USING DRIED DISTILLERS GRAINS WITH SOLUBLES (DDGS) IN SWINE DIETS

Malachy Young
Gowans Feed Consulting
1837-11th Ave., Wainwright, Alberta, T9W 1N3
E-mail: malachyy@telus.net

INTRODUCTION

The rapid expansion of the North American ethanol industry has resulted in a large increase in the price of cereal grains. Grain prices have been further fueled by low yields of wheat due to droughts in certain parts of the world. Crop farms have historically produced grain crops for food for people and livestock. The ethanol industry is adding a third major use. With the large increase in feed costs we have experienced in Canada in recent months it is important we consider and optimize the use of alternative ingredients if we are to keep our feed costs in check. Dried Distillers Grains with Solubles (DDGS) is one such product and a co-product of ethanol production. As the ethanol industry in North America has expanded, there has been a subsequent increase in the production and availability of DDGS.

DRIED DISTILLERS GRAINS WITH SOLUBLES (DDGS)

Cereal grains including barley, corn, rye, sorghum, and wheat can be used for producing ethanol and subsequently DDGS, however, corn and more recently wheat have been the major grains of choice for ethanol production in North America. The interest in DDGS is mainly due to the three fold increase in the concentration of nutrients (protein, fat, vitamins and minerals) in the DDGS compared with its parent grain, which could potentially make DDGS a better feed ingredient (Table 1). The nutrient profile of corn DDGS is quite different from wheat DDGS. Corn DDGS contains more fat, while wheat DDGS is higher in crude protein. Some considerations to take into account when purchasing DDGS:

- Quality and consistency of the final product.
- Ease of handling (loading & unloading) and transport.
- Incidence of mycotoxins – Is the plant testing & frequency.
- Nutrient profile of DDGS – Total fat, protein, fiber content, etc.
- Amino acid content and availability.
- Know plant where sourcing from – All sources are **not** the same and there can be large differences between sources in nutrient content and value.

Nutrient Composition of DDGS

Dried Distillers Grains with Solubles (DDGS) is a source of protein, energy and available phosphorous to swine diets and will replace a portion of the grain, protein source(s) and supplemental phosphorous. It is important to remember that the DDGS products are still

evolving, which emphasizes the importance of knowing the source you are using as it is likely produced from new ethanol plants is a much different product than sources produced from older generation plants 3-5 years ago. In corn DDGS, the crude protein can range from 22 to 32%, while total lysine ranges from 0.40 to 0.99%, whereas in the wheat-based DDGS, the crude protein ranges 23 to 37%, while total lysine ranges from 0.49 to 0.94% (Payne, 2007). If we look at the amino acid availability for corn DDGS and specifically lysine which is the first limiting amino acid for swine, we observe a large range in lysine digestibility between sources (Table 2; Stein, 2006). The variation in lysine content and digestibility can be attributed to a number of factors: 1) Variation associated with parent grain due to variety, regional or environmental differences, drying and storing. 2) Perhaps the most significant reason is the variation in the drying process from one plant to the next for the DDGS. Drying temperature can range 120 to 620 ^{o}C and if not controlled effectively, over-heating can cause significant damage and renders lysine and other heat susceptible amino acids unavailable to the pig post digestion.

Table 1. Nutrient profile of wheat, wheat DDGS, corn, and corn DDGS as fed.

Item	Wheat	Wheat DDGS[1]	Corn	Corn DDGS[1]
Moisture, %	12.0	9.8	11.0	11.9
Protein, %	13.5	35.0	8.3	27.2
Fat, %	1.9	6.0	3.9	9.5
ADF, %	4.0	13.6	2.8	9.9
NDF, %	13.5	33.1	9.6	25.3
Total lysine, %	0.34	0.90	0.26	0.85
Av. phosphorous, %	0.19	0.39	0.04	0.52
ME, Mcal/kg	3.21	2.97	3.42	3.34
NE, Mcal/kg	2.54	2.00	2.73	2.45

[1] New generation ethanol plants.

