Benefits and Limitations of Feeding Corn DDGS to Grower-Finisher Pigs

Dr. Jerry Shurson
Department of Animal Science
University of Minnesota

Introduction

Corn dried distillers grains with solubles (DDGS) has become the most popular, economical, and widely available alternative feed ingredient in U.S. swine diets. Its high energy (3,674 to 4,336 kcal ME/kg DM), moderate protein (27 to 33%, DM basis) and lysine (0.60 to 1.1%, DM) content, along with its relatively high concentration of phosphorus (0.57 to 0.85%, DM basis) and digestibility (50 to 68%), make it an excellent partial replacement for corn, soybean meal, and inorganic phosphate in swine diets. Due to extremely favorable price of DDGS relative to corn and soybean meal during the past two years in the U.S., there has been a tremendous economic incentive for pork producers to increase dietary DDGS inclusion rates to 30 to 40% in grower-finisher diets. In fact, U.S. pork producers have saved $3 to $7 in feed costs per pig by adding DDGS to grower-finisher the diets during the past few years. However, feeding high levels of DDGS to grower-finisher pigs has created some challenges including:

1. Managing variation in nutrient content and digestibility among DDGS sources.
2. Using accurate nutrient loading values for DDGS in diet formulation to maintain satisfactory growth performance.
3. Inconsistent responses in carcass yield.
4. Reduced pork fat firmness.

The benefits and limitations of feeding DDGS to swine have been described in detail in a recent scientific review (Stein and Shurson, 2009) and the purpose of this paper is to summarize the key nutrition and feeding management factors that affect the economics of DDGS use in grower-finisher diets.

Determining Value and Managing Nutrient Variability Among DDGS Sources

Nutritionists want consistency and predictability in nutrient content and digestibility of feed ingredients they purchase and use. Fat, fiber, ash, lysine, tryptophan, and phosphorus concentrations are the most variable of all nutrients among DDGS sources. With some ethanol plants using front-end fractionation or back-end oil extraction technologies, the nutrient composition of distiller’s co-products is becoming more diverse and confusing. The term “DDGS” is often misused when describing these nutritionally different corn co-products that are becoming available in the feed ingredient market (e.g. high protein DDGS). As a result, DDGS is less of a “commodity” compared to other feed ingredients such as corn and soybean meal.

To manage the diversity among DDGS sources, some commercial feed manufacturers are requiring identity preservation of their choices of DDGS sources, and are limiting the number of DDGS sources on feed company's preferred suppliers list. Use of commercially available nutritional "tools" such as Cargill's "Reveal" (www.cargillcs.com/Screens/ToolsAndTechnology/Reveal-Biofuel.aspx) and Value Added Science and Technologies (http://v-ast.com/services.htm) "Illuminate" can greatly improve purchaser and end user capabilities to identify DDGS sources that provide the best nutritional and economic value, as well as provide accurate nutrient loading values for specific DDGS sources for more accurate diet formulations. These tools are commercially available.

Several DDGS value calculator tools have been developed to determine DDGS feeding value for livestock and poultry. These tools are extremely useful for determining the actual economic value of DDGS in specific livestock and poultry diets and should be used when evaluating whether the current price for DDGS is economical relative to its nutrient contributions and price relative to other competing ingredients. The most recent and comprehensive DDGS evaluation tool was developed by researchers at Iowa State University (Dahlke and Lawrence, 2008) and is useful for a wide variety of diets and food animal species: http://www.matric.iastate.edu/DGCalculator. *SESAME,* www.sesamesoft.com developed by researchers (Drs. Normand St-Pierre, Branislav Cobanov and Dragan Glamocic, 2007) at Ohio State University, is a comprehensive tool to help livestock and poultry producers make better feed-purchasing choices. In addition, three DDGS evaluation tools have been developed specifically for swine:

University of Illinois DDGS Calculator developed by Drs. Beob G. Kim and Hans H. Stein (Dec. 2007).

DDGS Cost Calculator for Swine - developed by Dr. Bob Thaler, South Dakota State University Extension Swine Specialist (Sep. 2002).

DDGS Value Calculator - developed by Dr. Dean Koehler, Vita Plus Corporation, Madison, WI (Sep. 2002).

Effect of DDGS on Growth Performance

Stein and Shurson (2009) summarized results from 25 growing-finishing or finishing experiments in which growth performance was evaluated when feeding diets containing up to 30% corn DDGS (**Table 1)**. The majority of these studies showed no change in ADG (72% of experiments), ADFI (65% of experiments), and G:F ratio (64% of experiments), with the others showing either increases or decreases in performance. Based on the information provided from reports on these 25 experiments, it is difficult to explain why pig performance was maintained in most, but not in all experiments in which DDGS was included in the diets. It is possible that the DDGS nutrient values used when formulating diets in these experiments were overestimated resulting in poorer performance than expected. Another explanation is that in some of the experiments in which reduced performance was observed, the crude protein content was significantly increased when DDGS was added to the diet, resulting in excess dietary nitrogen which may have reduced pig performance. In most of the experiments where ADG was reduced, a reduction in ADFI was also observed. This reduction in ADFI may have been due to using lower quality DDGS sources.

