WHAT'S NEW IN FEEDING DISTILLER'S BY-PRODUCTS TO SWINE

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INTRODUCTION

One of the major concerns for U.S. pork producers is whether they will have access to large quantities of reasonably priced corn in the future. The rapid growth of the U.S. ethanol industry has turned some corn surplus regions in the Corn Belt into corn deficit areas due to the high quantities being used by ethanol plants in those areas. This is good news for corn farmers because the price basis has increased in these areas, and if they are shareholders of local ethanol plants, they have been earning excellent return on their investment by adding value to each bushel of corn they supply to their ethanol plant. However, pork producers who purchase corn must compete with the ethanol industry for supply and price. Based upon current ethanol prices and production costs, many modern ethanol plants can afford to pay as much as $7 to $8 per bushel of corn to breakeven. It is understandable why pork producers are getting nervous about their current and future feed costs.

As the U.S ethanol industry continues to grow, there is going to be increasing supplies of multiple types of by-products that will be available for use by the feed, livestock, and poultry industries. The ethanol industry is here to stay, and the by-products it produces will be used in the feed industry. The challenge is to determine the benefits and limitations of these by-products so that they can be valued and used appropriately.

There is increasing interest among ethanol plants to modify ethanol production processes to increase the amount of ethanol that can be produced from each bushel of corn as well as lower the cost of production. Due to high natural gas prices and the challenges of "getting rid of" the syrup or solubles that are produced, one Minnesota ethanol plant has modified their processes to burn the solubles as a fuel source for the plant, and subsequently, are producing dried distiller's grains (DDG). Other upper Midwestern ethanol plants are using various fractionation processes to remove the germ, bran, and perhaps other components of the corn kernel before going into the fermenter in order to increase efficiency of ethanol production. Along with fractionation, changes in enzymes and heat used in the ethanol production process also are altering the nutrient composition and digestibility of distiller's by-products. The challenge for the feed and food animal industry will be to determine the feeding value and best applications for this growing portfolio of corn based by-products. Depending upon the nutrient composition of these by-products, some of them will have limited value in swine diets, whereas others may provide significant lower cost nutrient contributions to practical swine diets.

With the growing supply of corn distiller's by-products being produced, a significant portion of these by-products will be used in swine feeds. The purpose of this paper is to identify and briefly discuss some of the issues that have hindered dried distiller's grains with solubles (DDGS) acceptance and use in the pork industry.

WHAT IS BEING DONE TO IMPROVE CONSISTENCY AND QUALITY OF DDGS?

There is a paradigm shift that is beginning to occur in the U.S. ethanol industry. Bankers and investors of ethanol plants that are being planned, are under construction, or have recently started operation recognize that 10 to 15% of the revenue stream of an ethanol plant is from the sales of distiller's by-products. As a result, ethanol plants are being forced by their bankers and investors to look for distiller's by-product marketers that are more customer sensitive, and to develop production systems that ensure more consistent, high quality by-products. In fact, during this past year, at least one major ethanol production company is implementing a comprehensive DDGS Quality Assurance Program to improve consistency, quality, and transparency of the distiller's by-products they produce. However, there still are many ethanol producers and marketers of distiller's by-products who are unaware or unconcerned about customer needs and the importance of product quality and consistency. They simply want to "get rid of it" at a competitive price without spending additional time, effort, and money to deal with needs and demands of their customers. Currently, there are no distiller's by-product quality standards in the ethanol industry. Instead of establishing distiller's by-product standards, it appears that many segments of the ethanol industry are moving toward branding their by-products as a way of differentiating their ingredients in the market. The Renewable Fuels Association and the American Feed Ingredient Association have formed working committees to determine which nutrient analytical procedures should be adopted by the ethanol industry to standardize methodology for nutrient guarantees and disputes. If these standards are developed and accepted by the ethanol industry, they will help DDGS users better evaluate the nutrient composition differences among sources because the same analytical procedures will be used for comparison. Until the ethanol industry as a whole, gets more serious about DDGS quality and consistency, here are some strategies to help deal with variability in nutrient content and quality among DDGS sources:

- Identify sources that have implemented a comprehensive DDGS quality assurance program, preferably ISO 9000 and HAACP certified
- Limit the number of sources used
- Question generic nutrient specification values provided by the supplier when formulating diets
- Request current, complete nutrient profiles from source(s) being considered. We have nutrient profile information for several DDGS sources on our U of M DDGS web site (www.ddgs.umn.edu).
- Request evidence of consistent quality and nutrient content from each source.