The low digestibility of lysine is often associated with low analyzed total lysine in the sample. Calculating the lysine to crude protein ratio gives an estimate of the quality of the lysine in the sample. If the lysine to crude protein ratio is 2.80% or greater for corn DDGS then this sample has an average or above average quality, but if the ratio is lower than 2.80%, then it has reduced quality. Because lysine is usually the first limiting amino acid in diets fed to swine, corn DDGS samples with a lysine to crude protein ratio that is less than 2.80 should not be used in swine diets. Because wheat DDGS is a relatively new product there are few published reports that provide estimates of amino acid digestibility for swine and those available are with product from older generation plants that may not be representative of product available today from new generation plants.

Table 2. Concentration and digestibility of crude protein and amino acids in 36 samples corn DDGS.[1]

		Standard ileal digestibility, %			
Item	Average	Average	Low	High	CV
Crude protein, %	27.5	72.8	63.5	84.3	7.32
Lysine, %	0.78	**62.3**	**43.9**	**77.9**	**12.2**
Methionine, %	0.55	81.9	73.7	89.2	5.0
Threonine, %	1.06	70.7	61.9	82.5	7.4
Tryptophan, %	0.21	69.9	54.2	80.1	10.0
Isoleucine, %	1.01	75.2	66.5	82.6	6.3
Valine, %	1.35	74.5	65.8	81.9	6.3

[1] Stein, 2006.

The digestibility of phosphorous in the DDGS is greater than in the parent grain and may be a result that some bonds that bind phosphorous to the phytate complex in the parent grain have been hydrolyzed during the fermentation process in the ethanol plants, which makes more phosphorous available for absorption. If DDGS is included in swine diets this reduces the need for supplemental inorganic phosphorous and decreases the amount of phosphorous that is excreted in the manure. Because of the variation among sources of DDGS it is recommended that producers examine the concentration of nutrients in the product before buying DDGS. A suggested check list for corn DDGS is outlined in Table 3 (Stein, 2007). In addition it is recommended that assurances be sought for the absence of mycotoxins in DDGS before it is purchased.

Table 3. Checklist when buying corn DDGS.[1]

Item	Minimum	Maximum
Crude protein, %	27.0	-
Fat, %	9.0	-
Phosphorus, %	0.55	-
Lysine	2.80% of crude protein	-
ADF, %	-	12.0
NDF, %	-	40.0

[1] Stein, 2007

Feeding Recommendations for DDGS

Many feeding trials have been carried out over the past 5 years with corn DDGS in the US to determine the maximum feeding level for different ages of swine. We conducted a grow-finish feeding trial at a commercial research barn in Iram, AB with corn DDGS sourced from a new generation ethanol plant in Minnesota (Table 4). The feeding trial found we could feed up to 25% corn DDGS from this new generation ethanol plant and achieve similar biological performance as with a typical Western Canadian diet without corn DDGS.

From a number of research trials with corn DDGS compared to a corn soybean meal control diet it is suggested that yield or dressing percent declines 0.3% for each 10% corn DDGS included in the diet. It is believed that the higher fiber and/or excess protein in the diet with the increasing DDGS levels in the diet are involved with the reduction in dressing percent. Some more recent trials are investigating the impact of removing corn DDGS from the diet 4-6 weeks before marketing in an attempt to mitigate the impact on dressing percent. Thus, it is important that this be taken into account when calculating the net return to using DDGS and in the decision whether to use DDGS. As a lot of the feeding trials were conducted using corn DDGS sourced from different ethanol plants with some major differences, corn source, old vs. new plant (technology), drying process, etc. many of the feeding trials come up with different feeding recommendations.

For the most part if the corn DDGS source is purchased from a plant which is taking due care sourcing good quality grain, have a controlled drying process of the DDGS, where regular nutrient analysis and mycotoxin screening is being conducted the following are suggested feeding levels: Late nursery 10-15%, grower and finisher 20%, dry sow 20-25%, and nurse sow 10-15%. Because of the severe negative long term impact mycotoxins can have on sow reproductive performance it is recommended that regular screening for mycotoxins of DDGS be conducted to ensure mycotoxins are absent or at very low levels. It is very important that producers choose carefully when sourcing DDGS as quality varies from plant to plant. In addition if you are purchasing DDGS through a broker that you know the plant where the DDGS is being sourced from and the broker is clear that he needs to receive approval from you or your nutritionist to change source.

