2.15	2.09	2.09	2.08	0.041	2.13	2.08	0.024
ADFI, lb[a]	5.78	6.02	5.97	5.97	5.86	5.98	0.105	6.16	5.70	0.061
F/G[a]	2.81	2.78	2.79	2.86	2.81	2.88	0.051	2.90	2.74	0.029
d 0 to 89										
ADG, lb[a]	2.04	2.04	2.03	1.98	1.98	2.00	0.031	2.04	1.99	0.018
ADFI, lb[a]	5.32	5.35	5.36	5.40	5.29	5.29	0.096	5.53	5.14	0.056
F/G[a,e]	2.61	2.62	2.64	2.72	2.66	2.64	0.037	2.71	2.59	0.022

[1] A total of 962 pigs (PIC L337 × 1050, initial BW = 86.1 lb) were used with 27 pigs per pen and 6 pens per treatment.
[a] Gender effect: $P < 0.05$.
[b] Linear effect of decreasing duration of DDGS withdrawal (Treatments 1, 2, 3, and 6); $P < 0.05$.
[c] Linear effect of decreasing duration of DDGS withdrawal (Treatments 1, 2, 3, and 6); $P < 0.10$.
[d] Quadratic effect of decreasing duration of DDGS withdrawal (Treatments 1, 2, 3, and 6); $P < 0.05$.
[e] Quadratic effect of DDGS level (100%, 50%, and 0%) withdrawn from the diet 41 d before market (Treatments 2, 4, and 6); $P < 0.05$.
[f] Linear effect of DDGS level (100%, 50%, and 0%) withdrawn from the diet 20 d before market (Treatments 3, 5, and 6); $P < 0.10$.
[g] Effect of 20 d vs. 41 d step-down program regardless of DDGS level withdrawn from the diet (Treatments 2 and 4 vs. 3 and 5); $P < 0.05$.
[h] Effect of 20 d vs. 41 d step-down program regardless of DDGS level withdrawn from the diet (Treatments 2 and 4 vs. 3 and 5); $P < 0.10$.

Table 3. Effect of dried distillers grains with solubles (DDGS) step-down or withdrawal regimen on carcass characteristics of growing-finishing pigs[1]

	DDGS, %							
Treatment:	1	2	3	4	5	6		
d 0 to 48:	0	30	30	30	30	30		
d 48 to 69:	0	0	30	15	30	30		
d 69 to 89:	0	0	0	15	15	30	SEM	Probability, $P <$
Carcass weight, lb	201.0	200.3	198.8	198.9	198.0	198.5	3.09	0.98
Yield, %	75.11	75.72	75.85	75.09	75.24	75.71	0.422	0.59
Backfat[2], in.	0.71	0.71	0.70	0.68	0.74	0.68	0.040	0.88
Lean, %[2]	55.16	55.43	54.73	55.68	54.29	55.63	0.731	0.70
Loin depth[2], in.	2.39	2.34	2.32	2.40	2.26	2.37	0.051	0.39
Fat-free lean index[2]	49.81	49.86	49.92	50.19	49.43	50.14	0.494	0.89

[1] A total of 962 pigs (PIC L337 × 1050, initial BW = 86.1 lb) were used with 27 pigs per pen and 6 pens per treatment.
[2] Values are adjusted to a common carcass weight.

Table 4. Effect of dried distillers grains with solubles (DDGS) step-down or withdrawal regimen on carcass fat composition[1]

	DDGS[2], %									
Treatment:	1	2	3	4	5	6				
d 0 to 48:	0	30	30	30	30	30				
d 48 to 69:	0	0	30	15	30	30		Gender[3]		
d 69 to 89:	0	0	0	15	15	30	SEM	Barrow	Gilt	SEM
Total SFA[4], %										
Backfat[a,b]	36.96	34.99	34.77	34.80	34.42	34.39	0.601	35.93	34.19	0.322
Belly fat[a,b]	35.11	33.64	33.26	33.09	32.70	32.69	0.524	34.11	32.72	0.281
Jowl fat[a,b]	33.71	32.45	31.97	31.67	31.79	31.56	0.454	32.95	31.44	0.247
Total MUFA[5], %										
Backfat[c,d]	45.68	42.19	43.16	42.72	41.46	42.26	0.522	43.17	42.66	0.279
Belly[c]	48.12	44.23	44.65	44.66	43.44	44.02	0.569	45.12	44.59	0.305
Jowl[b]	50.03	47.66	47.74	47.38	46.79	47.17	0.545	47.64	47.96	0.297
Total PUFA[6], %										
Backfat[a,c]	16.31	21.86	21.04	21.43	23.17	22.37	0.798	19.89	22.17	0.427
Belly[a,b]	15.70	21.05	21.07	21.23	22.81	22.23	0.749	19.71	21.66	0.402
Jowl[a,b]	15.20	18.79	19.15	19.73	20.32	20.14	0.670	18.28	19.50	0.365
Iodine value, g/100 g										
Backfat[a,b]	66.89	73.19	72.77	73.07	74.89	74.24	1.111	70.77	74.24	0.595
Belly[a,b]	67.82	73.53	73.90	74.21	75.88	75.40	0.993	72.00	74.91	0.532
Jowl[a,b]	68.60	72.59	73.34	74.15	74.57	74.65	0.852	71.81	74.16	0.464