HOW DOES FEEDING DIETS CONTAINING DDGS AFFECT PORK QUALITY?

One of the hottest topics related to DDGS use in the pork industry today involves questions related to whether feeding diets containing DDGS will have a negative effect on pork quality, and specifically, pork fat quality. Most of the DDGS used in swine feeds is consumed in the grower-finisher phase of production at a dietary inclusion rate of 10%. However, many nutritionists and pork producers want to use higher dietary inclusion levels of DDGS to achieve greater diet cost savings without compromising growth performance and carcass quality. Very little research has been conducted to evaluate the effects of increasing dietary levels of DDGS on growth performance and carcass quality of grow-finish pigs. We have completed two studies at the University of Minnesota related to feeding diets containing DDGS to grower-finisher pigs to get an initial look at this question. We also have two additional studies underway that will give us a more complete understanding of how different dietary levels of DDGS, and length of feeding period affects pork quality. But until these studies are completed, here is what we know so far.

In order to prevent soft pork fat, a fairly rigid standard was established by the Danish Meat Research Institute (Barton-Gade, 1987). Using iodine value (ratio of unsaturated:saturated fatty acids) as the criteria for measurement for pork fat quality, a maximum iodine value of 70 is used as the standard for comparison in Europe. In addition, European dietary specifications generally include a maximum dietary level of 1.6% linoleic acid for finisher pigs. However, this threshold value has not been clearly established for pork produced in the U.S. (Ellis et al., 1998). Boyd (1997) suggested that the iodine value threshold for pork fat in the U.S. should be set at 74, and dietary linoleic acid levels should be set at a maximum of 2.1 % of the diet, because pigs fed a corn-soybean meal diet with no added fat could exceed an iodine value of 70. Soft fat is an undesirable property for further processing and the ability of pork products to meet export specifications, especially in Japan. Japan is the largest export market for U.S. pork and soft fat is the principle factor for downgrading and reducing the price because of decreased quality of processed pork products (Irie et al 1992).

Study 1

In our first study (Whitney et al., 2006), a total of 240 crossbred pigs with an initial body weight of about 63 lbs were assigned to one of four diet sequences in a 5-phase grower finisher feeding program. Corn-soybean meal diets were formulated to contain 0, 10, 20, or 30% DDGS. Diets were formulated on total lysine basis, and also contained up to 4% soybean oil as a supplemental fat source. Soybean oil was chosen as the supplemental fat source for this study because we did not have the ability to use animal fats at the location where this study was conducted. Therefore, these experimental diets contained unusually high levels of unsaturated fatty acids compared with what is currently being fed to grower-finisher pigs in the U.S. pork industry.

As shown in Table 1, pigs fed the diets containing 10% DDGS grew at the same rate, consumed the same amount of feed, and had the same feed conversion as pigs fed the control corn-soybean meal diets. Feeding diets containing 20% DDGS resulted in reduced growth rate but feed conversion was not significantly affected. However, feeding the diets containing 30% DDGS reduced growth rate and feed conversion compared to pigs fed the corn-soybean meal control diets or the diets containing 10% DDGS. This reduction in performance at higher DDGS inclusion rates was likely due to formulating diets on a total amino acid basis and not accounting for the digestibility of amino acids in DDGS, which likely resulted in not meeting the pigs' amino acid requirements at the 20 and 30% dietary inclusion rates for DDGS.

Table 1. Effect of Dietary DDGS Level on Overall Growth Performance of Grower-Finisher Pigs.

	0% DDGS	10% DDGS	20% DDGS	30% DDGS
ADG, lbs	1.90[a]	1.89[a]	1.82[bc]	1.78[bd]
ADFI, lbs	5.24	5.22	5.09	5.19
Feed/Gain	2.76[a]	2.76[a]	2.80[a]	2.92[b]
Final Wt., lbs	258[a]	259[a]	252[b]	247[b]

[a, b] Means within row with unlike superscripts are different ($P < .05$).
[c, d] Means within row with unlike superscripts are different ($P < .10$).