There is not a lot of research information here in Canada on feeding wheat DDGS to swine. Some of the initial studies have been conducted using wheat DDGS with reduced protein quality and suggest that increasing levels of wheat DDGS may reduce feed intake and growth performance (Thacker, 2006). For some of these trials diets were not formulated on a NE and digestible amino acid basis, which may have contributed to the reduced growth performance. Contrary to this research from the Netherlands (Cited by Zijlstra, 2007; Smits, 2007, personnel communication) with diets formulated on a NE and digestible amino acid basis using high quality wheat DDGS found that they can include up to 15% in the diet with no impact on performance. We expect that wheat DDGS sourced from new generation ethanol plants which have taken due care in sourcing good quality wheat, and have a controlled drying process for the DDGS will produce a good quality DDGS. However, it will be important to characterize the quality of the source before using.

Table 4. Effect of feeding increasing levels of corn DDGS on grow-finish performance in a commercial facility.

	Corn DDGS, %							P <	
Item	0	5	10	15	20	25	SED	Linear	Quad.
Pig weight kg, day									
0	36.9	37.0	37.0	36.9	36.9	36.8	0.15	0.35	0.19
53	87.6[a]	89.8[b]	89.0[b]	88.9[b]	90.1[b]	89.6[b]	0.60	0.01	0.15
Day 0 to 53									
ADG, kg/d	0.936[a]	0.975[b]	0.964[b]	0.958[ab]	0.972[b]	0.967[b]	0.0118	0.05	0.14
ADFI, kg/d	2.33	2.41	2.36	2.29	2.38	2.31	0.029	0.12	0.48
F:G	2.49[a]	2.47[a]	2.45[a]	2.39[b]	2.45[a]	2.39[b]	0.026	0.01	0.16
Carcass wt, kg	87.7	89.2	88.7	89.4	89.1	88.7	0.67	0.19	0.05
Backfat, mm	19.9	20.5	20.2	19.8	20.4	20.3	0.36	0.68	0.92
Loin depth, mm	64.6	63.9	63.3	63.7	63.8	63.3	0.67	0.11	0.45
Lean, %	60.2	60.0	60.1	60.2	60.0	60.0	0.21	0.56	0.94
Index	1.111	1.106	1.108	1.111	1.107	1.107	0.0040	0.55	0.96

[a,b,c,d] Means with different superscript letter differ (P < 0.05).

Additional Considerations

As DDGS is a relatively new ingredient we are rapidly learning about sourcing and handling it. Disruptions to supply have been a concern with DDGS sourced from the US as rail companies get setup to handle larger quantities of this product. Due to the high fat content of the corn DDGS and fineness of grind flow ability problems of the DDGS and feed containing high inclusion levels have been a concern from feed bins and in feeders. Modifications may be required in storage and delivery systems to be able to handle the product. Due to the higher fiber content of the DDGS compared with corn and soybean meal, for each 10% DDGS that that is included in the diet, the volume of the diet will increase by approximately 3% compared with a corn soybean meal diet. The fat in corn DDGS has a relatively high concentration of unsaturated fatty acids, which may cause increased belly softness of pigs fed diets containing DDGS at higher inclusion levels > 20% (Whitney et al., 2006). However, this may not be a concern with all packers.

Screening for mycotoxins in corn used for ethanol and corn DDGS produced varies from frequent to minimal testing. It is very important that you determine the level of testing being done where your DDGS source is coming from as mycotoxins present in corn will be elevated 3 times in corn DDGS. As corn DDGS contains 9-12% fat and when replacing corn and soybean meal (4 and 3% fat) in the diet the total fat content of the diet increases 1.5-2% when included at 20-30% of the diet. Practical experience from feed mills suggests that pellet durability index (PDI) will be negatively effected with increasing levels of corn DDGS in the diet. However, there is a lack of research data to back up these experiences.

CLOSING COMMENTS

With the continued expected growth of the ethanol industry in North America and the resulting availability of corn and wheat DDGS there will be increased availability for and use of DDGS in swine diets. However, considering the variation in nutrient content it is extremely important you get informed as much as possible about the source of DDGS to be purchased or being used as all sources are not equal. It is recommended that proper quality control guidelines (minimum specification, nutrient analysis, mycotoxins screening, etc) be put in place and be conducted on a regular basis to allow diets be adjusted as needed to avoid risking animal performance.

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