[1] A total of 962 pigs (PIC L337 × 1050, initial BW = 86.1 lb) were used with 27 pigs per pen and 6 pens per treatment.
[2] Values are means of 12 observations per treatment.
[3] Values are means of 36 observations per treatment.
[4] Saturated fatty acids.
[5] Monounstaurated fatty acids.
[6] Polyunsaturated fatty acids.
[a] Gender effect; $P < 0.05$.
[b] Linear effect of decreasing duration of DDGS withdrawal (Treatments 1, 2, 3, and 6); $P < 0.01$.
[c] Quadratic effect of decreasing duration of DDGS withdrawal (Treatments 1, 2, 3, and 6); $P < 0.05$.
[d] Quadratic effect of DDGS level (100%, 50%, and 0%) withdrawn from the diet 20 d before market (Treatments 3, 5, and 6); $P < 0.05$.

Table 5. Effect of dried distillers grains with solubles (DDGS) step-down or withdrawal program on economics[1]

	DDGS, %							Gender		
Treatment:	1	2	3	4	5	6				
d 0 to 48:	0	30	30	30	30	30				
d 48 to 69:	0	0	30	15	30	30				
d 69 to 89:	0	0	0	15	15	30	SEM	Barrow	Gilt	SEM
Feed cost, $/pig[2,a,b]	44.81	43.45	42.65	42.46	41.56	40.99	0.755	44.24	41.06	0.436
Revenue, $/pig	119.61	120.77	119.53	121.10	117.73	119.94	2.265	120.35	119.21	1.264
Discount, $/pig	2.18	2.02	1.82	1.57	1.93	2.17	0.550	1.68	2.21	0.307
Income over feed cost, $/pig	74.30	77.32	76.88	78.65	76.02	78.86	1.969	75.92	78.09	1.098

[1] A total of 962 pigs (PIC L337 × 1050, initial BW = 86.1 lb) were used with 27 pigs per pen and 6 pens per treatment.
[2] Feed cost was based on corn at $3.05/bu and 46.5% soybean meal at $370/ton.
[a] Linear effect of decreasing duration of DDGS withdrawal (Treatments 1, 2, 3, and 6); $P < 0.01$.
[b] Linear effect of DDGS level (100%, 50%, and 0%) withdrawn from the diet 41 d before market (Treatments 2, 4, and 6); $P < 0.05$.

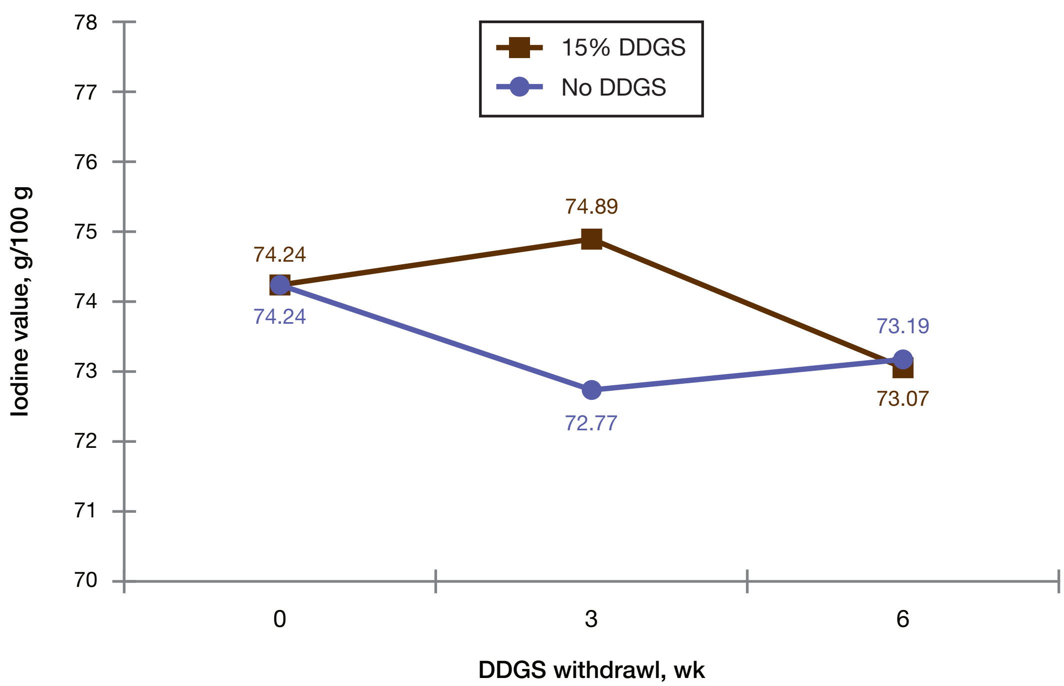

Figure 1. Effect of duration and level of DDGS withdrawal on backfat iodine value.