At the end of the feeding portion of this study, pigs were slaughtered to obtain carcass (Table 2), muscle (Table 3), and fat (Table 4) quality measurements. Carcass weight and dressing percentage of pigs fed the 0 and 10% DDGS diets were the same, and greater than those from pigs fed the 20 and 30% DDGS diets. The lighter carcass weights of pigs fed the 20% and 30% DDGS diets were a result of reduced growth rate and lighter live weights compared to pigs fed the) and 10% DDGS diets. However, there was no difference in backfat thickness or percentage of carcass lean among the different DDGS feeding levels. Pigs fed the 0% DDGS diets had greater loin depths compared to pigs fed the 30% DDGS diets, with intermediate loin depths from pigs fed either 10 or 20% DDGS. The differences in loin depth were influenced by the differences in slaughter weight of pigs assigned to the four dietary treatments. These results indicate that, although growth performance was negatively affected by increased dietary DDGS, carcass composition was largely unaffected as indicated by the similar fat depths and percent carcass lean across dietary treatments.

Furthermore, none of the muscle quality measurements except 11-day purge loss were affected by dietary DDGS level (Table 3). It is unclear why muscle from pigs fed the 20% DDGS had a higher 11-day purge loss compared to muscle from pigs fed the control diet, but 11-day purge loss was not different between the 0, 10, and 30% DDGS treatments. These data indicate feeding DDGS in swine finishing diets did not have meaningful effects on pork muscle quality.

Iodine number increased linearly, and thus, belly fat became more unsaturated, as the dietary concentration of DDGS increased (Table 4). Researchers have clearly established that feeding diets containing an unsaturated fat source can alter the degree of saturation in pork fat. Lea et al. (1970) indicated that adequately firm pork fat has an iodine number below 70. Boyd (1997) suggested that the iodine value threshold for pork fat in the U.S. should be set at 74. In our study, iodine values were greater than 70, but less than 74, for the diets containing 30% DDGS, and about 70 for the pigs fed the 20% DDGS diets. We added a significant amount of unsaturated fatty acids to experimental diets from supplemental soybean oil in addition to the corn oil present in DDGS. We estimate, based on NRC (1998), that a typical swine finishing diet without supplemental fat (85% corn, 11% soybean meal) would contain about 3% unsaturated fatty acids. By comparison, we estimated our phase 5 control diet contained 4.33% unsaturated fatty acids and the phase 5 diet with 30% DDGS contained 4.96% unsaturated fatty acids. We expect that if an animal fat source, which is lower in unsaturated fatty acid concentration, was added to the diets, or no supplemental fat was added, the iodine values of carcass fat from pigs fed high concentrations of DDGS would be lower, and the negative effects of adding high levels of DDGS to the diets on pork fat quality would be less. The effect of DDGS feeding level on iodine number was reflected in the analysis of belly firmness score. Lower belly firmness scores indicated that bellies from pigs that were fed 30% DDGS were softer than bellies from pigs fed 0 or 20% DDGS. Softer bellies were most likely a consequence of elevated concentrations of dietary unsaturated lipids supplied by soybean oil and DDGS.

Table 2. Effects of Dietary DDGS Level on Carcass Characterisitics of Grower-Finisher Pigs.

	0% DDGS	10% DDGS	20% DDGS	30% DDGS
Slaughter weight, lbs	258	263	249	247
Carcass weight, lbs	189[c]	191[c]	180[d]	178[d]
Dressing %	73.4[c]	72.8[c]	72.1[d]	71.9[d]
Fat depth, in.	0.85	0.87	0.84	0.82
Loin depth, in.	2.26[ac]	2.16[b]	2.19[c]	2.06[d]
% Carcass lean	52.6	52.0	52.6	52.5

[a, b] Means within row with unlike superscripts are different ($P < .05$).
[c, d] Means within row with unlike superscripts are different ($P < .10$).

Table 3. Muscle Quality Characteristics from Grower-Finisher Pigs Fed Diets Containing 0, 10, 20, and 30% DDGS.