Effect of DDGS on Carcass Characteristics

Stein and Shurson (2009) reported that in 10 of the 18 experiments where pigs were fed diets containing up to 30% DDGS, carcass dressing percentage was not affected. However, carcass dressing percentage was reduced in 8 experiments when grower-finisher pigs were feed DDGS. In general, if dressing percentage is reduced from feeding DDGS diets, we can expect about 0.03% carcass yield reduction per 1% DDGS in the diet, but results from some field studies have suggested that withdrawal of DDGS for 6 weeks prior to harvest can prevent reductions in yield. Therefore, one can estimate potential carcass yield reduction by using this information and knowing DDGS feeding level(s) during the last 6 weeks prior to harvest. Previous studies have shown that adding ingredients high in fiber to growing-finishing pig diets may reduce dressing percentage because of increased gut fill and increased intestinal mass (Kass et al., 1980). This may explain the reduced dressing percentage observed in pigs fed DDGS diets in some experiments, but it is unknown why this effect was not observed in other experiments. However, the increased diet costs resulting from reducing or eliminating DDGS from the finishing diet in order to avoid a potential slight reduction in carcass yield has generally been too high relative to the value of slightly heavier carcasses at a pre-determined time end point.

Backfat thickness, loin depth, and % carcass lean are generally unaffected by adding DDGS to the diet (**Table 1**). Only one study reported a reduction in backfat thickness (Widmer et al, 2008), and two studies reported a reduction in loin depth (Whitney et al., 2006; Gaines et al., 2007) when DDGS diets were fed. In the studies that reported a reduction in loin depth, pigs fed DDGS had lower ADG and were marketed at a lighter weight. Only one study (Gaines et al., 2007) reported a reduction % carcass lean.

Table 1. Effects of including corn DDGS in diets fed to growing-finishing pigs on growth performance and carcass characteristics.[1]

Item	N	Response to dietary corn DDGS		
		Increased	Reduced	Not changed
ADG	25	1	6	18
ADFI	23	2	6	15
G:F	25	4	5	16

Dressing percentage	18	0	8	10
Backfat, mm	15	0	1	14
% carcass lean	14	0	1	13
Loin depth, cm	14	0	2	12
Belly thickness, cm	4	0	2	2
Belly firmness	3	0	3	0
Iodine value	8	7	0	1

[1] Adapted from Stein and Shurson (2009). Data based on experiments published after 2000 and where a maximum of 30% DDGS was included in the diets.

Effects of DDGS on Pork Quality

Adding DDGS to grower-finisher diets does not affect muscle quality, eating characteristics, and shelf life of pork, but can negatively affect belly and pork fat quality, especially at high (> 20%) dietary inclusion rates (Xu et al., 2010a). Reduced pork fat quality has been a concern of pork processors when purchasing market hogs from producers feeding high (> 20%) levels of DDGS during the grower-finisher period. However, there are no accurate, inexpensive, and fast methods of determining pork fat firmness in commercial pork processing facilities. Consequently, it is difficult to quantitatively differentiate pork carcasses based on pork fat firmness.

Dried distillers grains with solubles contains approximately 10% corn oil, and is comprised of approximately 60% linoleic acid, which is a long-chain, unsaturated fatty acid. Feeding diets containing high amounts of unsaturated fatty acids, particularly linoleic acid, can reduce fat firmness and increase the amount of unsaturated fatty acids in pork fat. Results from two studies where DDGS was fed to grower-finisher pigs showed that belly thickness was linearly reduced when increasing levels of corn DDGS were added to the diet (Stein and Shurson, 2009). However, pigs fed DDGS containing diets in these studies also had reduced ADG, and as a result, were marketed at a lighter weight than the control pigs, which may explain the reduction in belly thickness for these pigs. In the studies where no differences in belly thickness were observed, there were no differences in the final body weight of the pigs. Results from all (3) of the studies that measured belly firmness showed a reduction in firmness when pigs were fed diets containing DDGS. This observation is supported by the results from 8 studies showing that the iodine value (IV; ratio of unsaturated to saturated fatty acids) of the belly fat is increased in pigs fed DDGS. Carcass fat IV can be a reasonable indicator of carcass fat quality because high IV results in softer bellies. However, because determination of fatty acid profiles of pork fat is expensive and time consuming in order to calculate IV, it is not a practical way of assessing pork fat quality in commercial pork processing facilities.