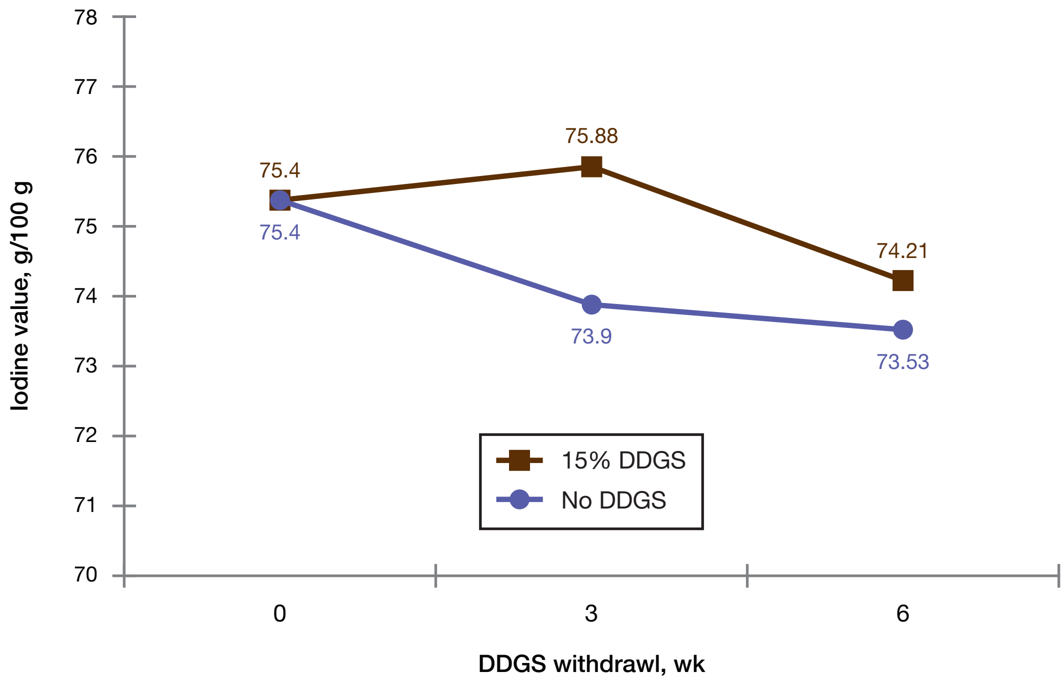

Figure 2. Effect of duration and level of DDGS withdrawal on belly fat iodine value.

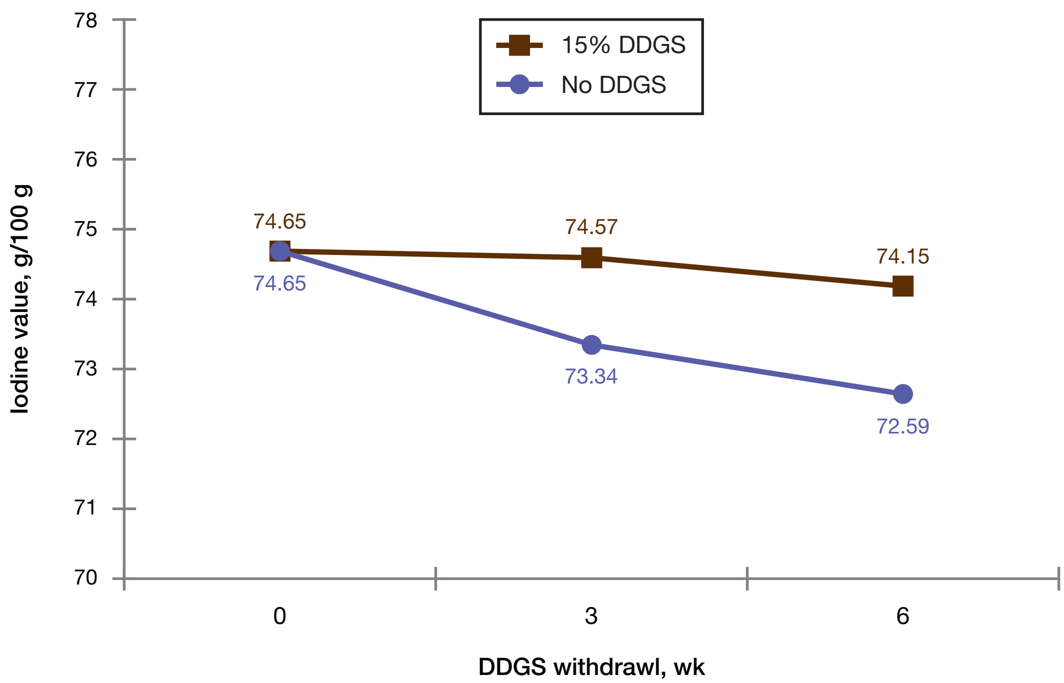

Figure 3. Effect of duration and level of DDGS withdrawal on jowl fat iodine value.