	0%	10%	20%	30%
L*[c]	54.3	55.1	55.8	55.5
Color score[d]	3.2	3.2	3.1	3.1
Firmness score[e]	2.2	2.0	2.1	2.1
Marbling score[f]	1.9	1.9	1.7	1.9
Ultimate pH	5.6	5.6	5.6	5.6
11-d purge loss, %	2.1[a]	2.4	2.8[b]	2.5
24-hr drip loss, %	0.7	0.7	0.7	0.7
Cooking loss, %	18.7	18.5	18.3	18.8
Total moisture loss, %[g]	21.4	21.5	21.8	22.1
Warner-Bratzler sheer force, kg[h]	3.4	3.4	3.3	3.3

[a, b] Means within row with unlike superscripts are different ($P < .05$).
[c] 0 = black, 100 = white
[d] 1 = pale pinkish gray/white; 2 = grayish pink; 3 = reddish pink; 4 = dark reddish pink; 5 = purplish red; 6 = dark purplish red
[e] 1 = soft, 2 = firm, 3 = very firm
[f] Visual scale approximates % intramuscular fat content (NPPC, 1999)
[g] Total moisture loss = 11-d purge loss + 24-h drip loss + cooking loss
[h] Measure of tenderness

Table 4. Fat Quality Characteristics of Market Hogs Fed Corn-Soybean Meal Diets Containing 0, 10, 20, and 30% DDGS.

	0% DDGS	10% DDGS	20% DDGS	30% DDGS
Belly thickness, cm	3.15^{a}	3.00^{ab}	2.84^{bc}	2.71^{c}
Belly firmness score, degrees	27.3^{a}	24.4^{a}	25.1^{a}	21.3^{b}
Adjusted belly firmness score, degrees	25.9^{d}	23.8^{de}	25.4^{d}	22.4^{e}
Iodine number	66.8^{d}	68.6^{e}	70.6^{f}	72.0^{f}

$^{a, b, c}$ Means within row with unlike superscripts are different ($P < .10$).
$^{d, e, f}$ Means within row with unlike superscripts are different ($P < .05$).

Based upon these results, including 10% distiller's dried grain with solubles in conventional swine grower-finisher diets has no detrimental effects on pig performance, carcass quality or pork quality. When diets are formulated on a total amino acid basis, it appears that inclusion rates of 20% or higher result in depressed growth performance. Including distiller's dried grain with solubles at concentrations of 20 and 30% of the diet, and using soybean oil as the supplemental fat source for grower-finisher pigs, does not affect muscle composition or quality, but decreases the saturation of fatty acids, resulting in softer bellies, and may negatively affect further processing traits.

Study 2

We recently completed a second study to further evaluate the impact of feeding conventional corn-soybean meal grower finisher diets, with or without 10% DDGS, on pork fat quality. This study was funded by Land O' Lakes/Purina Feed and was a field study to validate that feeding diets containing 10% DDGS under commercial field conditions has no detrimental effect on pork fat quality.

Two cooperating pork producers were selected for this study. Each produced had typical commercial 1000 head finishing barns and were located in southern Minnesota. Each barn had 40 pens, was a double curtain sided building with 8' pits, utilized pit fans for ventilation, and had weighted baffle ceiling air inlets. Both farms had common genetics consisting of Monsanto Genepacker sows mated with Monsanto EB terminal line boar semen. Overall health status of both groups of pigs was very good. Feed for both farms was formulated and provided by Land O' Lakes/Purina Feed. Producer A fed typical corn-soybean meal diets, whereas Producer B fed corn-soybean meal diets containing 10% DDGS. A 7-phase mixed sex feeding program was used and the last finisher diet contained 4.5g Paylean per ton of diet. Diets within each phase contained similar nutrient levels with and without 10% DDGS. All diets within each phase contained the same level of choice white grease as the supplemental fat source (supplemental levels ranged from 1.25 to 3.75% depending on the diet phase).

One hundred twenty eight pigs were randomly selected from each group for evaluation of carcass traits. All pigs were slaughtered at Hormel Foods in Austin, MN. At 24 hours postmortem, a total of 48 mid-belly samples were collected from each dietary treatment group, with equal numbers of barrows (n=12) and gilts (n=12) from each farm. From the 48 mid-belly samples, a visual color score (on a scale from 1 to 4 with 1 = pale and 4 = dark) was determined by a group of 6 panelists using the National Pork Producer Council's plastic Japanese pork fat color standards. All belly fat samples were then analyzed to determine complete fatty acid profiles. Iodine value and mean melting point were calculated using fatty acid data from each sample.