Feeding and Formulation Strategies to Minimize DDGS Effects on Pork Fat Quality

In order to minimize the negative impact of feeding DDGS diets on pork fat quality, researchers have been evaluating alternative nutritional strategies. The most practical strategy to achieve the desired pork fat IV is to reduce dietary inclusion or withdraw DDGS from the diet for a time period prior to harvest. Xu et al. (2010b) showed that feeding 30% DDGS diets up to 3 weeks before harvest and then withdrawing it from the diet, resulted in backfat and belly fat having an IV less than 70, which is considered acceptable by current U.S. pork industry standards. Hill et al. (2008) showed similar results.

Feeding wheat and barley based diets result in much lower IV in pork fat than when feeding corn-soybean meal diets. Beltranena et al. (2010) showed that IV of pork fat in western Canada diets (wheat, barley, and canola meal) is low compared to U.S. corn-soybean meal based diets, and withdrawing corn DDGS from wheat and barley based diets is a good strategy for reducing pork fat IV, compared to feeding 30% DDGS continuously.

Results from studies where conjugated linoleic acid (CLA) was added to DDGS diets fed to finishing pigs have consistently shown a reduction in pork fat IV. White et al. (2007) showed that the addition of 1% CLA to diets containing 20 or 40% corn DDGS for 10 d prior to harvest, reduced fat IV and the n6:n3 ratio. A recent study conducted by Pompeu et al. (2009) confirmed the positive effects of adding CLA to finishing pig diets containing 30% DDGS on improving pork fat firmness. Thus, addition of conjugated linoleic acid to DDGS containing diets fed during the late finishing phase may be used to reduce IV in carcass fat. However, the cost effectiveness of adding CLA to finishing diets is currently questionable.

Adding more saturated animal fat sources to DDGS diets have resulted in inconsistent responses on pork fat quality. Stevens et al. (2009) showed that feeding a corn-soybean meal-DDGS diets, with or without 5% choice white grease, during a 26-day DDGS withdrawal program resulted in a partial recovery of some of the adverse fat quality effects caused by the increase in linoleic acid contributed from DDGS. However, they indicated that a longer DDGS withdrawal period is required for complete recovery of pork fat quality. The addition of a dry animal fat source (4% of the diet) high in saturated fatty acids (70%) did not alleviate the increase in IV resulting from the addition of 30% DDGS to the diet (Freitas et al., 2009). This was most likely due to the low digestibility of the saturated fat used in the study. Recently, research at the University of Minnesota (Pomerenke et al., 2010; unpublished) showed that adding 5% tallow to 30% DDGS diets did not improve belly firmness. Based on the results of these studies, we need to learn more about fatty acid digestibility among various fat sources in order to understand how they may or may not impact pork fat quality in pigs fed DDGS diets.

The iodine value product (IVP) concept is a feed formulation strategy that is being used with some success to manage pork fat quality. It was developed by Madsen et al. (1992) and is based on the idea that if the diet and carcass IV's are known, diet formulation adjustments can be made to get closer to the target IV for pork fat in the carcass. Iodine product value involves a calculation including the amount of fat and the IV of fat in each ingredient in the diet to meet a desired final diet IV specification. This formulation method was later revised by Boyd et al. (1997), where the IV of backfat = 0.32(IVP) + 52.4 and IVP = IV of the diet oil x % diet oil x .1. Using IVP does not always result in desired final carcass IV because there are several confounding factors such as growth rate, genetics, and health that likely underestimate the impact of linoleic acid on pork fat firmness. The IVP of corn DDGS is quite high (112) compared to corn (47), barley (23), wheat (23), and soybean meal (18). Therefore, use of IVP in diet formulation is another tool that can help manage pork fat quality concerns when feeding DDGS diets to growing-finishing pigs.

Economics of Feeding DDGS Diets Relative to Pork Fat Quality

The economic benefit of adding corn DDGS to swine grower-finisher has been significant during the past few years due to high corn and soybean meal prices. Commercial pork production operations in the U.S. have reduced feed cost by $3 to $7/head by adding DDGS to the diet, depending on its price and nutrient value. However, if restrictions and price discounts are implemented by pork processors for not meeting certain pork fat quality standards (e.g. IV) feed cost/pig will increase substantially because of reduced feeding levels and/or feeding time of DDGS. Depending on DDGS price and nutrient content, as well as the cost of other feed ingredients, a reduction in one pork fat IV unit adds $0.30 to $1.10 per pig in increased feed cost. If restrictions for DDGS use are implemented to achieve a low diet IVP, these restrictions will be more costly than restrictions to achieve higher diet IVP.

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