As shown in Table 5, pigs fed the 10% DDGS grew equally well, consumed less feed, had better feed conversion, and lower feed cost per pound of gain compared to pigs fed the corn-soybean diets without DDGS. At slaughter, there were no differences in carcass weight, backfat thickness, or percentage of ham, loin, and belly relative to total carcass weight (Table 6). In addition, there were no differences in loin depth or percentage of lean muscle in the carcasses between the two groups. These results are in agreement with the growth performance and carcass composition results obtained in our initial study, and clearly show that feeding corn-soybean meal diets containing 10% DDGS has no negative effects on growth performance and carcass characteristics of grower-finisher pigs. In fact, the producer who fed the DDGS diets in this study obtained the same carcass quality at a lower feed cost per pound of gain compared to the producer who fed diets without DDGS.

When we evaluated the composition and quality characteristics of belly fat from these pigs, we saw no difference in color score based upon Japanese pork fat quality standards (Table 7), nor were there any differences in mean melting point of the belly fat. However, bellies from pigs fed the 10% DDGS diets had a higher iodine value than pigs fed the diets without DDGS. These results are also in agreement with the results we obtained in our first study (Table 4). The iodine values are similar, and are below the suggested maximum threshold of 70. These results clearly show that feeding diets containing 10% DDGS to grower-finisher pigs have no negative effects on pork fat quality. As expected, the levels of linoleic acid, polyunsaturated fatty acids, and omega 6 fatty acids increase in belly fat when pigs are fed diets containing 10% DDGS, but are well within accepted standards of acceptable pork fat quality.

Table 5. Growth Performance, Feed Usage and Feed Cost of Grower-Finisher Pigs Fed Diets Containing 0 or 10% DDGS.

	0% DDGS	**10% DDGS**
ADG, lbs	1.81	1.84
ADFI, lbs	4.94	4.62
Feed/Gain	2.73	2.54
Lbs Feed/Head	570	554
Feed Cost/Lb Gain, $	0.17	0.16

Table 6. Carcass Characteristics of Grower-Finisher Pigs Fed Diets Containing 0 or 10% DDGS.

	0% DDGS	**10% DDGS**
Carcass weight, lbs	212	210
Last rib backfat, in.	1.09	1.11
Tenth rib backfat, in.	1.01	0.99
Ham, %	11.74	11.74
Loin, %	7.93	7.91
Belly, %	10.51	10.41
Loin depth, in.	2.72	2.72
% Carcass lean	56.36	56.47

Table 7. Mid-Belly Fat Quality Characteristics of Carcasses from Grower-Finisher Pigs Fed Diets Containing 0 or 10% DDGS.

Measurement	**0% DDGS**	**10% DDGS**
Japanese fat color score	1.76	1.81
Mean melting point, °C	29.3	28.7
Iodine value	66.7[a]	68.3[b]
Oleic acid (18:1), %	47.39[c]	45.12[d]
Linoleic acid (18:2), %	11.94[c]	13.98[d]
Saturated fatty acids, %	33.99	34.26
Monounsaturated fatty acids, %	51.78[c]	49.47[d]
Polyunsaturated fatty acids, %	14.02[c]	16.11[d]
Total omega 3 fatty acids, %	0.98	0.96
Total omega 6 fatty acids, %	13.02[c]	15.14[d]
Omega 6:omega 3 ratio	13.28[c]	15.78[d]

[a, b] Means within row with unlike superscripts are different ($P < .05$).
[c, d] Means within row with unlike superscripts are different ($P < .0001$).

Based upon our research results, there is no reason for concern when feeding grower-finisher diets containing 10% DDGS on carcass or pork quality. The composition of some fatty acids (e.g. linoleic acid, polyunsaturated fatty acids, and omega 6 fatty acids) in pork fat increase with the addition of DDGS to corn-soybean meal diets, but do not alter the acceptability of pork based upon current industry standards. Furthermore, there is no evidence suggesting that feeding grower-finisher pigs diets containing 10% DDGS will decrease the quality and acceptability of U.S. pork in the Japanese export market. The studies we are currently conducting will help us better understand if we can feed higher dietary levels (20 or 30%) of DDGS to grower-finisher swine without negatively impacting pork fat quality and consumer acceptability of U.S. pork.

CONTROVERSY OVER THE IMPACT OF DDGS DIETS ON FEED INTAKE

Studies conducted at the University of Minnesota have consistently shown that adding increasing levels of high quality DDGS to nursery, grower-finisher, and sow diets have minimal, if any effect on average daily feed intake compared to pigs fed corn-soybean meal control diets. As shown Table 8, feeding Phase 2 and Phase 3 diets containing up to 25% DDGS to nursery pigs, weaned at 19 days of age and weighing about 15 lbs, resulted in no significant effect on feed intake during those feeding periods or for the entire 35 day trial (Whitney and Shurson, 2004). However, in this same study, when pigs were weaned at 17 days of age and averaged 11.5 lbs at weaning, increasing levels of DDGS in the diet linearly decreased feed intake in Phase 2, but not during Phase 3 or for the overall 35 day feeding period. Since early weaned pigs are very sensitive to diet composition, one would expect to see a feed intake depression during the nursery phase if DDGS has a negative effect on feed intake. This only occurred during the Phase 2 feeding period for pigs weaned at 17 days of age.

Similarly, our initial study feeding increasing levels (0, 10, 20, and 30%) of DDGS to grower finisher pigs resulted in no significant effect on ADFI across dietary levels of DDGS (Table 1). In fact, in a Salmonella typhimurium challenge study where diets containing 50% DDGS were fed throughout the grower-finisher period, feed intake was only significantly reduced compared to feeding the corn-soybean meal control diet during two weigh periods (wks 2-4 and wks 12-14) as shown in Table 9. One might expect that this unusually high DDGS feeding level would have had a more detrimental effect on feed intake than observed in this study. DeDecker et al. (2005) fed diets containing 0, 10, 20, and 30% DDGS to grower-finisher pigs and found no effect of DDGS level on growth rate and feed intake, and observed an improvement in feed conversion for pigs fed the 20 and 30% DDGS diets from 48 to 90 lbs. These researchers concluded that DDGS can be included at levels up to 30% of the diet for growing pigs without detrimentally affecting growth performance. Similar results have also been reported by Hansen et al. (1997).

We recently completed a sow lactation study where we fed diets containing 0, 10, 20, and 30% DDGS. Experimental diets were introduced on day 109 of gestation. Dietary DDGS level had no significant effect on average daily feed intake (Table 10). Therefore, there is an increasing amount of scientific evidence that feed intake is not affected when DDGS is added at levels up to 30% of the diet for nursery, grower-finisher pigs, and lactating sows.

Table 8. Average Daily Feed Intake of Nursery Pigs Fed Diets Containing Increasing Levels of Corn Distiller's Dried Grains with Solubles.

Item	0%	5%	10%	15%	20%	25%
Initial age, days	18.9	19.3	18.9	18.9	18.7	19.1
Initial weight, lbs	15.7	15.7	15.4	15.7	15.7	15.7
Days 0-14 ADFI, lbs/d	0.89	0.85	0.86	0.87	0.85	0.83
Days 14-35 ADFI, lbs/d	2.19	2.18	2.22	2.13	2.33	2.29
Days 0-35 ADFI, lbs/d	1.67	1.65	1.68	1.62	1.74	1.71

Whitney and Shurson (2004).

Table 9. Average Daily Feed Intake of Grower-Finisher Pigs Fed Corn-Soybean Meal Diets Containing Either 0 or 30% DDGS.

Weeks, lbs/day	**0% DDGS**	**50% DDGS**
0-2	2.07	2.04
2-4	3.23[a]	2.93[b]
4-6	3.83	3.60
6-8	4.83	4.36
8-10	4.56	4.25
10-12	4.81	5.11
12-14	5.69[a]	5.18[b]
14-16	5.51	5.44

[a, b] Means within row with unlike superscripts are different ($P < .05$).
Spiehs et al. (2004).

Table 10. Average Daily Feed Intake of Lactating Sows Fed Diets Containing Increasing Levels of DDGS.

	0% DDGS	**10% DDGS**	**20% DDGS**	**30% DDGS**
ADFI, lbs/day	13.8	14.2	15.3	14.6

Song et al. (2006) unpublished data.

However, a few recent reports have shown significant reductions in feed intake when increasing levels of DDGS are added to the diet. Fu et al. (2004) fed diets containing 0, 10, 20, and 30% DDGS using a 5-phase growing-finishing feeding program for a 92 day feeding period. Diets were formulated to be isocaloric and to contain equivalent amounts of apparent ileal digestible lysine. They observed a linear decrease in ADG, ADFI and final body weight as increasing levels of DDGS were added to the diet, but a linear improvement in feed conversion (Table 11). However, they observed no differences in backfat, loin depth, percentage of carcass lean and yield among DDGS feeding levels.

Table 11. Effects of Feeding Increasing Levels of DDGS to Grower-Finisher Pigs on Growth Performance Over a 92-Day Feeding Period.

	0% DDGS	**10% DDGS**	**20% DDGS**	**30% DDGS**
ADG, lbs/day	2.27	2.23	2.18	2.16
ADFI, lbs/day	5.64	5.58	5.38	5.31
G/F	0.405	0.400	0.407	0.405
Final body wt., lbs	273	268	267	262

Fu et al. (2004).

Hastad et al. (2005) conducted three studies to evaluate the effects of dried distillers grains with solubles (DDGS) on palatability and feed intake of growing pigs. In their first experiment, pigs were given a choice of one of three diets consisting of a corn-soybean meal control diet, a diet containing 30% DDGS from an ethanol plant built before 1990, and a diet containing 30% DDGS from an ethanol plant built after 1990. From day 0 to 7, there were no differences in average daily feed intake among diets, but from day 7 to 13 and overall, feed intake was reduced for both DDGS diets compared to the corn-soybean meal control diet. In the second experiment, a 21 day preference trial was conducted to determine if diets containing 0, 10, 20, or 30% DDGS affected feed intake. Increasing DDGS levels in the diet linearly reduced feed intake for the overall trial (1.71, 1.15, 0.73, and 0.34 lbs/day for the 0, 10, 20, and 30% DDGS diets, respectively). In their third feed preference trial, they offered pigs diets containing either 0 or 30% DDGS, with or without a feed flavor additive. In this trial, adding DDGS to diets decreased feed intake but adding the feed flavor had no effect on feed intake in both the 0 and 30% DDGS diets.

It is unclear why these feed preference trials resulted in a dramatic reduction in feed intake compared to results from several other studies previously described. It is important to remember that feed preference studies can be misleading regarding the impact of diet, or its components, on feed intake if pigs are not given a diet choice. If the DDGS used in these preference studies was contaminated with mycotoxins, this could explain these responses. Other quality differences in DDGS (e.g. overheating) may also be a factor that could contribute to reduced feed intake under some circumstances.

TAKE-HOME MESSAGE

As the U.S. ethanol industry continues to grow, increasing quantities of corn will be used to produce ethanol and distiller's by-products. This increase in demand for corn by the ethanol industry could significantly reduce supply available and increase the price of corn for use in swine diets. However, due to the increased supply of DDGS and cost effectiveness of partially replacing some of the corn and soybean meal in swine diets, it will be used to a greater extent in pork production. The challenges are identifying high quality, consistent sources of DDGS, and evaluating the feeding value of new fractionated by-products as they enter the feed ingredient market. Two of the greatest concerns among some nutritionists and pork industry professionals is the impact of feeding diets containing DDGS on feed intake and pork fat quality. Our studies clearly show that feeding diets containing 10% DDGS to growing finishing pigs result in the same growth performance and carcass quality as pigs fed typical corn-soybean meal diets. The amount of linoleic acid and unsaturated fatty acids increase as increasing levels of DDGS are added to the diet, but using carcass fat iodine value of 70 as a standard, DDGS should be able to be added to corn-soybean meal grower-finisher diets at levels up to 20% before the amount of unsaturated fatty acids in pork fat become a concern.

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